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PAPR Reduction of OFDM Using Companding of Selective Mapping and Partial Transmit Sequence

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***Abstract*— In recent years orthogonal frequency division multiplexing (OFDM) has gained a lot of involvement in diverse digital communication applications. It is a new ensuring transmission scheme for broadband communications over a wireless channel. In OFDM data is transmitted simultaneously through multiple frequency bands. It offers many advantages over single frequency transmission such as high spectral efficiency, unrefined to channel fading and the capability to handle frequency-selective fading without resorting to complex channel equalization schemes. Despite the fact that OFDM has a number of advantages, one of the major drawbacks of OFDM signal is its large envelope fluctuation, likely resulting in large peak-to-average power ratio (PAPR). These degradations would seriously affect the performance of OFDM systems. The PAPR reduction scheme changes the formation of the OFDM signals with high PAPR before multicarrier modulation, e.g. coding, partial transmit sequence (PTS) and selective mapping (SLM). With PTS and SLM companding we can get better PAPR by modifying the OFDM without distortion**

Key Words -OFDM; RS-SLM; PTS; PAPR; IFFT

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing is a special form of multicarrier modulation which is particularly suited for transmission over a dispersive channel. Here the different carriers are orthogonal to each other so that they all are totally independent of one another. This is done by placing the carrier exactly at the nulls in the modulation spectra of each other. In other words, when the OFDM signal with high PAPR passes through non-linear device, (for example power amplifier working in the saturation region); the signal will suffer significant nonlinear distortion.

This non-linear distortion will result in in-band distortion and out-of-band radiation. Because of in-band distortion system performance degradation results and due to out-of-band radiation adjacent channel interference (ACI) results that affects working of the neighbour bands systems. To lessen the signal distortion, it requires a linear power amplifier with large dynamic range. However, this linear power amplifier has poor efficiency and is so expensive.

The PAPR reduction scheme changes the formation of the OFDM signals with high PAPR before multicarrier modulation, e.g. coding, and selective mapping (SLM). The researches reduce the computational complexity for the SLM scheme. In SLM we can get better PAPR by modifying the OFDM without distortion.

II. BACKGROUND OF PAPR

The PAPR of OFDM is defined as the ratio between the maximum power and the average power, The PAPR of the OFDM signal X(t) is defined as

$$\mathrm{PAPR} = \frac{P_{peak}}{P_{average}} = \frac{\max[|x_n|^2]}{E[|x_n|^2]} \qquad (1)$$

Where x_n = An OFDM signal after IFFT (Inverse Fast Fourier transform)

E[.] = Expectation operator, it is an average power. The complex baseband OFDM signal for N subcarriers represented as

$$X(t) = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} X_n e^{j2\pi n \Delta f t}, (0 \le t \le NT) \qquad (2)$$

III. PAPR PROBLEM &TECHNIQUE FOR REDUCTION

There have been many new approaches developed during the last few years. Several PAPR reduction techniques have been proposed in the literature. These techniques are divided into two groups, which are signal scrambling techniques and signal distortion techniques. The signal scrambling techniques are:

A. Amplitude Clipping And Filtering

In this approach, we can perform time-domain based clipping or frequency-domain based coding. The simplest approach for PAPR reduction is to deliberately clip the amplitude of the signal to a predefined value before amplification. However, there are several drawbacks of this approach, such as signal distortion and spectral re-growth. Hence simple clipping is not enough, we have to use coding techniques that are applied to OFDM signals in order to find the optimum threshold for every specific signal\. However, this technique works well only when the number of subcarriers is small, because at higher subcarriers, the clipping ratio is to be very low which will lead to more distortion.

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B. SELECTIVE MAPPING

This method is used for minimization of peak to average transmit power of multicarrier transmission system with selected mapping. A complete set of candidate signal is generated signifying the same information in selected mapping, and then concerning the most favourable signal is selected as consider to PAPR and transmitted. In the SLM, the input data structure is multiplied by random series and resultant series with the lowest PAPR is chosen for transmission. To allow the receiver to recover the original data to the multiplying sequence can be sent as 'side information'.

Let us define data stream after serial to parallel conversion as $X=[X_0, X_1........, X_{N-1}]^T$. Initially each input $X_n^{(u)}$ can be defined as equation:

$$x_n^{(u)} = x_n . b_n^{(u)} \quad (3)$$

$B^{(u)}$ can be written as $x_n^{(u)} = [x_0^{(u)}, x_1^{(u)}, ..., x_{N-2}^{(u)}]^T$

Where n = 0, 1, 2…… N-1 and (u=0, 1, 2......U) to make the U phase rotated OFDM data blocks. All U phase rotated OFDM data blocks represented the same information as the unmodified OFDM data block provided that the phase sequence is known.

