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PTS OFDM Scheme Based on ICA Algorithm for PAPR Reduction in Satellite Communication

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Abstract

Objectives: Using the imperialist competitive algorithm (ICA) for finding the optimal values of the phase in PTS method in order to Peak-to-average power ratio reduction. **Methods/Analysis:** In order to PAPR reduction we have used a numerical method to calculate the Bose–Einstein equations that appear in efficiency of solar cells. **Findings:** The proposed method reduces the PAPR more than other methods and also does not lead to an increase in BER. PAPR is reduced the amount of 3.97 dB that is equal to 34.75% of initial value of PAPR. Also by increasing the subcarrier amount of these reductions are increased but required to increasing in compute the increase and cost. Novelty of the Study: For the first time, imperialist competitive algorithm (ICA) is used for finding the optimal values of the phase in Partial Transmit Sequence (PTS) method. **Conclusion/Application:** One of the most important applications of the results of this study is the satellite communication system. Also, PAPR reduction will be reduced operating costs dramatically.

Keywords: ICA Algorithm, PAPR Reduction, PTS OFDM Scheme, Satellite Communication

1. Introduction

The rapid development of wireless communications and users need to send data at a higher bit rate and consequently, the need for more bandwidth, has guided us toward the use of Orthogonal Frequency Division Modulation (OFDM), due to the high resistance frequency selective channels. Imperialist Competitive Algorithm (ICA) is one of the most powerful evolutionary algorithms has been used extensively to solve different kinds of optimization problems. This method is based on socio-political process of imperialistic competition[1–3].

In OFDM system, when all sub-carriers have the same phase, power of the moment the signal can be very large and thus the maximum of OFDM signal is much greater than the average signal. This phenomenon is called the PAPR problem. PAPR is one of the major problems in OFDM systems and is considered of the characteristics of the multi sub-carrier signal[4]. High PAPR requires to additional Back-off to achieve linear amplification in the transmitter that is causing inefficient power consumption and thereby creating a major problem in implementation a portable system[5].

Previous attempts to solve this problem in general can be divided into two groups: Peak-to-Average Power Ratio (PAPR) reduction signal and different methods in achieving the linear amplification and power effectiveness[6]. All methods suffer from weakness such as complexity, computational time, memory requirements, reduces the data rate and high distortion[7,8]. The main objective of this paper is the PAPR reduction of OFDM signals using Imperialist Competitive Algorithm (ICA) and compares it with other methods. In continuo, according to its nature, will be used to Simulation and expression of the results of the placement techniques for reduce PAPR.

2. PAPR Reduction Process using the Algorithm ICA-PTS

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Since the algorithm used is based on the PTS, Therefore, initially the algorithm is briefly described. Block diagram of the ICA-PTS algorithm provided is shown in Figure. 1. Input vector X in the frequency domain that the number of sub-carriers of the segments are equal, is broken to the independent sector V (Sub blocks). Each of the sections are shown with the words X_v, Where v = 1, 2 ... V and the result of equation (1) will be established.

$$X = \sum_{v=1}^{V} X_v \tag{1}$$

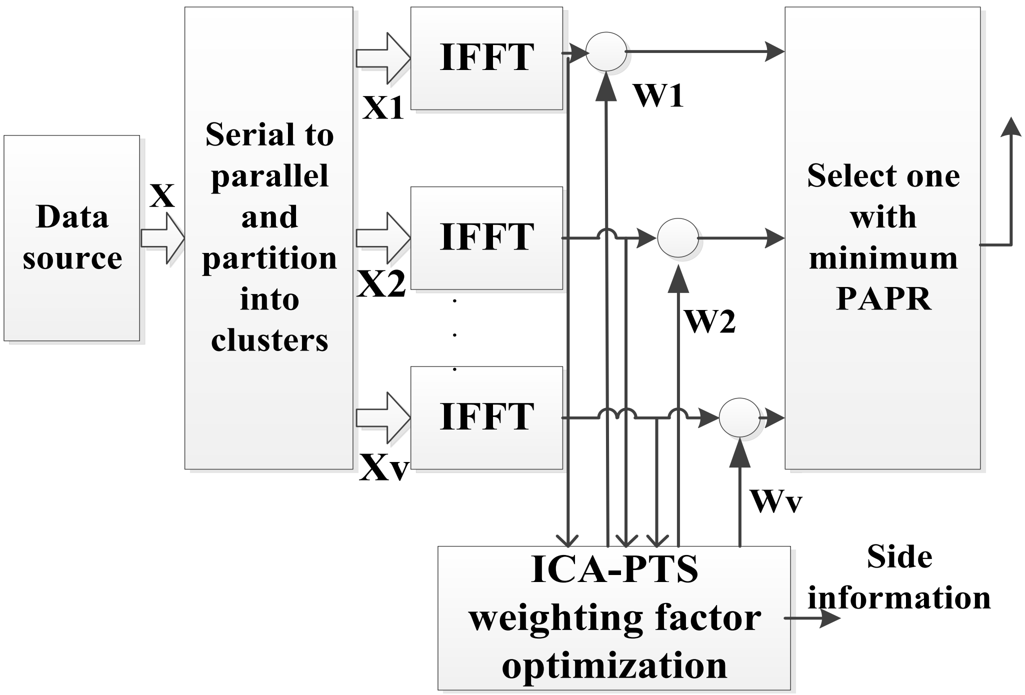

Figure 1. Provide of Block diagram of the ICA-PTS algorithm.

