International Journal of Innovative Technologies
WWW.IJITECH.ORG
ISSN 2321-8665
Volume.06, Issue.01,
January-June, 2018,
Pages:0041-0044

A New SLM Technique Based On Genetic Algorithms for PAPR Reduction in OFDM Systems

CHAITANYA KUNDURU[1], P. POORNA PRIYA[2]
[1]PG Scholar, Dept of ECE, Dadi Institute of Engineering & Technology, Visakhapatnam, AP, India.
[2]Assistant Professor, Dept of ECE, Dadi Institute of Engineering & Technology, Visakhapatnam, AP, India.

Abstract: Orthogonal Frequency Division Multiplexing (OFDM) technique has been widely adopted in many wireless communication systems due to its high data-rate transmission ability and robustness to the multipath fading channel. Peak average power ratio (PAPR) reduction in orthogonal frequency division multiplexing (OFDM) had been main concern upon last year's. One of the promising PAPR reduction methods is the Selective Mapping method (SLM) which can achieve better PAPR performance without signal distortion. Therefore some artificial intelligence methods, such as Genetic Algorithm technique, partical swarm optimization etc are introduced. In this paper, a new effective PAPR reduction technique using SLM based on Genetic Algorithm (GA) is proposed. GA is applied to SLM-OFDM systems. Matlab tool is used to perform the operation.

Keywords: OFDM, MIMO, SLM, PAPR.

I. INTRODUCTION

It is generally expected that future portable correspondence frameworks will apply multicarrier OFDM transmission due to the way that it takes into account high data transfer capacity productivity. Moreover, multicarrier transmission guarantees high adaptability in transmission asset task, which is extremely alluring for future rich collection of expected administrations including different information transmission rates and QoS prerequisites. Nonetheless, in spite of numerous points of interest of OFDM, there are a few downsides of it also. Among them, a high estimation of Peak-to-Average Power Ratio (PAPR) is the one, which draws consideration of numerous researchers [1]. For this situation some momentary power yield may increment significantly what's more, turned out to be far higher than the mean energy of framework. To transmit signals with such high PAPR, it requires control speakers with high power scope. These sorts of speakers are extremely costly and have low proficiency cost [2]. On the off chance that the pinnacle control is too high, it could be out of the extent of the direct power intensifier. This offers ascend to nonlinear bending which changes the superposition of the flag range bringing about execution debasement. Assuming no measure is taken to lessen the high PAPR, MIMO-OFDM framework could confront genuine confinement for viable applications [3-4]. PAPR can be portrayed by its corresponding aggregate circulation work (CCDF) [5]. In this paper we have proposed a method based on the conventional SLM technique which not only has a better PAPR reduction capability but also exhibits lower computational complexity. Rest of the paper is organized as follows: in section II, a brief overview of the OFDM and the PAPR issue are discussed. Section III gives a complete view on the SLM technique. In Section IV, the proposed algorithm known as GA based SLMOFDM is proposed along with simulation results in section V and finally, conclusions are made in Section VI.

II. OFDM SYSTEM AND PAPR

A typical OFDM system transmitter is shown in Fig1 and works as follows: Serial stream of bits $\{b_0, b_1, b_2, \ldots\}$ are encoded using an encoder such that bi = 0 or 1; for i = 0,1,2,…. The serial bit stream at the output of channel encoder is fed into a serial to parallel converter block that forms an N parallel stream where N represents the number of subcarriers used in the OFDM system. The number of bits entering a particular branch or subcarrier depends on the mapper (i.e. the digital modulation block) which is used after the serial to parallel converter. The number of bits per subcarrier is given by $L = \log_2 M$ where M is the constellation size used by the mapper and depends on the modulation scheme being used. For Quadrature Phase Shift Keying (QPSK) mapper the output is denoted by $D = \{d_0, d_1, \ldots, d_{N-1}\}$ such that dk can take one of the values from (1,–1, j, –j). Note that throughout the paper, we have used the QPSK mapper.

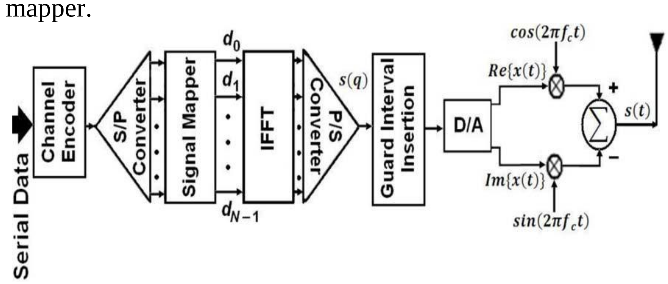

Fig.1. A typical OFDM transmitter.

