

PAPR reduction in OFDM systems via genetic algorithm

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Abstract— Peak average power ratio (PAPR) reduction in orthogonal frequency division multiplexing (OFDM) had been main concern upon last year's. Many researchers try to unveil the optimal values for it. Many methods had been proposed for this aim. The partial transmit sequences (PTS) method, variable to variable crossover in genetic algorithm (GA) and combination between the two methods are the most popular algorithms for optimization PAPR reduction. The least value the algorithm can achieve is the main target; Max blocks to be used are main challenge. In our paper we apply to have minimum PAPR value of 2 dB after 20 iteration. The code methodology aimed to target variable to variable crossover steps in order to fetch better genes out of the input parents. The parameter for simulation used standard WLAN in IEEE 802.11a system.

1 INTRODUCTION

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Orthogonal frequency division multiplexing (OFDM) is one of the brilliant solutions to fasten wireless communication that is required for digital signal processing technology advances [1], [2]. OFDM has become a criterion as part of the IEEE 802.11a and IEEE 802.11g in transmission over wireless LANs to elevate data bit rate [3]. It has been inserted in several application and standards as digital audio broadcasting (DAB), digital video broadcasting (DVB), the European HIPERLAN/2 and the Japanese multimedia mobile access communications (MMAC) [4], [5]. Although all advantages of OFDM, there are some obstacles such as high Peak to Average Power Ratio (PAPR) and Bit Error Rate (BER). The issue of PAPR that weakens system performance is related to the sensitivity of OFDM transmitter devices such as DAC (Digital to Analogue Converter) and HPA (High Power Amplifier) is very husky to the signal processing loop that induce spectral regrowth and detection efficiency degradation. Several techniques have been suggested to decrease PAPR basically including four categories [6] signal distortion, probabilistic (scrambling) techniques, coding methods, pre-distortion methods. The concepts of PAPR reduction will be broadened for distortion less transmission and identifying better alternatives for performance increase, low data rate loss, efficient use of channel and overcoming complexity issues [7]. One of signal scrambling techniques to reduce PAPR in OFDM systems is Partial transmit sequences (PTS) that is the most charming schemes. The conventional PTS scheme demands an exhaustive inspection to overall combinations of allowed phase factors [8].

Genetic algorithm is commonly applied for global optimum in combination problems; method of variable to variable crossover operation will enhance results to obtain best PAPR reduction with less BER [9].

2 Methodology:

2.1 Generating OFDM signal and computing PAPR:

In IEEE 802.11a generate number of bits randomly for the OFDM signal data flow then bit in N number of symbols X and convert every symbol to decimal number then modulated onto sub channels of equal bandwidth by using 64 QAM modulations. The collection of all data symbols X_n , $n = 0, 1, \dots, N - 1$, that will be termed a data block the OFDM baseband signal consisting of N subcarriers is given by:

$$x(t) = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} X_n \cdot e^{j2\pi n \Delta f t}, 0 \leq t < NT, \quad (1)$$

Where $j = \sqrt{-1}$, Δf is the subcarrier spacing, and NT indicates the useful data block period. In OFDM the subcarriers are selected to be orthogonal (i.e., $\Delta f = 1/NT$). To calculate the PAPR of the OFDM signal apply the equation number (2)

$$PAPR = \frac{\max_{0 \leq t < NT} |x(t)|^2}{1/NT \cdot \int_0^{NT} |x(t)|^2 dt} \quad (2)$$

Where $x(t)$ is the original signal, t is the time interval, $\max |x(t)|^2$ is the peak signal power and $E[|x(t)|^2]$ is the average signal power, Where $E[\]$ is the anticipation operator.

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2.2 Implementation by conventional Partial transmit sequences PTS:

As shown in figure (1) is one of the most efficient techniques to diminish PAPR. First the sequential signal data rearranged then divided into M sub-blocks and every sub-block converted to real and imaginary to be valid input for PTS algorithm then placed in transpose later collected again with placing in transpose. Then calculate the PAPR of the output signal in this method need side information.

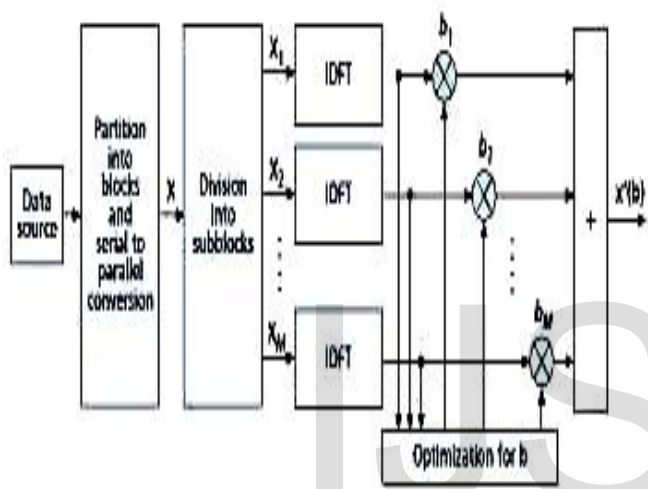


Figure (1): Block diagram of conventional PTS scheme [10].