When we applying the SLM technique, then the complex envelope of the transmitted OFDM signal becomes

$$x\,(t) = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} x_n e^{j2\pi n \Delta f t}, (0 \le t \le NT) \quad (4)$$

Where $\Delta f = \frac{1}{NT}$, and NT is the OFDM data block duration. Lowest PAPR output data is selected for transmission. Effect of PAPR reduction will be better when the copy block number U is increased. SLM method reduces PAPR effectively without any signal distortion.

C. PARTIAL TRANSMIT SEQUENCE

In the PTS technique, input data block X is partitioned in M disjoint sub-blocks $X_m = [X_{m,0}, X_{m,1}, ...X_{m,N-1}]^T, m = 1,2, , , , , , M$, such that $\sum_{m=1}^{M} X_m = X$ and the sub – blocks are combined to minimize the PAPR in the time domain. The L times oversampled time domain signalof $X_m, m = 1,2, , , , , , M$, is obtained by taking the IDFT of length NL on X_m concatenated with $(L - 1)N$ zeros. These are called the partial transmit sequences. Complex phase factors, $b_m = e^{j\emptyset m}, m = 1,2, , , , , , M$ are introduced to combine the PTSs. The set of phase factors is denoted a vector $b = [b_1, b_2, ... b_M]^T$. The time domain signal after combining is given by

$$x'(b) = \sum_{m=1}^{M} b_m . x_m \quad (5)$$

Where $x'(b) = [x'_0(b), x'_1(b), ... x'_{NL-1}(b)]^T$. The objective is to find the set of phase factors that minimizes the PAPR. Minimization of PAPR has the relation to the minimization of $max_{0 \le k \le NL-1} |x'_k(b)|$.

IV. PROPOSED PTS-SLM ALGORITHM

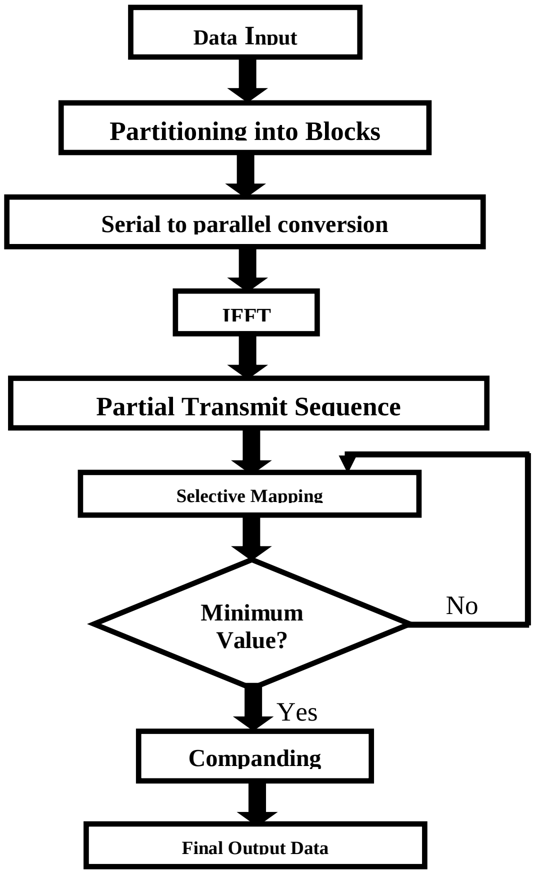

Figure 1: Flow diagram for proposed work

V. SIMULATION AND RESULT

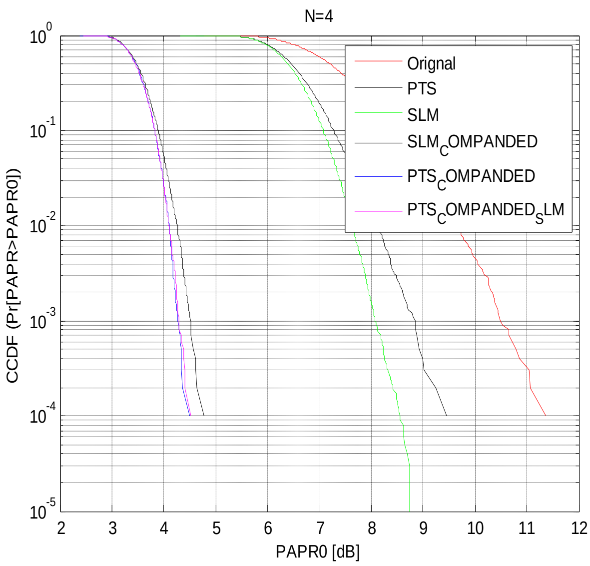

Figure 2: Comparison of different schemes (showing PAPR v/s CCDF)

VI. CONCLUSION

This article proposes an improved algorithm—PTS-SLM Companded which is based on SLM and PTS. Both the numerical analysis and the simulation results predict that the new algorithm is effective in reducing the PAPR of OFDM system. Though its PAPR performance is a little worse than the SLM scheme, this new algorithm can reduce complexity of OFDM system greatly.

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