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PERFORMANCE ANALYSIS OF PARTIAL RANSMIT SEQUENCE USING FOR PAPR REDUCTION IN OFDM SYSTEMS

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ABSTRACT

Wireless Broadband services heavily rely on Orthogonal Frequency Division Multiplexing (OFDM) technique. OFDM has several advantages which makes it suitable for high speed data communications. One of the major drawback of OFDM is its high peak-to- average power ratio (PAPR). There are several methods to overcome this drawback. Partial Transmit Sequence (PTS) is one of them. In this paper, a modified version of the iterative flipping algorithm has been proposed i.e. modified flipping PTS (M-PTS) , which reduces the performance gap between the iterative flipping algorithm (I-PTS) and the conventional PTS technique. In the proposed algorithm, performance analysis has been done with considering performance/ complexity trade-off.

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) system has several desirable advantages such as high spectral efficiency, less sensitivity to sample timing offsets, robustness with respect to multi-path fading, high immunity to inter-symbol interference and ability to cope up with frequency selective fading of wideband communication with tolerable complexity. These factors makes OFDM fit for incorporating in various wireless technologies like Digital Video Broadcasting(DVB-T), wireless LAN, WiMAX, smart grid system, Long Term Evolution (LTE) etc[1]. OFDM has several disadvantages too .It has noise like amplitude, with a very large dynamic range and it is more sensitive to carrier frequency offset and drift as compared to single carrier systems. Due to that, it suffers from the problem of high Peak-to-Average- Power Ratio (PAPR), which reduces the efficiency of High Power Amplifier (HPA) at transmitter end. PAPR forces the HPA to operate beyond its optimum linear range, which results nonlinear distortion in the transmitted signal. PAPR can be reduced by several methods like Companding, Coding, Inter- leaving, Selective Mapping (SLM), Partial Transmit Sequence (PTS), Active Constellation Extension, Tone Reservation and Tone Injection etc. [2] PAPR reduction techniques can be classified into two category: (i) which reduce PAPR before modulation and (ii) that reduces PAPR after modulation. Partial Transmit Sequence (PTS) falls under later category. PTS is considered to be a very efficient technique in reducing PAPR but at high complexities.

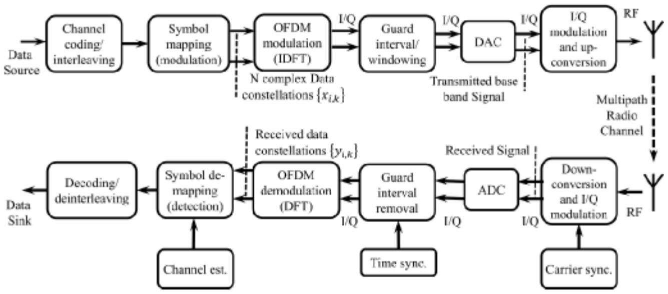

Fig 1. The block diagram of OFDM system

This paper analyzes the complexity factor in Partial Transmit Sequence (PTS) and presents an efficient algorithm which reduces complexities and increases efficiency of the OFDM system. The paper provides performance analysis for PAPR reduction in OFDM system using M-Flipping algorithm.

II. DEFINITION OF OFDM SIGNALS AND PAPR

OFDM is a multi-carrier modulation technique, a block of N data symbols $\{X_n, n=0,1,\dots,N-1\}$ that forms one OFDM signal, is transmitted. Figure 1 shows the block diagram of OFDM signal. Basically the bit stream is divided into several orthogonal sub-carriers, each modulated at a low rate [3]. Each OFDM signal modulates a different sub-carrier from set $\{f_n, n = 0,1,\dots, N - 1\}$. The N sub-carriers are orthogonal i.e. $f_n = n\Delta f$, where $\Delta f = 1$ NT and T is the symbol period.

III. PARTIAL TRANSMIT SEQUENCE

In classical Partial Transmit Sequence (PTS) technique, the whole data Block is partitioned X into M disjoint sub-blocks as $X = [X0, X1,\dots, XN-1]^T$ and then calculating individual IFFT's as

$$x_m = [xm,0,xm,1,\dots,xm,N-1]\ T \quad (4)$$

where m = 1,2.. M.

The phase rotation vectors b1, b2,...,bM are multiplied with the above generated disjoint subsets. This I is the stage, where phase optimization techniques are employed to lower the PAPR of the signal. After this, only the sets which have optimal phase vectors with lowest PAPR are transmitted. PTS technique involves selection of OFDM signal with lesser PAPR sets, results more complex in nature. So, the transmitter needs to track the information of the sent data blocks. There are three kinds of sub-block partitioning scheme: adjacent, interleaved and pseudo-random partitioning. The input signal (candidate signal) is the sum of the products of phase rotation vector and corresponding sub-block.

The main issue with PTS technique is its complexity because it requires an exhaustive search over all the combinations of allowed phase factors [5],and due to this, the complexity increases exponentially with respective the number of sub- blocks. Sub-block partitioning also affects the PAPR reduction performance in PTS. The PTS technique works with an arbitrary number of sub-carriers and any modulation scheme.

