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Image transmission with OFDM using Low-complexity PTS with DCT

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Abstract - *Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier communication system. The feature of High data rate, Bandwidth efficiency, and immune to fading makes the OFDM systems preferred choice for modern communication system. However, this faces Peak-to-Average Power Ratio (PAPR) problem which is a major drawback. High PAPR in multicarrier transmission system degrades the performance of power amplifier. PTS is one of best technique available for PAPR reduction. But the computational complexity is high in PTS technique. In this paper, to overcome the problem of high PAPR as well as for lower complexity Interleaved partition Partial transmit sequence (PTS) technique with Discrete Cosine Transform (DCT) is proposed. Interleave partitioning reduces the computational complexity of system and use of DCT helps in enhancing the PAPR reduction ability of proposed system. Result of simulation shows that PAPR reduction capability of proposed scheme is better than conventional PTS scheme and complexity of system is also reduced.)*

***Key Words*: OFDM, PTS, DCT, PAPR.**

1. INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) technology is one of the best suited candidates for fourth generation wireless communication. OFDM technology is based on the concept of Frequency division multiplexing along with the multicarrier principle. It effectively combats the multipath fading channel and improves bandwidth efficiency. At the same time, OFDM also will increase system capacity to give a reliable transmission.

The basic principle of OFDM is to divide a high-rate data stream into variety of lower-rate streams that are transmitted at the same time over variety of subcarriers. These subcarriers are overlapped hence utilizes the available bandwidth efficiently. OFDM has mainly two problems that are: Inter symbol Interference (ISI) and high PAPR. ISI can be managed by applying guard band into each OFDM symbol. Large peak-to-average power ratio distorts the signal if the transmitter contains nonlinear parts like power amplifiers (PAs). In band and Out band distortion are caused due to high PAPR that reduces the efficiency of amplifiers. Therefore, reducing the PAPR is of practical interest. Several PAPR reduction strategies are proposed. Some strategies are designed supported using redundancy, like coding, selective mapping with explicit or implicit side information or tone reservation. an apparent result of using redundancy for PAPR reduction is the reduced transmission rate. PAPR reduction might also be achieved by using extended signal constellation, like tone injection, or multi-amplitude CPM. The associated disadvantage is that the increased power and implementation complexity. a simple PAPR reduction technique can be achieved by clipping the time-domain OFDM signal.

The organisation of the paper is as follows problem associated with OFDM is given in section 2, section 3 gives information about methods that are being used in proposed method. Section 4 gives details about the proposed methodology. Section 5 contains simulation and result. Section 6 concludes the paper.

2. BASICS OF OFDM AND PAPR

The basic idea of OFDM is to divide the high data rate d data stream into N parallel data stream with reduced data rate of d/N. Then modulate and demodulate each data stream with orthogonal subcarriers using IFFT and FFT at transmitter and receiver respectively.

In discrete time, complex OFDM signal x[n] can be represented as

$$x[n] = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} x_k e^{\frac{j2\pi kn}{N}} \qquad n= 1,2,3,....N-1 \qquad (1)$$

Where N is number of subcarriers, X_k is k^{th} modulated data in frequency domain.

PAPR is defined as the ratio of the maximum peak power and average power for the same OFDM signal:

$$PAPR(dB) = 10\log_{10} \frac{\max\{|Xn|^2\}}{\mathrm{Av}\{|Xn|^2\}} \qquad (2)$$

2. PROBLEM DEFINITION

Orthogonal Frequency Division Multiplexing (OFDM) faces the Peak-to-Average Power ratio (PAPR) drawback that's a serious drawback of multicarrier transmission system that results in power inefficiency of system.

PAPR is the main problem of the application of this technology that means radio frequency power amplifier of the system must have a wide linear range to avoid transmission signal spectrum spreading and non-linear distortion resulting in higher cost and higher power, as well as greater difficulty of realization.

