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Performance Improvement of OFDM System by PAPR Reduction

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Abstract— **in this paper we propose a few approaches for peak-to-average power ratio (PAPR) reduction for a performance improvement of (OFDM) system. Although several PAPR reduction algorithms exist in the literature, they are often only effective for specific scenarios. In this paper various techniques is described for reducing the PAPR of OFDM signals like Selective mapping (SLM) and Companding methods.**

***Keywords*— Peak-to-average power ratio (PAPR), orthogonal frequency division multiplexing, (OFDM), Selective mapping (SLM), Companding.**

I. Introduction

ORTHOGONAL Frequency Division Multiplexing (OFDM) is a multicarrier transmission scheme that has become the technology of choice for next generation wireless and wired digital communication systems because of its high speed data rates, high spectral efficiency, high quality service and robustness against narrow band interference and frequency selective fading. On the other hand, one of the major drawbacks of OFDM signal is its large envelope fluctuation, likely resulting in large peak-to-average power ratio (PAPR) at the transmitter [1]. When the OFDM signals with high PAPR are transmitted through a nonlinear device, such as a high-power amplifier (HPA) or a digital-to-analog converter (DAC), a high peak signal generates out-of-band energy and in-band distortion. These degradations would seriously affect the performance of OFDM systems.

In order to reduce the PAPR of OFDM systems, methods [2]–[8] have been studied for a few years. The researches [4]–[6] reduce the computational complexity for the SLM scheme. The authors in [7] reduce the computational complexity for the PTS scheme. The researches [4]–[7] maintain the original BER of OFDM systems but require a large number of computational complexity and side information.

The μ–law companding scheme [8] is a common companding scheme. Then, the other companding scheme [9] utilizes a nonlinear operation to transform the original OFDM signals into the uniform distribution and efficiently reduce PAPR with a low Bit Error Rate (BER). Similarly, the exponential companding scheme [10] transforms the amplitude of the original OFDM signals into the uniform distribution. The referred uniformly distributed companding schemes [9], [10] can keep the same average power as that of the original signal and significantly outperform the μ–law companding scheme [8]. Furthermore, the piecewise nonlinear companding scheme [11] has been also proposed to compare with the exponential companding scheme [10], i.e. one uniformly distributed uniformly-distributed scheme [9]. Although the uniformly-distributed scheme [9] can offer the efficient PAPR reduction with low BER, it cannot fulfill the performance requirements for various systems.

II. Methods

Companding

In companding the OFDM signal is compressed at the transmitter and expanded at the receiver. Compression is performed according to the well known μ-Law viz.

$$y = V\frac{\log\left(1+\mu\frac{|x|}{V}\right)}{\log(1+\mu)}\operatorname{sgn}(x) \quad \ldots\ldots (1)$$

Where V is the peak amplitude of the signal, and x is the instantaneous amplitude of the input signal. Decompression is simply the inverse of (1). Compression improves the quantization resolution of small amplitude signals at the cost of lowering the resolution of large signals. This also introduces quantization noise; however, the effect of the quantization noise due to reduction in resolution of the peaks is relatively small as the peaks occur less

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frequently. The compression algorithm as described by amplifies the signals of lower amplitude with the peaks remaining unchanged.

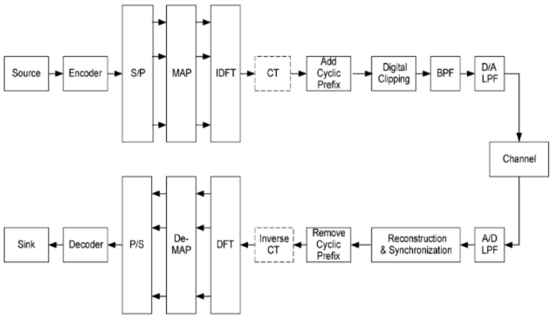

Figure1: Block diagram of a baseband OFDM system companding transform

Selective mapping (SLM)

In the SLM technique, the transmitter generates a set of sufficiently different candidate data blocks, all representing the same information as the original data block, and selects the most favourable for transmission. A block diagram of the SLM technique is shown in Figure 2. Each data block is multiplied by U different phase sequences, each of length N, $B^{(u)} = [bu,0, bu,1, \cdot \cdot\cdot, bu,N{-}1]^T$ $u = 1, 2, \cdot \cdot\cdot, U$, resulting in U modified data blocks. To include the unmodified data block in the set of modified data blocks, we set $B^{(1)}$ as the all-one vector of length N.