After that, Sub blocks using inverse fast Fourier transform are converted to V in the time domain. In order to reduce the PAPR an OFDM signal, each of these sequences independently by a phase components $\phi = [\phi_0, \phi_1, \ldots, \phi_{V-1}]$ are phase shift, As shown in equation (2).

$$x'(\phi) = \sum_{v=0}^{V-1} e^{j\phi_v} x_v \tag{2}$$

The objective of implementation of this algorithm is to find the values of the phases where the least amount possible PAPR is achieved. In other words, to find the optimum phase-matching equation (3) is the desired result.

$$\min\{\max|x'(\phi)|\} \tag{3}$$

The main problem is to find the optimal combination of phases which is relatively complicated and time consuming. Because of the difficulty of searching for the optimal case, the ICA algorithm is used. This means that this method along with PTS can be used to obtain the best values of the phase.

3. Results

The main purpose of this paper is PAPR reduction. In order to validate the algorithm used, and in order to better compare the Effect of PTS based on ICA, on the value of this parameter, has been examined. Figure 2 shows the variation of this parameter (PAPR) for different values and also with and without the use of ICA-PTS algorithm.

In order to calculate the PAPR reduction, with Production 10000 random blocks, there is a possibility to evaluate the algorithm for different values PAPR. Also the Number of sub-carriers used, is equal to 128. The criteria for performance measurement considered here are the complementary cumulative distribution function $CCDF = P_r[PAPR > PAPR_0]$ and is related to different values of PAPR and average. According to this definition, CCDF is the probability that the PAPR of a symbol exceeds the threshold level PAPR0. Also, in order to better compare, Results of the algorithms ICA-PTS, EM-PTS and PTS conventional is shown in Figure 3. for k = 64. The results are shown in Figure 3 and 4 prove that ICA-PTS algorithm compared to other two methods, achieve more reduced PAPR. Also, the PAPR reduction with using ICA-PTS algorithm is greater than conventional PTS which confirms the results of previous researches.

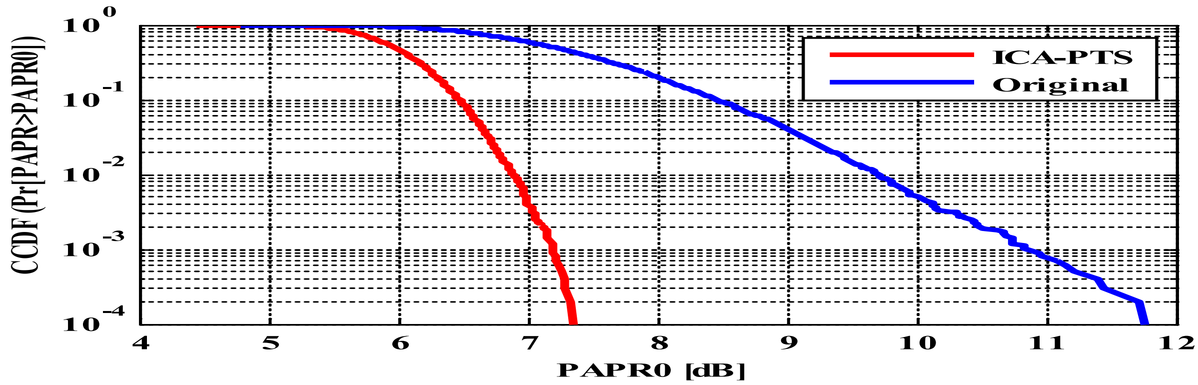

Figure 2. PAPR reduction using ICA-PTS.