The larger PAPR would cause the severe degradation of bit error rate (BER) performance due to the intermodulation noise occurring in the non-linear amplifier

3. METHODS USED IN PROPOSED METHODOLOGY

There are two methods that are used for transmission of an Image over OFDM system with reduced PAPR. Details of these methods are given below:

3.1 Discrete Cosine Transform (DCT)

DCT has widely used for the information compression. The signal decomposition based on DCT algorithms has four essential steps: dividing a signal into N sub-parts; DCT computation for every block; Thresholding & Quantization of the DCT coefficients; and encoding of the quantized DCT coefficients discrete cosine transform is defined as

$$X(n) = \left(\frac{1}{N}\right)^{\frac{1}{2}} \sum_{i=0}^{N-1} x(i) \cos\left[\frac{\pi n}{2N}(2i+1)\right] \quad (3)$$

While the inverse IDCT is defined as:

$$x(i) = \left(\frac{1}{N}\right)^{\frac{1}{2}} \sum_{n=0}^{N-1} X(n) \cos\left[\frac{\pi i}{N}(2n+1)\right] \quad (4)$$

DCT provides the decomposed coefficient of the original signal and it provides the more weight to low-pass coefficients to high-pass coefficients.

3.2 Partial Transmit Sequence (PTS)

In CPTS, the input symbol sequence in the frequency domain is firstly partitioned into several subblock sequences by employing the corresponding subblock partition methods, where only a part of subcarrier signals exist and the other ones are padded by zeros. Let X and V be the input symbol sequence and the number of subblock sequences respectively.

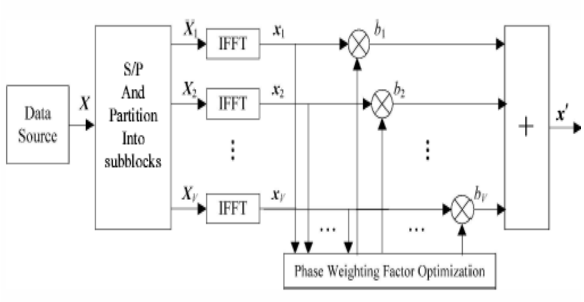

Fig- 1: Block diagram of Partial Transmit Sequence

After the subblock partition is completed, the input sequence can be expressed by

$$X = \sum_{i=1}^{v} Xi \quad (5)$$

where X; denotes the ith subblock sequence.

For each subblock, a phase weighting factor is adopted for weighting it. Then, by employing TFFT operation, the candidate sequence x' can be obtained, given by

$$x' = IFFT\{\sum_{i=1}^{V} biXi\} = \sum_{i=1}^{V} bi \cdot IFFT\{Xi\} = \sum_{i=1}^{V} bixi \quad (6)$$

where b; denotes the phase weighting factor for ith sub block sequence and X; represents the i[th] sub block sequence in the time domain.

Finally, among all the candidate sequences, the one with the lowest PAPR is chosen for transmitted. The block diagram of CPTS scheme is shown in Figure 1.

At the receiver, in order to recover the original data sequence successfully, the side information must be required. Assume there are Wallowed phase weighting factors in CPTS.

3.3 Segmentation or Partitioning Methods

There are three types of segmentation methods-

a) Adjacent segmentation
b) Interleaved segmentation
c) Pseudo-random segmentation

3.3.a Adjacent segmentation

Adjacent partition is one of attractive technique for PAPR reduction of OFDM signal. Adjacent partition has better PAPR reduction capability than interleaved partition when both are used in PTS. But adjacent partitioning is less efficient than pseudo-random partitioning. Adjacent partitioning can be easily understood by figure 2. In adjacent partitioning fixed number of samples of sub block are taken one after one and rest sample are taken zero/ null. In terms of complexity of partitioning adjacent partitioning is in between the pseudo-random and interleaved partition.

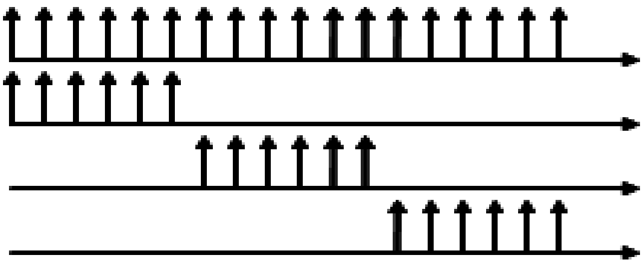

Fig- 2: Adjacent Partitioning

3.3.b Interleaved segmentation

Interleaved partition is one of the simplest partition techniques that reduce PAPR efficiently. In interleaved partition one sample after fixed gap or providing fixed zeros are taken. Interleaved partition less efficient in PAPR reduction than pseudo-random and adjacent partitioning used in PTS algorithm. Figure 3 shows interleaved partitioning. It has lowest computational complexity among all three partitioning technique.