2-3 Apply variable to variable crossover in genetic algorithm for OFDM systems:

As shown in figure (2) for the flowchart:

First ascending the values of the original OFDM signal in 8 elements then calculating PAPR for every 8 elements it is also ascending values for PAPR for every 8 elements called genes, selecting set of parents are half of the above genes then we have two set of parents.

2-3-1 Variable to variable crossover in genetic algorithm:

Now begin the loop firstly pick a cross-over point randomly and export number of row and column from this point this is a cross-over point. Secondly transferred from parent 1 to child 2, and parent 2 to child 1, Put child 1, child 2 in new functions this compose a matrix.

2-3-2 Mutation process:

Randomly flip all the elements in this matrix then put it in one row. Repeated the two above operation until the number of iteration finish.

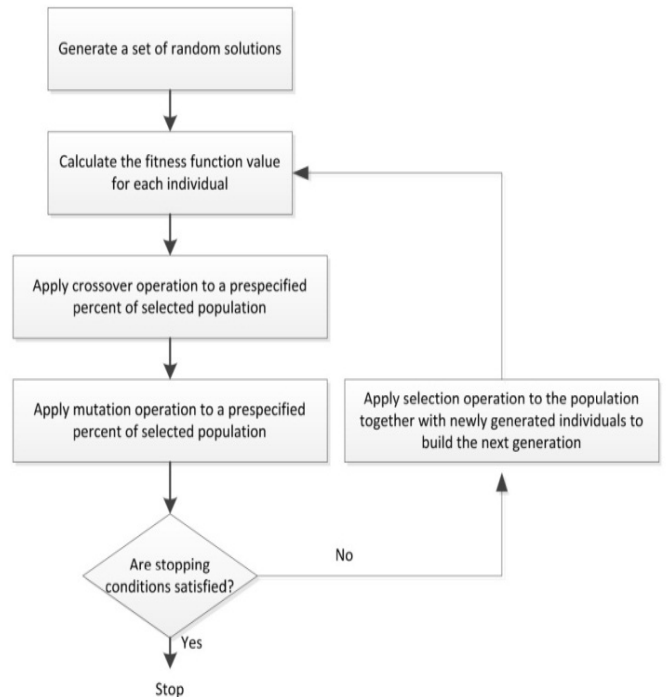


Figure (2): Flowchart for variable to variable crossover in genetic algorithm

3 Simulation Results:

Evaluation and comparison the performance of OFDM, traditional PTS and the variable to variable crossover in genetic algorithm to optimize PAPR reduction method. Simulate all the based on the standard IEEE 802.11a in table (1):

TABLE 1

PARAMETER FOR SIMULATION:

Modulation	64 QAM
No of sub carrier	48
No of FFT points	64
No of sub blocks	8
Channel model	18-path Rayleigh Fading
Doppler frequency	20 HZ
Multipath delay profile	50ns

Table (2): Represent comparison between three types:

OFDM in dB	Conventional PTS in dB	Variable to variable crossover in genetic algorithm in dB
50	30	1.5

7	17	23
7	14	23
23	24	7
36	23	17
25	17	7
19	14	3.5
9	17	22
4	37	14
23	17	12
7	13	9
22	16	7
9	16	16
20	20	27
2.5	12	25
25	20	17
17	23	27
33	27	7
6	6	4.5
25	23	27
9	11	6
65	35	27
13	13	30
8	17	30
23	10	7
13	13	8
19	8	37
34	34	32
7.5	21	30
2.5	4	2.5

3-1 PAPR performance: In Figure (3) we found that the PAPR for genetic algorithm less than 2dB after 20 iteration from first rerun as shown in table (2) when original signal gives 19dB and the conventional PTS gives near 15dB also the code give 43.5% good result when rerun with more iteration after 2000 we get PAPR less than 1dB at the 32 rerun as shown in figure (4) with 38% good results.

