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PAPR Reduction in OFDM using GSA Optimised PTS

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Abstract

Orthogonal frequency division multiplexing is becoming more and more popular nowadays. OFDM is widely used in 4G technologies in recent time. Main advantage of OFDM is that it uses orthogonal signal so removes inter signal interference. PAPR ratio in OFDM is very high because it uses multicarrier modulation ,which is its main drawback .OFDM is consist of the large number of the independent subcarrier, as a result of which the amplitude of the such a signal can have high peak values as it uses multicarrier modulation. More PAPR ratio means that more power needs to be transmitted from transmitter side .In our work we will try to reduce the PAPR using PARTIAL TRANSMIT SEQUENCE TECHNIQUE. In this technique data blocks are divided into non overlapping sub-block with independent weighting factor. This weighting factor generates time domain data using which it select signal having lowest PAPR. These weighting factors are binary in form and PAPR reduction depends upon their arrangement which is optimized by GSA optimization in our case. Results will be compared on the basis of the CCDF (complementary cumulative distribution function).

Keywords: DLC; OFDM; PAPR

1. Introduction

Multicarrier modulation has recently gained fair degree of prominence among modulation schemes due to its intrinsic robustness in frequency selective fading channels. This is one of the main reason to select Multi-carrier modulation a candidate for systems such as Digital Audio and Video Broadcasting (DAB and DVB), Digital Subscriber Lines (DSL), and Wireless local area networks (WLAN), metropolitan area networks (MAN), personal area networks (PAN), home networking, and even beyond 3G and 4G wide area networks (WAN). Orthogonal Frequency Division Multiplexing (OFDM), a multi-carrier transmission technique that is widely adopted in different communication applications. OFDM systems support high data rate transmission.

The Orthogonal Frequency Division Multiplexing (OFDM) is one of the very efficient and often used modulation Techniques used in broadband wireless communication systems like 4G, Wi-MAX, DVB-T. One of the main issues of the OFDM based systems is the Peak-to-Average Power Ratio (PAPR) of the transmitted signal. Due to the time-domain superposition of the many data subcarriers which composes the OFDM signal, the PAPR may reach high values. Due to the large number of subcarriers, the resulting time-domain signal exhibits Rayleigh-like characteristics and large time-domain amplitude variations. These large signal peaks requires the high power amplifiers (HPA) to support wide linear dynamic range. The increased signal level causes nonlinear distortions leading to an inefficient operation of HPA causing inter-modulation products resulting unwanted out-of-band power [3].

$$\mathrm{PAPR} = \frac{\mathrm{P_{peak}}}{\mathrm{p_{avg}}} = \max[\![\mathrm{x_n}^2]\!]/\mathrm{E}[\![\mathrm{x_n}^2]\!]$$

Where, x_n= An OFDM signal after IFFT

In order to reduce the PAPR of OFDM signals, many solutions have been proposed and analyzed. These methods can be characterized by various parameters like non-linearity, amount of processing and size of side information needed to be sent to receiver.

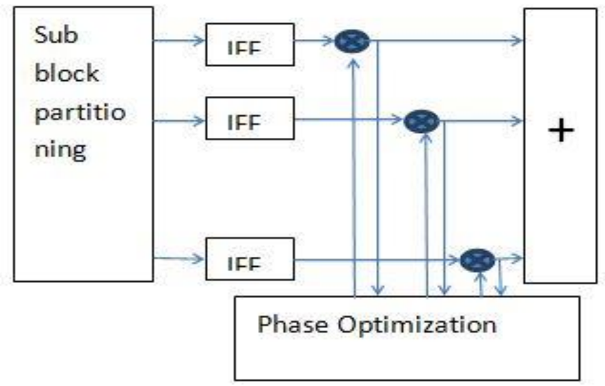
Some of the well known linear methods use for the reduce PAPR are partial transmit sequence (PTS), and clipping and coding. Clipping is very simple method which require very less computational time but it introduces the distortion and also degrades BER performance [1]. Coding is also one of the method use for reduces PAPR but it introduced bandwidth expansion and distortion [2]. The partial transmit sequence is the best method for reduces the PAPR with compare to clipping and coding, [3] but in the partial transmit sequence complexity is increase due to number of the IFFT operation.

2. Proposed work

This work is based on the optimal decision of weighting factor in partial transmit sequence (PTS). Since OFDM communication is considered for the reduction of PAPR with AWGN channel, the parallel data transmission sequence takes place. In PTS scheme some weighting factors are multiplied with these parallel data channels to reduce the PAPR. A schematic block diagram is shown in figure 1.

Figure 1: Block diagram of conventional PTS

The weights assigned to sub blocks in above figure can either be + or -1. In data sub blocks Xn, n=0,1,….N-1 is defined as vector, x=[x0,x1,x2….x]^T . Then partition X into V disjoint sets,



represented by vectors $X^{(v)}$, v=1,2,…,V such that

$$X = \sum_{v=1}^{V} x^v \qquad (1)$$

The objective of PTS approach is to form weighted combination of V clusters, each of equal size.

$$S = \sum_{v=1}^{V} b^v x^v \qquad (2)$$

In time domain

$$S(t) = \sum_{v=1}^{V} b^v x^v \qquad (3)$$

where $b^{(v)}$, v=1,2,…,V are weighting factors or phase factors and are assumed to be pure rotations. The vector $x^{(v)}$ called partial transmit sequence is the IFFT of $X^{(V)}$. The weighting factors are chosen to minimize the PAPR by searching for the appropriate combination of each cluster and by corresponding weighting clusters.