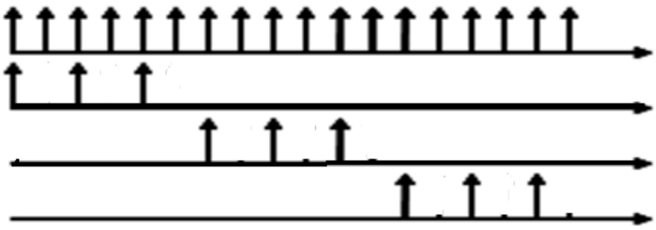

Fig- 3: Interleave Partitioning

3.3.c Pseudo-random segmentation

Partial transmit sequence with pseudo-random partition achieve lowest PAPR. But this partitioning technique is complex than other two partition technique. Figure 4 shows how pseudo-random partitioning is done of sub blocks. In this partitioning samples are chosen in random manner.

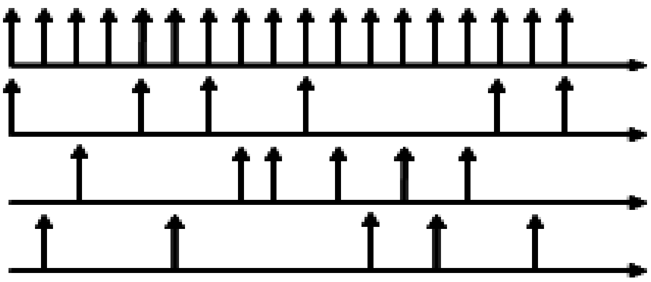

Fig- 4: Pseudo-random Partitioning

Any of above explained partition technique can be used in PTS method for increase its PAPR reduction ability and also for lesser computational complexity.

4. PROPOSED METHODOLOGY

For transmission of an image over OFDM system we proposed low complexity PTS with DCT. To lower the complexity of PTS interleaving partitioning is used. In proposed method, an image to be transmitted is taken and converted into binary form. This binary data is applied to multicarrier system for OFDM generation. DCT is applied to this OFDM signal and this transformed signal is applied to PTS system where we have three options for segmentation. Interleaved segmentation is used because this segmentation is less complex than other segmentation techniques like Adjacent and Pseudo- random segmentation. Output of this segmented PTS is then transmitted through AWGN channel.

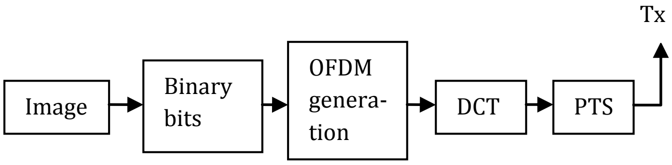

Fig- 5: Block diagram of Transmitter

Figure 5 represent the block diagram of transmitter. At receiver section exact reverse of transmitter is done to recover the transmitted image.

5. SIMULATION RESULTS

The proposed work has been implemented using MATLAB R2012a. Performance of proposed method is evaluated by the CCDF vs. PAPR (dB) graph. Figure 6 illustrate the CCDF vs. PAPR graph. This graph represents the comparison between conventional PTS, PTS with DCT, PTS with Interleaved segmentation and Interleaved PTS with DCT. From comparison it is found that proposed scheme has better PAPR reduction capability.

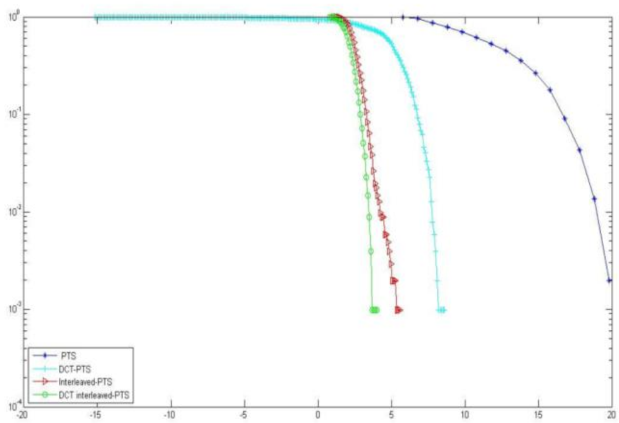

Fig- 6: CCDF vs. PAPR of proposed method compared with other PTS techniques

Fig- 7: Transmitted image and Received image

Conventional PTS has 19.89dB, PTS with DCT has PAPR of 8.25dB, Interleaved PTS has PAPR of 6.12dB and Interleaved PTS with DCT has PAPR value of 4.65dB which is better PAPR than other techniques above discussed. Figure 7 represents the Transmitted image and Received image.