The simulation result in Figure 3, shows CCDF vs PAPR performance curve of Partial Transmit Sequence (PTS) with 256 sub-carriers for QPSK modulation. For 1 disjoint subsets (i.e. M=1), the PAPR is calculated around 10.9 db at CCDF of 10^{-3}, for 2 disjoint subsets (i.e. M=2), PAPR observed is approximately 9.8 db at CCDF of 10^{-3} and for 4 disjoint subsets (i.e. M=4), the calculated PAPR is approximately 7.8 db at CCDF of 10^{-3}. Similarly, for 16 disjoint subsets (i.e. M=16), PAPR) is 7.6 db at CCDF of 10^{-3}. From the above simulation results it can be deduced that, for more number of subsets the PAPR is less. Alternatively, PAPR reduction capability increases with increasing number of sub-carriers [6].

IV. PAPR ANALYSIS USING MODIFIED FLIPPING ALGORITHM

A suboptimal technique for PAPR reduction called modified iterative flipping (M-Flipping) algorithm has been proposed in this section, which offer better performance than other techniques like iterative flipping technique (I-PTS) and OFDM, which we have discussed in this paper. Among various PAPR reduction techniques for OFDM signals as mentioned in literature, the PTS is very promising since it does not gives rise to any kind of signal distortion. But becasue of its high complexity, it is very much difficult to use it in a practical system. Cimini and Sollenberger [7] proposed an iterative flipping algorithm (I-Flipping), in which complexity issue of the PTS technique has been discussed and resolved. Following steps are involved in sub-optimal scheme called I-Flipping algorithm:

1) The input data S will be partitioned into M disjoint sub-blocks as we do in the PTS scheme.
2) In each sub-block, LN-point IDFT is applied and results that M PTSs will be generated.
3) Set b_l = 1 for all l and we will add the M-PTSs together and PAPR will be calculated.
4) Set b1 = -1 and then PAPR will be computed again. If the calculated PAPR is smaller than that in the previous step, b1 = -1 should be retained; otherwise, b1 will be reverted back. This operation is called ”flipping”. The algorithm will be repeated till all M bits have been explored. Computational complexity has been significantly reduces after applying I-Flipping algorithm. The iteration number C is reduced to the number of sub-blocks, *i.e.*C = M.

A. Proposed Modified Flipping Algorithm technique

A varient of iterative flipping algorithm for PAPR reduction in OFDM systems has been discussed in [8]. Even though the I-Flipping algorithm greatly reduces the complexity of the PTS, but some performance gap still present between the ordinary PTS and the I-flipping algorithm. The M- Flipping technique partitions the formed PTSs into even and odd number of groups and then "flipping" operation will be applied in to group by group. Assume that D1 denote a group including four PTSs of odd numbers and D2 a group including four PTSs of even numbers, for M = 8 sub-blocks. Two groups of four PTSs are formed after performing IDFT operations . For partitioning of PTSs, adjacent partition scheme has been used. After that the best combination of phase sequence will be selected according to the input data which gives the values of minimum PAPR. Following steps are involved in the proposed M-Flipping algorithm.

1) The input data S will be partitioned into M disjoint sub-blocks as we do in the PTS scheme.
2) In each sub-block, LN-point IDFT is applied and results that M PTSs will be generated.
3) Set b_l= 1 for all l and PAPR will be calculated after adding the PTSs together.
4) Arrange the PTSs in to descending order.
5) All M disjoint sub-blocks will be partitioned into two groups where each group includes four PTSs.
6) First group Q1 consist of PTS1, PTS3, PTS5, PTS7 and second group Q2 consist of PTS2,PTS4,PTS6, PTS8. Multiply Q2 with -1.
7) Take x1 as summation of all 4 PTSs of group Q1, and x2 as summation of all 4 PTSs of group Q2.
8) Finally, add x1 and x2 and take minimum value of PAPR.

For further reduction in the computational complexity a PAPR threshold parameter can be used too. It means that if the PAPR drops below the given threshold, the proposed M- Flipping algorithm will be terminated . The receiver should having the information and data about the sequence and phase factor, which were used to generate the signal. So that original data can be recovered and the used sequence with phase factor can be transmitted as side information in OFDM system.

V. SIMULATION RESULT

In this section, simulation results has been shown to represent the performance of the proposed method i.e. M-PTS with OFDM, PTS and I-PTS techniques. Following parameters have been considered for simulation purpose using MATLAB software: Various simulations have been conducted for evaluating the performance of M-Flipping technique. For calculation of CCDF of the PAPR, 10,000 QPSK modulated OFDM symbol are randomly generated. Oversampling factor L = 4 has been taken for the signals to better approximate the value of continuous-time PAPR. The sub-carriers are divided into M=8 subblocks with continuous subcarriers. The phase vector W is chosen as $\{1, -1\}$. We used the adjacent partition method throughout the simulations.

VI. CONCLUSION

In this paper, a new algorithm M-flipping has been proposed for PAPR reduction in OFDM system and compared with original OFDM, PTS and I-Flipping schemes. From the simulation result it can be seen that proposed M-Flipping scheme offer optimum PAPR reduction with reduced complexity. To further evaluate their PAPR reduction performance for various sub-carriers, we compare the proposed M-Flipping, I-Flipping and PTS with the original OFDM scheme. It can be seen that the proposed scheme offers better PAPR reduction with performance/ complexity trade-off as compared to other techniques. Further research work can be extended to reduce the PAPR as well as computational complexity with variations in sub-blocks, iterations, samples etc. Efficient PAPR reduction scheme is one which reduces the PAPR to minimum without affecting much to the performance and also with low implementation cost and should be key to future wireless high speed communication systems.

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