The Inverse Fast Fourier Transform (IFFT) block transforms the discrete complex signal into another discrete complex signal. A typical baseband signal at the output of the IFFT block is given by the following well known Inverse Discrete Fourier Transform (IDFT) equation is given as [6]:

$$s(q) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} d_k e^{j2\pi kq/N}; \quad k,q = 0,1,\ldots,N-1 \tag{1}$$

where s(q) are samples for the resultant baseband signal. The output of the IFFT block is the result of summation of various complex sinusoids with varying amplitudes and phases. At some sample points of these sinusoidal signals, constructive summations may occur, resulting in high peaks in the signal. When transmitting high peak signals through a non-linear power amplifier, distortion occurs within the transmitted signal at the output of the amplifier in the form of inter symbol interference (ISI) and out-of-band radiation. Hence, the influence of high peaks is evident at the output of a non-linear power amplifier but the point of occurrence of these peaks is at the output of an IFFT block. One widely used measures for the power of these peaks is Peak to Average Power Ratio (PAPR) which is mathematically expressed as:

$$PAPR = \frac{\max\{P(q)\}}{P_{avg}} = \frac{\max\limits_{0 \le q \le N-1} |s(q)|^2}{\frac{1}{N}\sum_{q=0}^{N-1} |s(q)|^2} \tag{2}$$

Here, P(q) represents the instantaneous power and Pavg represents the average power of the OFDM signal. Oversampling by a factor of J can be used for better PAPR estimation and to capture peaks in OFDM signals. It has been shown that J = 4 is sufficient to capture the peaks [7].

III. SELECTED MAPPING (SLM) METHOD FOR PAPR REDUCTION

In SLM technique as shown in Fig.2, from a single OFDM sequence D having a length of N, number of sequences are generated that represent the same information using some rotation factors and the sequence with lowest PAPR is transmitted. If the number of generated new sequences is U, called the SLM length, then all these sequences are the result of multiplying the incoming original OFDM sequence D by U different rotation factors. These factors are given in vector form as,

$$B^{(i)} = [b_0^{(i)}, b_1^{(i)}, \ldots, b_{N-1}^{(i)}] \tag{3}$$

where i = 1 to U and represents the indices of these factors and B is the represent the rotation factor in vector form. After multiplying these factors by the original OFDM sequence D, we get:

$$X^{(i)} = [d_0 b_0^{(i)}, d_1 b_1^{(i)}, \ldots, d_{N-1} b_{N-1}^{(i)}] \tag{4}$$

The multiplication factors are phase rotations selected appropriately such that multiplying a complex number by these factors results in rotation of that complex number to another complex number representing a different point in the constellation. Hence,

$$b_n^i = e^{-j\theta_n^i} \text{ where } \theta_n^{(i)} \in [0, 2\pi) \tag{5}$$

where θ is the angle of rotation. The rotation vectors are used as side information which are transmitted for signal recovery.

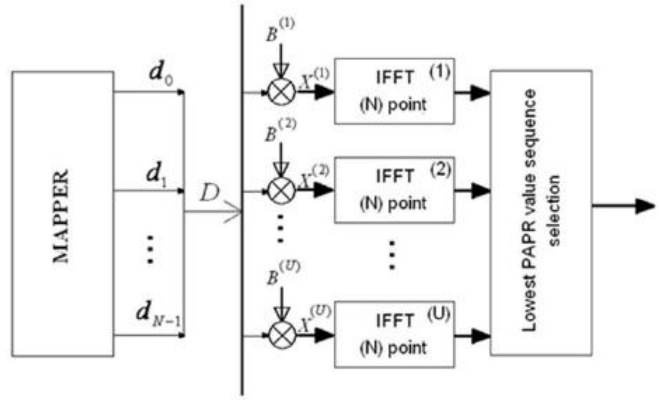

Fig. 2. Conventional SLM technique at the transmitter end.

