Chapter 4
Nature–Inspired–Based PTS for PAPR Reduction in OFDM Systems

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ABSTRACT

OFDM is widely used in high data rate applications due to its ability to mitigate frequency selectivity. However, OFDM suffers from high PAPR problem. This degrades the system performance. PTS is a promising PAPR reduction technique. However, its computational complexity is large; to reduce it, different suboptimal solution (heuristics) were presented in literature. Heuristics PTS algorithms can be categorized into descent-heuristics and metaheuristics. In this chapter, descent-heuristics-based PTS and metaheuristics-based PTS are compared. Results showed that RS-PTS is the best one among descent-heuristics algorithms. Metaheuristics algorithms can also be classified into single solution-based methods and nature-inspired methods. Among metaheuristics algorithms, two natural inspired algorithms and one single solution-based methods, namely PSO, ABC, and SA, were selected to be compared with descent-heuristics algorithms. Results showed that PTS based on nature-inspired methods is better than PTS based on descent heuristics and PTS based on single-solution metaheuristics method.

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INTRODUCTION

In recent high data rate application such as Wireless Wide Area Network (WWAN), Wireless Local Area Network (WLAN), Long-Term Evolution (LTE) the 3GPP 4G, and Asymmetrical Digital Subscriber Loop (ADSL), Orthogonal Frequency Division Multiplexing (OFDM) is used due to the ability of OFDM to mitigate Frequency selectivity in communication channels. Thanks to simple equalization process of OFDM (i.e. one tap frequency equalizer). However, OFDM suffer from disadvantage, namely high Peak-to-Average Power Ratio (PAPR). High PAPR signal reduce Power Amplifiers (PA) efficiency. As the PAs have to work with large Input-back-off (IBO) to preserve the signal from nonlinear distortion. Reducing IBO will cause the signal to be nonlinearly amplified. Nonlinearly amplified signal will suffer from Bit Error Rate (BER) degradation and Out-of-Band (OOB) radiation. In order to increase HPA efficiency without BER degradation or OOB emission, different PAPR reduction techniques were introduced in literature (Mounir et al., 2017). Among them, Partial Transmit Sequence (PTS) got a large attraction in literature, due to its high PAPR reduction gain with a small number of side information bits, in addition to small computational complexity in the receiver side. However, PTS requires large computational complexity in the transmitter side. Finding the optimum solution for PTS is combinatorial (Discrete) optimization problem (Youssef, Tarrad, & Mounir, 2016). In literature, different suboptimal solutions were proposed to reduce PTS computational complexity in the transmitter side.

Heuristics methods of PTS can be categorized into metaheuristics and descent heuristics. In descent heuristics, only downhill moves are accepted. In contrary, uphill moves may be accepted to prevent fast stuck to local minimum. Metaheuristics methods may be classified into single solution based methods (such as, simulated annealing (SA)) and population based methods, also called Nature Inspired methods (e.g. Grey Wolf Optimization (GWO) algorithm, Cuckoo Search (SC), BAT algorithm (BA), Firefly algorithm (FA), Artificial Bee Colony (ABC), Particle Swarm Optimization (PSO), and Genetic Algorithm (GA)) (Yang, 2010).

In literature, there are number of descent heuristics algorithms used with PTS, such as, iterative flipping algorithm (IPTS) (Cimini, & Sollenberger, 2000) random search based PTS (RS-PTS) (Cimini, & Sollenberger, 2000), and gradient descent based PTS (GD-PTS) (Han, & Lee, 2004). Similarly, metaheuristics base PTS are found in literature, such as, SA based PTS (Jiang, Xiang, Richardson, Guo, & Zhu, 2007), PSO based PTS (Wen, Lee, Huang, & Hung, 2008), ABC based PTS (Wang, Chen, & Tellambura, 2010), FA based PTS (Singh, & Patra, 2018), CS based PTS
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