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Proportional presentation investigation of dissimilar intonation methods for ber and papr decline by firefly algorithm of OFDM signal

B.Biksam

Assistant Professor
Department of ECE
DVR &HS MIC College of Technology
Kanchikacherla,Andhra Pradesh, India

Abstract:

Orthogonal Frequency Division Multiplexing (OFDM) may be a digital transmission methodology developed to satisfy the increasing demand for higher information rates in communications which may be employed in each wired and wireless environments. However OFDM is significantly affected by peak-to-average-power ratio (PAPR). This paper describes the issue of the PAPR in OFDM which is a major drawback, and presents firefly algorithm used for optimizing companding technique to reduce it. The effect on system performance in terms of the Bit Error Rate (BER) is simulated for an OFDM transceiver with a saturated High Power Amplifier and the simulation results are compared with other techniques proposed in literature.

Keywords: BER, CCDF, Companding, Firefly Algorithm, HPA, OFDM, PAPR.

Introduction

As a pretty technology for wireless communications, Orthogonal Frequency Division Multiplexing (OFDM), which is one of multi-carrier modulation (MCM) techniques, offers a considerable high spectral efficiency, multipath delay spread tolerance. However, still some challenging issues remain unresolved in the design of the OFDM systems. One of the major problems is high Peak-to-Average Power Ratio (PAPR) of transmitted OFDM signals [2]-[3]. A large PAPR is a problem as it reduces the efficiency of the High Power Amplifier (HPA). If the high PAPR is allowed to saturate the HPA out of band radiation is produced affecting adjacent channels and degrading the Bit Error Rate (BER) at the receiver.

This paper emphasis mainly on the PAPR reduction of OFDM system using law Companding technique which is optimized using Firefly algorithm for maximum reduction in PAPR. Several techniques have been proposed to reduce PAPR and these can be classified as: Signal Scrambling and Signal Distortion. Scrambling category consists of different variations of codes used for scrambling to achieve PAPR reduction. The main drawback is that as number of carriers increases the associated overhead with search for best code increases exponentially. Amongst this category better techniques are selective mapping, partial transmit sequences and block coding [4]-[6]. The distortion category attempts to reduce PAPR by manipulation of signal before amplification. Clipping of signal prior to amplification is a simplest method but it causes increase in both out-of-bands (OOB) as well as in-band interference thus compromises upon performance of system. Amongst this category better techniques include companding [7], peak windowing, peak power suppression, peak cancellation, weighted multicarrier transmission etc. So improved Companding technique is proposed in this paper and simulation results obtained using MATLAB for PAPR reduction are compared with previously discussed techniques in literature. Also system performance is evaluated as BER v/s SNR results are simulated and the results are compared with other techniques.

The remaining of this paper is organized as follows: In Section II, PAPR and the complementary cumulative distribution function (CCDF) are introduced. The principle of companding technique and proposed firefly algorithm are described in Section III. In Section IV, the simulation results for proposed technique are presented and compared with conventional techniques. Conclusions are made in Section V.

2. Motivation for PAPR Reduction

A. Definition of PAPR and CCDF

An OFDM signal consists of a number of independently modulated SCs, which can give a large peak-to-average power ratio (PAPR) when added up coherently.

(1)

The probability that the PAPR of a data-block exceeds a given threshold PAPR0 is given by CCDF. If the CCDF graph is plotted against the threshold values, the more vertical the graph is, the better is the PAPR reduction performance. It is denoted by,

(2)

B. Nonlinear characteristics of HPA

Non linearities provide the greatest obstacle to OFDM as a practical system due to their distorting effect on the quality of the system. The RF amplifier must be driven as close as possible to the maximum signal in the linear region to make it efficient, however when operating near the saturation point. This distortion causes spectral regrowth in the transmitter which can adversely affect adjacent frequency bands, and an increased BER at the receiver. A balance must be met between allowable distortion and the linear region of an amplifier. It is thus necessary to aim at an influence economical operation of the non-linear HPA with low back-off values and take a look at to produce attainable solutions to the interference drawback caused. Hence, a much better answer is to undertake to stop the prevalence of such interference by reducing the PAPR of the transmitted signal with some manipulations of the OFDM signal itself.