The efficiency of SLM approach depends on the amount of scrambling done by these rotation factors on the original OFDM sequence and the length of SLM U. As we increase number of SLM sequences, PAPR performance becomes better but at the expense of increase in system complexity. Although SLM technique has moderate implementation complexity, this complexity increases as U increases. For this reason, many researchers devoted their work in this field towards improving the complexity computation of conventional SLM [8,9]. The complexity of a typical SLM method considering no oversampling (i.e. J = 1) in terms of complexity additions are:

$$Complexity = UN\log_2 N \tag{6}$$

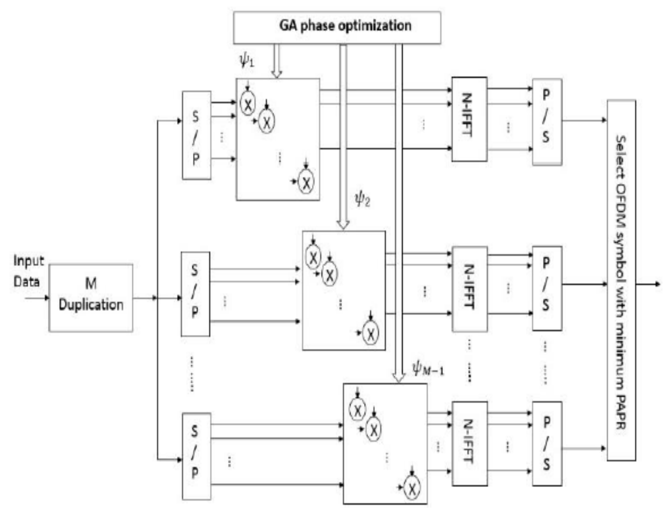

Fig.3. Functional block diagram of the proposed GA based SLMOFDM technique.

IV. PROPOSED GA BASED SLM-OFDM SYSTEM

This section investigates how GA can be used for phase optimization of SLM-OFDM system. In order to solve the optimization problem of this system and acquiring more PAPR reduction, the proposed technique uses GA as the selection mechanism of phase rotation factors for SLMOFDM system. GA, which is a search heuristic algorithm based on the process of natural evolution, can find a good solution for optimization problems by evolving the population of solutions with genetic operators such as selection, mutation and crossover [10]. The block diagram of the proposed GA based SLM- OFDM system is shown in Fig.3.

$$\psi_{opt} = argmin_{\psi}\left\{\frac{max_{0\leq n\leq N-1}|x_m(n)|^2}{E\{|x_m(n)|^2\}}\right\} \quad \textbf{(7)}$$

Where $m = 1,2, \ldots\ ., M$ and ψopt is the optimum phase rotation factors. The selection mechanism of GA based SLM-OFDM is described as follows:

Proposed Algorithm: GA-SLM-OFDM method

- Select the first population size, the mutation probability, crossover probability, and initial population randomly. Each gene represents a vector of phase factor candidate.
- Calculate the PAPR value for each gene by multiplying X with the set of phase rotation factors as given by (6).
- Select genes with smallest PAPR value (called set of parents).
- Crossover and mutate all genes to generate a new genes (offsprings).
- Go back to step 2 using the new generated population. The processing is repeatedly executed until termination (maximum number of generation). The vector of phase rotation factors with the lowest PAPR are used for the transmitted data and sent to the receiver.
- End

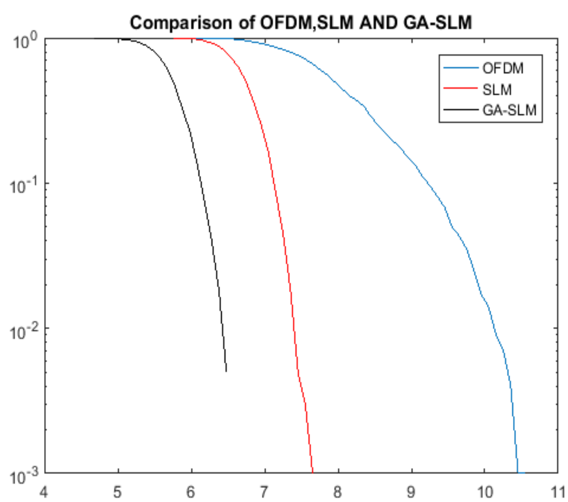

Fig.4. CCDF vs PAPR.