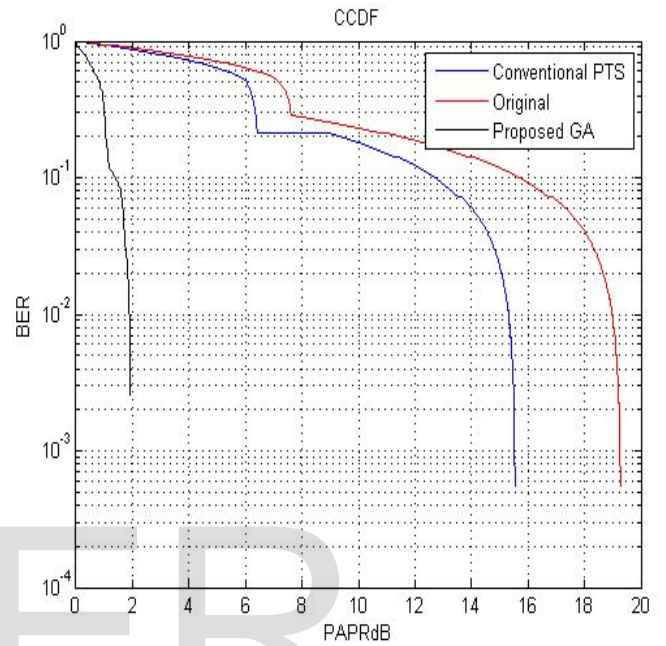


FIGURE (3) PAPR PERFORMANCE:

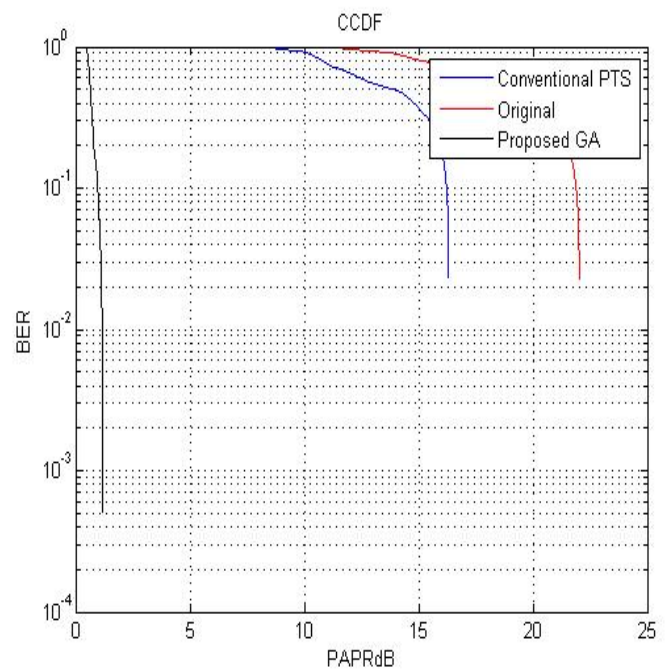


FIGURE (4) PAPR PERFORMANCE:

3-2 BER performance: Figure (5) shown that the PAPR for genetic algorithm give better BER performance than OFDM signals, Conventional PTS.

but with much iterations and the code give 38.8% good result when rerun.

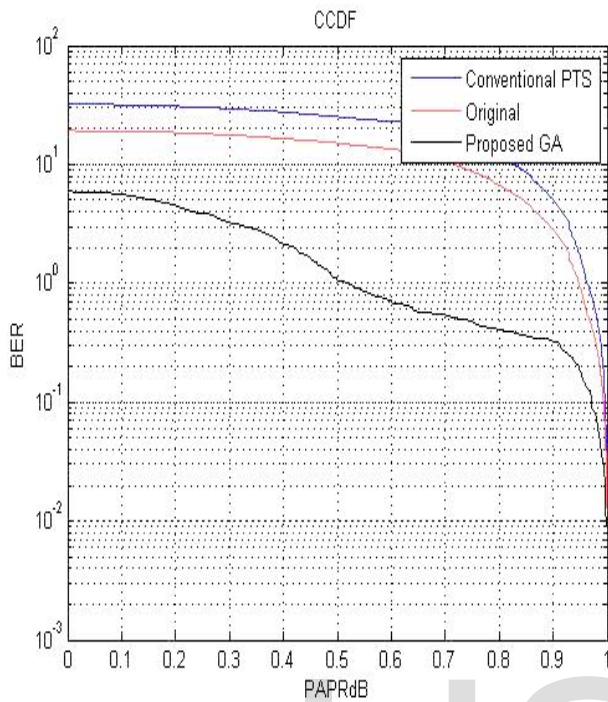


FIGURE (5) BER PERFORMANCE:

4 Discussion

Some other papers [11][12][13] work on optimization for the candidate vectors of phase rotation to PTS technique using variable to variable crossover in genetic algorithm study optimum solution searching for trade off PAPR reduction in OFDM systems and cost of calculation with increasing the number of sub-blocks, my work in genetic algorithm make tournament selection with single-point crossover and boundary mutation but with less sub-blocks than other papers and work directly on the OFDM signal with increasing one condition when plotting if there is consecutive (10) output PAPR are (0) then the code will change these values randomly with another PAPR result as not to be ten values equal 0 consecutive so my work care only for PAPR reduction values.

5 Conclusions:

The parameters of the simulation are determined by IEEE 802.11a the simulation result shows that the variable to variable crossover in genetic algorithm has better PAPR and BER performance than OFDM and conventional PTS methods

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