(3)

Where η is the HPA efficiency.

That means the efficiency of HPA is inversely proportional to the PAPR. Therefore, in order to have high efficiency, it is extremely important to employ some scheme to reduce PAPR.

3. SYSTEM MODEL

Companding technique using Firefly Algorithm

The bottleneck of the OFDM system in terms of high PAPR is power amplifiers and AD/DA converters. High peaks of the OFDM signal usually exceed the maximum amplification level, which result in clipping of high peaks by the amplifier.
Output to the IFFT is given as follows

$$x(n) = \frac{1}{\sqrt{N}} \sum_{k=1}^{\frac{N}{2}-1} \left(a_k cos \frac{2\pi kn}{N} + b_k sin \frac{2\pi kn}{N} \right)$$
$$, n = 0,1,2 \ldots\ldots N-1. \qquad (4)$$

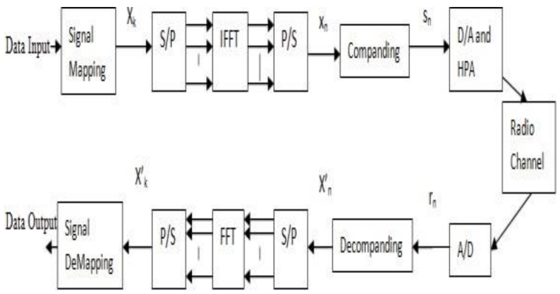

Figure 1: Block Diagram of OFDM System with Companding Technique

In the μ law companding, compressor squeezes the signal at the transmitter site according to the following formula:

$$s(n) = \frac{V sgn\,(x(n)) \ln\left[1+\mu\left|\frac{x(r}{V}\right.\right.}{\ln\,(1+\mu)} \quad (5)$$

Where μ is the μ -law compression parameter and V is normalization constant.

And at the receiver side μ law expander restores original signal by:

$$x(n) = \frac{V}{\mu}\left(e^{\frac{|s'_n|\ln(1+\mu)}{V}} - 1\right) sgn(s(n \quad (6)$$

The value of μ is optimized using firefly algorithm

[8]- [10].

We can idealize the flashing characteristics of fireflies so as to develop firefly-inspired algorithms.

In this paper, Objective function gives the papr value of the normal law companding technique. Initial Fireflies position is determined using the upper and lower bounds and the number of fireflies considered. Now these fireflies position are passed as input in the objective function which takes it as value of and calculates the papr at different values. These values determine the light intensity of fireflies and then the firefly with higher value of papr is moved towards the firefly having less value of papr. Finally they are ranked in descending order according to their papr value and the firefly position at which minimum papr is obtained is returned as the value of optimized value of .

Simulation Results

Table I illustrates the parameter name and value used for MATLAB simulation of the system model. Parameter description is given along with.

Table I: Parameter Settings For Simulation.

Parameter	Description	Value
N	No. of Subcarriers	64
Numfireflies	No. of fireflies in group	30
maxGen	Maximum no. of iterations	5
Alpha	Randomness	17
Beta	Attractiveness	1
Gamma	Absorption coefficient	0.2
delta	Randomness reduction	0.99