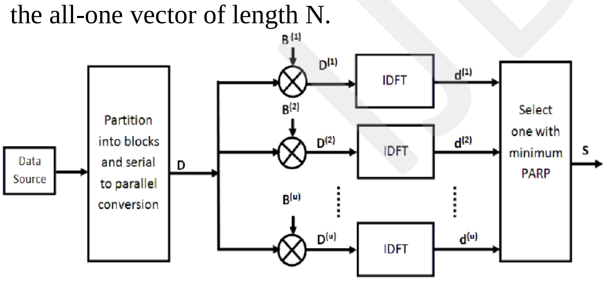

Figure 2: Block diagram of the SLM technique with U different signal Representation and phase weights to produce a minimized PAPR signal

Let us denote the modified data block for the u^{th} phase sequence

$$D^{(u)} = [D0b_{u,0}, D1b_{u,1}, \cdot \cdot\cdot, D_{N-1}b_{u,N-1}]^T$$

$u = 1, 2, \cdot \cdot\cdot, U$, after applying SLM to X, the multi-carrier signal becomes

$$d_k^{(u)} = \sum_{n=0}^{N-1} D_n . b_{u,n} . e^{j\frac{2\pi nk}{N}} \quad 0 \le k \le N -$$

Among the modified data blocks $D^{(u)}$, the one with the lowest PAPR is Selective for transmission. Information about the Selective phase sequence needs to be transmitted to the receiver as side information. At the receiver, the reverse operation is performed to recover the original data block.

III. SIMULATION & RESULTS

The simulation shows the PAPR reduction using cascading of Selective mapping and Companding technique.

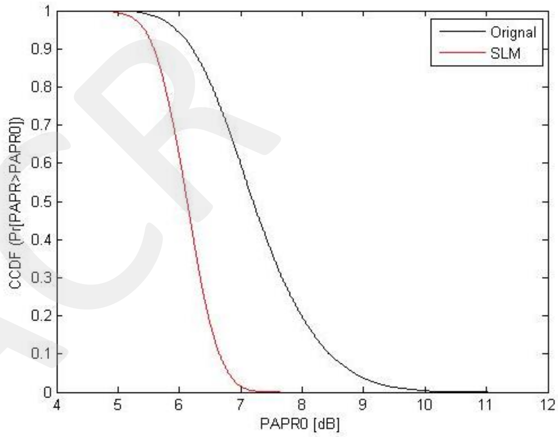

Figure3: Selective Mapping; for reduction in PAPR

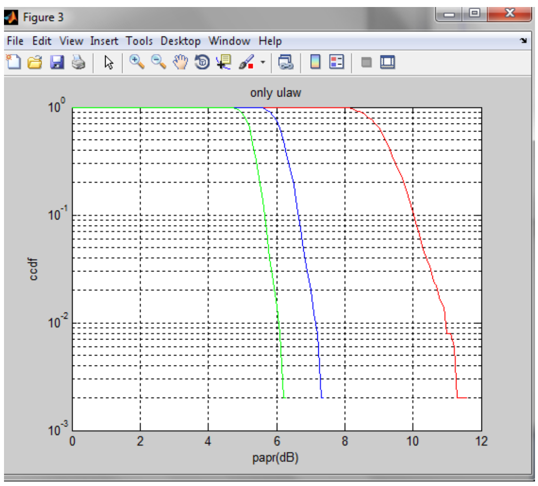

Figure3: Companding technique

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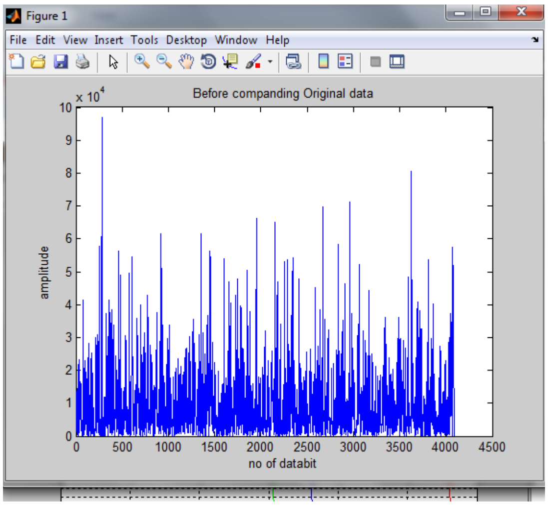

Figure 4: signal given to companding

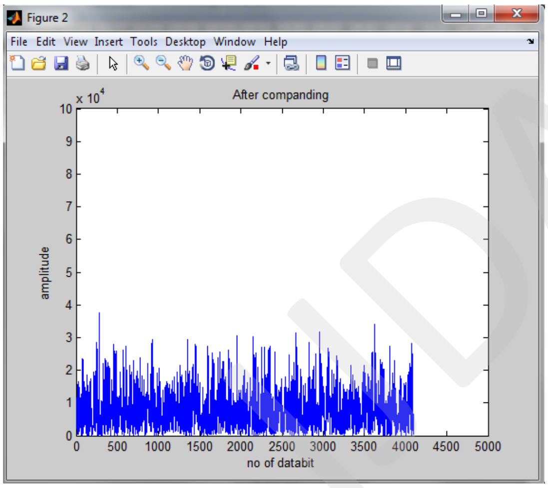

Figure 5: signal after companding

Figure 5 shows the signal with reduced peak-to-average power ratio.

IV. Conclusions

A new PAPR reduction scheme for OFDM systems is proposed in this project. Technique of reducing the PAPR of OFDM signals by Cascading of Selective and Companding methods has been presented. Simulation results has shown that the companded OFDM transmissions could overcome peak power problems, In general, these results have demonstrated that reduction in PAPR can be significant when companding is cascaded with Selective mapping technique.

Future research will concentrate on investigating and quantifying further the influence of PAPR as a function of different modulation mapping schemes, OFDM subcarrier levels, and companding PR levels and phasing schemes.

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