V. RESULTS

Using MATLAB software simulation analysis of PAPR reduction is performed by averaging over 104 randomly OFDM symbols with QPSK modulation. The analysis of PAPR performance for original OFDM, the conventional SLM-OFDM and GA based SLM-OFDM systems is presented in terms of CCDF. The comparison is done between OFDM, SLM and GA SLM. From the above fig.4 it is clear that GA SLM based is a good technique for reduction of PAPR as compared with other two techniques.

VI. CONCLUSION

OFDM has been seen as the core technique of the future communication systems because it has many advantages .OFDM transmission has many favorable features, such as robustness against multipath fading and narrow-band interference, high spectral efficiency and simple channel estimation and equalization, which are why it is an attractive method for wireless communication systems. One of the challenging issues for Orthogonal Frequency Division Multiplexing (OFDM) system is its high Peak-to-Average Power Ratio (PAPR). High peak-to-average power ratio (PAPR) of the transmitted signal is a major drawback of orthogonal frequency division multiplexing (OFDM).In this paper, an efficient technique based on GA is proposed to achieve PAPR reduction. The PAPR reduction performance of the proposed SLM-OFDM system using GA for optimum phase rotation factors searching was compared with the original OFDM and conventional SLMOFDM systems. According to the simulation results, the proposed GA based SLM-OFDM outperforms the compared systems with low computational complexity.

VII. REFERENCES

[1] Krzysztof Wesołowski,” On the PAPR Minimization Using Selected Mapping Algorithm in Pilot-Assisted OFDM Systems” Pozna´n University of Technology Chair of Wireless Communications Pozna´n, Poland.

[2] Y.Wu and W. Y. Zou, “Orthogonal frequency division multiplexing: A multi-carrier modulation scheme,” IEEE Trans. Consumer Electronics, vol. 41, no. 3, pp. 392–399, Aug. 1995.

[3] University of Alberta, “Home page - High capacity digital communicationslaboratory,”2007.Available:http://www.ece.u alberta. ca/~ HCDC/mimohistory.html.

[4] Shinsuke Hara, Ramjee, “Principle and history of MCM/OFDM,” in Multicarrier techniques for 4G mobile communication, Artech House.

[5] Suverna Sengar, Partha Pratim Bhattacharya,” Performance Improvement In Ofdmsystem By Papr Reduction,” Signal & Image Processing : An International Journal (SIPIJ) Vol.3, No.2, April 2012 Department of Electronics and Communication Engineering, Faculty of Engineering and Technology, Mody Institute of Technology & Science (Deemed University),Lakshmangarh, Dist – Sikar, Rajasthan, Pin – 332311, INDIA.

[6]. Jayalath, A.D.S., Tellambura C., “SLM and PTS peak-power reduction of OFDM signals without side information”, IEEE Transactions on Wireless Communications, vol. 4, no. 5, pp. 2006 – 2013, 2005.

[7] [11] C. Tellambura, “Use of m-sequences for OFDM peak-to-average power ratio reduction", IEE Elec. Lett, vol.33, no.15, pp. 1300-1301, 1997.

[8] Chin-Liang Wang, Sheng-Ju Ku., “Novel conversion matrices for simplifying the IFFT computation of an SLM-based PAPR reduction scheme for OFDM systems”, IEEE Transaction on Communication, vol. 57, no. 7, pp. 1903 – 1907, 2009.

[9] Chin-Liang Wang, Yuan Ouyang, "Low-complexity selected mapping schemes for peakto- average power ratio reduction in OFDM systems", IEEE Trans. on Signal Processing, vol. 53, no. 12, pp. 4652 – 4660, 2005.
[10] Y. Wang, W. Chen, and C. Tellambura, "Genetic algorithm based nearly optimal peak reduction tone set selection for adaptive amplitude clipping PAPR reduction," IEEE Trans. on Broadcast., vol. 58, no. 3, pp. 462- 471, Sept. 2012.

Author's Profile:

Chaitaanya Kunduru pursuing hir M.Tech in the department of Electronics and Communication Engineering , Dadi Institute of Engineering and Technology, Vizag, AP, India. He obtained his B.Tech(ECE) from VIIT, Vishakhapatanam, AP, India.

P. Poorna Priya, M.Tech, Ph.D working as Assistant Professor in the department of Electronics and Communication Engineering , Dadi Institute of Engineering and Technology, Vizag, AP, India.