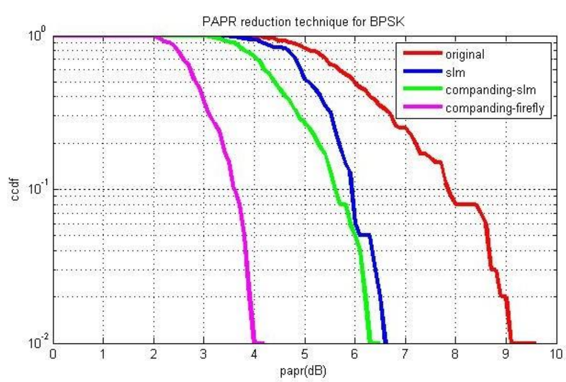

Figure 2. Distribution of PAPR for different PAPR reduction schemes for BPSK

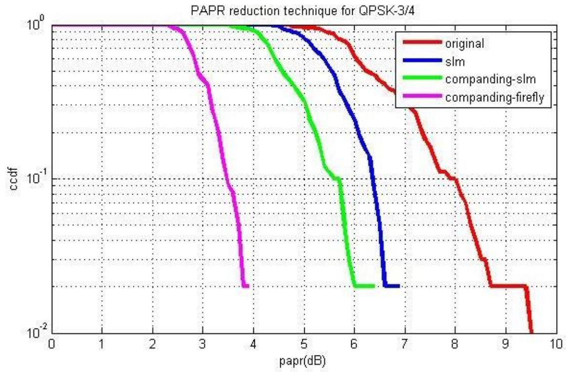

Figure 3. Distribution of PAPR for different PAPR reduction schemes for QPSK

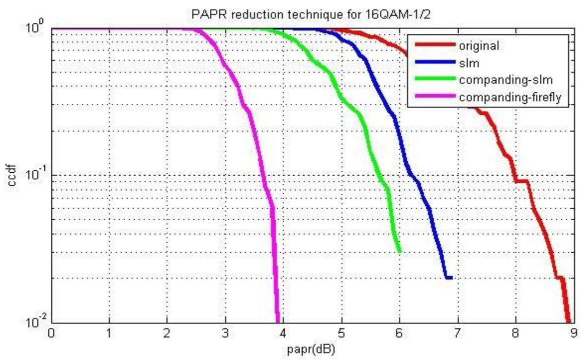

Figure 4. Distribution of PAPR for different PAPR reduction schemes for 16QAM

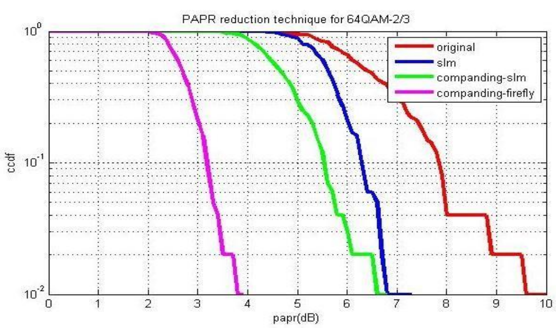

Figure 5. Distribution of PAPR for different PAPR reduction schemes for 64 QAM

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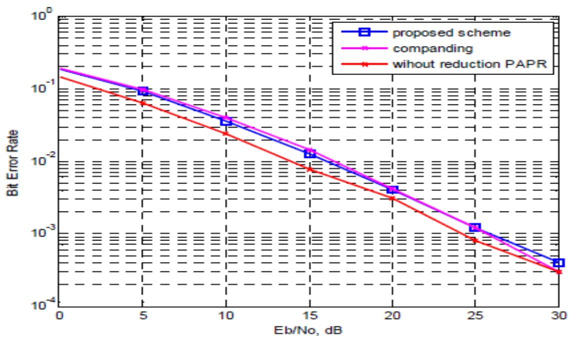

Figure 6. BER v/s SNR for different PAPR reduction techniques

The curves of the CCDF for random original OFDM symbols generated and the PAPR reduction scheme are shown in the above results. It is very clear that the Firefly optimized companding scheme reduce the PAPR significantly in OFDM system.

Figure.2-5 shows the CCDF performance of proposed scheme for the PAPR reduction for different modulation techniques. When, the CCDF is 10^{-2}, the PAPRs are 3.7 dB, 6.5 dB, 7 dB and 9.8 dB for the Firefly optimized companding, slm-companding, conventional SLM and original OFDM signals respectively for 64QAM modulation technique. Maximum PAPR reduction is obtained in this case.

Figure 6 shows the BER performances of OFDM system with proposed PAPR reduction scheme. As the value of is increased the BER of the system degrades. Here BER is only degraded by approximately 1 dB for firefly optimized system where as for companding technique using high values for reducing PAPR would degrade the system performance highly.

Conclusions

In this paper, performance of companding technique with value of optimized using Firefly algorithm is evaluated for PAPR reduction in OFDM system and the results are compared with the previously proposed techniques in literature. The simulation results reveal μ that proposed technique offers efficient PAPR reduction than the other conventional techniques. The performance of BER degrades as the value ofis increased and thus firefly algorithm searches for optimized value of that not only reduces the papr but also maintains the BER performance of system.Moreover Firefly algorithm has only three control parameters, so it is easy to be adjusted.

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