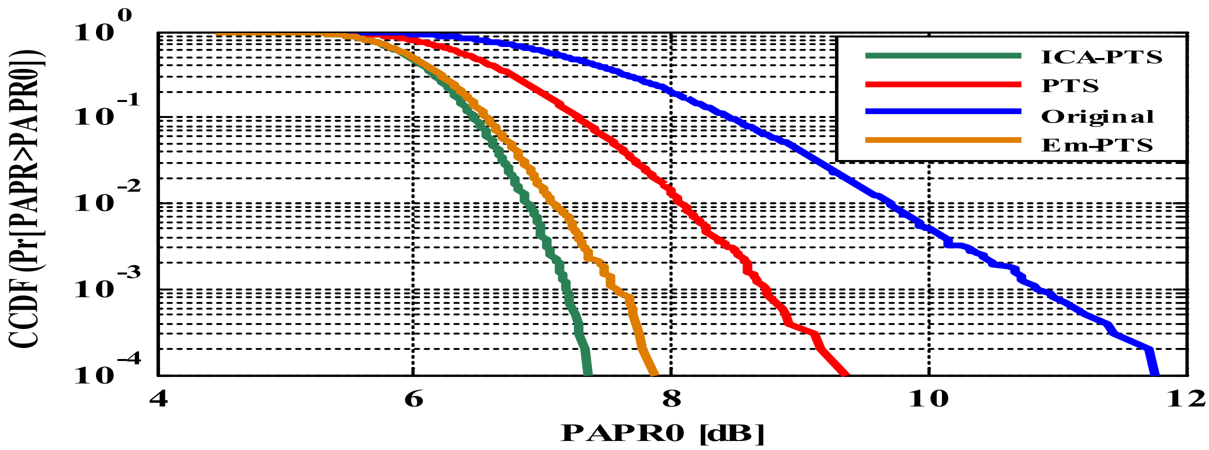

Figure 3. PAPR reduction using ICA-PTS, PTS and ICA-PTS for k = 64.

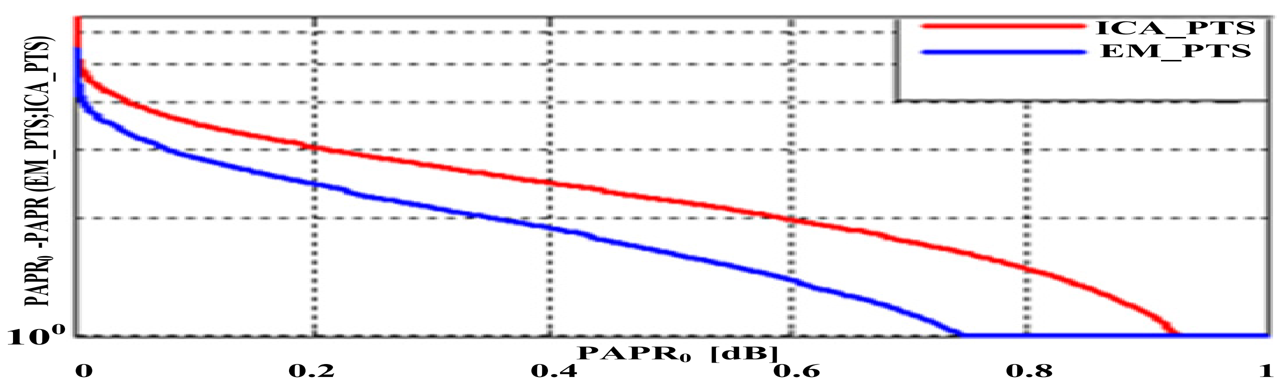

Figure 4. PAPR difference between ICA-PTS and EM-PTS.

As shown in Figure 4, there are high PAPR difference between ICA-PTS and ICA-PTS.

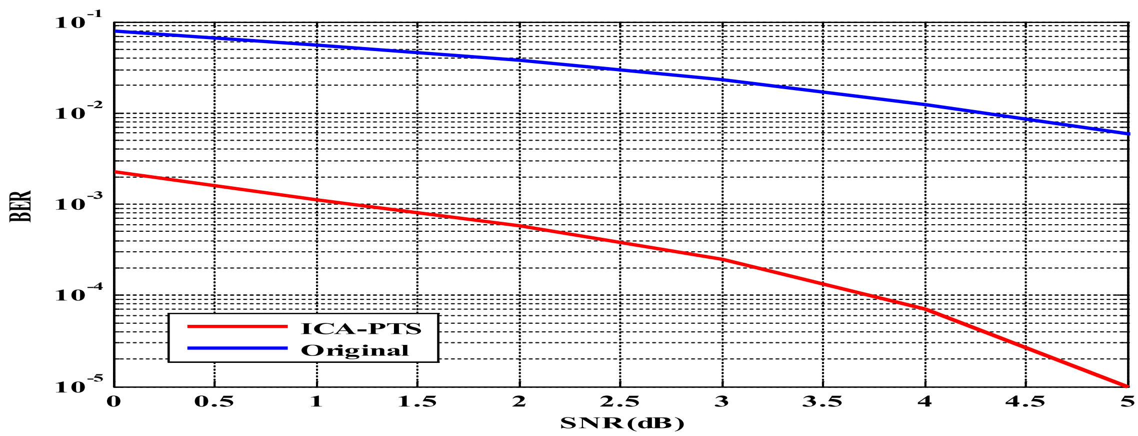

Figure 5. Improve of BER using proposed algorithm.

Also the difference between original PAPR and PAPR values of two methods ICA-PTS and ICA-PTS is shown in Figure 4 for k = 64.

4. Conclusion

The independent component analysis is a method for separating a signal to all other signals, so that the resulting signal is independent and non-Gaussian distribution. This method is a case of the blind source separation. Usually the problem is considered as a simple case that there is no delay in receiving a signal. In this paper, PAPR reduction by using ICA algorithms was carried out and the results of a number of approaches based on statistical and stochastic processes were compared. Results showed that reducing the PAPR reduction by using ICA algorithm significantly compared with the original value is obtained. The results of these observations indicate that with increasing the number of subcarriers amount of the reduction being more upward and but the time and cost required for the calculation will increase. The results indicate that PAPR amount declined to 3.97 db that is equal to 34.7 its initial value.

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