6. CONCLUSION

High peak-to-average power ratio is a challenging issue in Orthogonal Frequency Division Multiplexing. It is observed that PTS is one the best technique but the computational complexity is more [6]. To reduce this complexity and increase PAPR reduction ability segmented PTS with DCT was proposed in this paper. Interleaved segmentation is used as it has lower complexity than Adjacent and Pseudo-random segmentation. By simulation it is observed that complexity of system is reduced to some extent and PAPR reduction ability is also efficiently increased.

REFERENCES

[1] Prasanta Kumar Pradhan, Satyendra Singh Yadav & Sarat Kumar Patra, "PAPR Reduction in OFDM systems," Annual IEEE India Conference (INDICON), 2014

[2] Chen Hong, Qin Qin & Tang Chao, "An PTS Optimization Algorithm for PAPR Reduction of OFDM System," IEEE Transactions on Mechatronic Sciences, Electric Engineering and Computer (MEC), pp. 3775-3778, December 2013

[3] Jaturong Sarawong, Tanairat Mata, Pisit Boonsrimuang and Rideo KobayashI, "Interleaved Partitioning PTS with New Phase Factors for PAPR Reduction in OFDM Systems," IEEE Conference on Mechatronic Electrical Engineering Electronics, Computer, Telecommunications and Information Technology (ECTI) Association of Thailand, pp. 361-364, 2011.

[4] E.Kalaiselvan, P.Elavarasan and G.Nagarajan, "PAPR Reduction of OFDM Signals using Pseudo Random PTS without Side Information," IEEE International conference on Communication and Signal Processing, pp. 29-33, April 3-5, 2013

[5] Zihan Wang, Jiang Zhu and Kai Gao, "Proposal of PAPR reduction method for OFDM signal by optimized PTS combined with INTERLEAVING method," IEEE Conference on ChinaSIP, pp. 943-947, 2015.

[6] V.Vinayaka, P.Elavarasan and G.Nagarajan, "Reduction of PAPR in OFDM signals using Fountain coded PTS," IEEE International conference on Communication and Signal Processing, pp. 120-124, April 2013.

[7] Abolfazl Ghassemi and T. Aaron Gulliver, "PAPR Reduction of OFDM Using PTS and Error Correcting Code Subblocking," IEEE Transactions on wireless communications, vol. 9, no. 3, pp. 980-989, March 2010.

[8] Sulaiman A. A., Ehab F. B., Mohamed Darwish A. E., "Linear Companding Transform for the Reduction of Peak-to-Average Power Ratio of OFDM Signals", IEEE Transaction Broadcasting, Vol. 55, No. 1, pp. 195-200, March 2009.

[9] Jiang T., Wu Y., "An Overview: Peak-to-average power ratio reduction techniques for OFDM signals", IEEE Trans. Broadcasting, vol. 54, No. 2, pp. 257–268, Jun. 2008.

[10] Le Goff S. Y.,.Al-Samahi S.S, Boon K. K., Tsimenidis C. C., Sharif B. S., "Selected Mapping without Side Information for PAPR reduction in OFDM", IEEE Transaction on Wireless Communications, Vol. 8, No. 7, pp. 3320–3325, July 2009.

[11] C. Pradabpet, K. Dejhan "A new PAPR reduction in OFDM systems using PTS combined with APPR for TWTA nonlinear HPA" Songklanakarin J. Sci. Technol. 30 (3), 355-360, May - Jun. 2008.

[12] Sujay.S.N. and Mamatha.M,"An Efficient PAPR Reduction Method for LTE OFDM Systems," IJAREEIE, vol. 3, issue 7, July 2014, pp. 10588-10595.