In our work these weights are decided by GSA optimization which is a celestial body inspired optimization technique. GSA algorithm uses an objective function which calculates the maximum power as if power is increased then PAPR reduces. Multi carrier CDMA using OFDM is simulated in our work and for that PAPR is reduced. Steps for the proposed work are as:

Step1. Initialize all initial parameters of MC CDMA to model it.

Step2. Generate the input bits and modulate them as per the modulation instructed by user

Step3. Generate hadamard sequence or walsh code and spread the modulated input with this code to provide the uniqueness to each users' data.

Step4. Take the sum of these spreaded sequences and partitioned it into sub blocks for PTS.

Step5. Take the inverse fourier transform of these partitioned blocks and pass to proposed optimization being used.

GSA Initialization

Step6. The size of searching space dimensions of GSA optimisation is equal to length of PTS blocks chosen and all other initialization factor are selected randomly for GSA optimisation along with initial positions of agents.

Step7. These random positions which are equivalent to weighted factor sequence is passed to objective function for peak power calculation.

Step8. Peak power is calculated in objective function. This objective function is of general form.

Step9. After calculation, positions of fireflies are updated by the formula

$$v_i^d(t+1) = rand_i x v_i^d(t) + a_i^d(t)$$

$$x_i^d(t+1) = v_i^d(t+1) + x_i^d(t)$$

Description of this equation is given in earlier section.

Step10. The new positions thus achieved are passed to objective function again and new peak power is calculated which is compared with previously calculated power. If new power is less than previous then execution stops at this point otherwise it switches to step 9 to update the positions.

Step11. The final position of agents which is achieved either by matching the condition of power reduction or by reaching the maximum iterations.

Step12. Final positions of agents thus settled are considered as the final weighted sequence of PTS algorithm and multiplied with input sub blocks and PAPR is calculated Following these steps weighted factor of PTS are found out for reduced PAPR.

3. Results

For results analysis we have varied four parameters of the system which are: Keeping the other factors constant at some value, only number of users are changed, Type of modulation varies, Subcarriers in MC-CDMA also affects the PAPR so it's variation is also considered, The size sub blocks of PTS is also varied. Simulation parameters for these are given in table 1.

Table 1: Simulation parameters of MC CDMA

Spreading codes of MC CDMA	**Walsh code**
Modulaiton process	QPSK,8PSK, 16PSK
Number of users in MCCDMA	4,8,10,12
Number of subcarriers	16,32,64
Length of sub blocks of PTS	4,8,16,32
No of bits for each user	10000

Initially 4 users have been taken along with QPSK modulation, number of sub carriers=8 and length of sub blocks of PTS is 4. The constellation map of QPSK modulated input is shown in figure 2. Now number of users are varied and results are compared in PAPR0 vs ccdf graph as shown in figure 3 for various users. As is seen from the figure with the increase in the number of users the PAPR is also increased, but if it is compared in case of each different number of users then PAPR reduces significantly by our proposed algorithm.

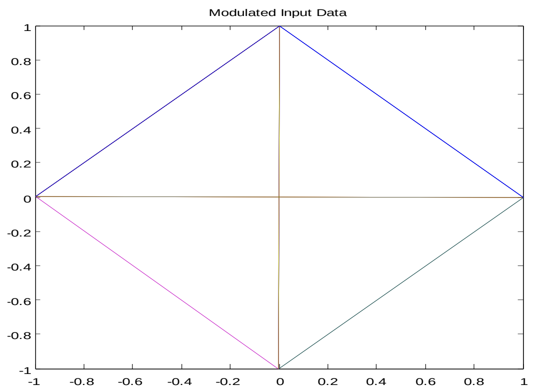


Figure 2: Constellation Map of QPSK Modulated Data

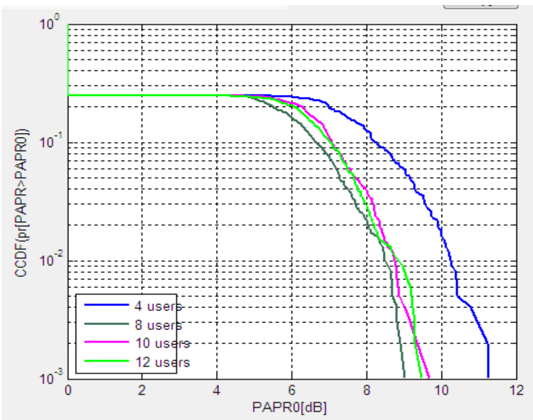


Figure 3: PAPR vs. CCDF for different no of Users

Now number of users, sub carriers and length of PTS block are kept fixed, but modulation type is varied. Modulation of signal is varied from QPSK to 8-PSK, 16- PSK etc. the resultant modulated input signal's constellation map will also change as shown in figure 4 for 8-PSK modulation.

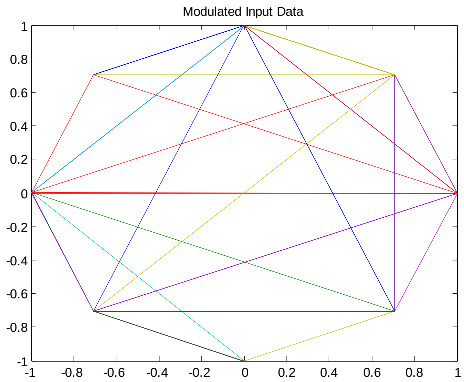


Figure 4: 8PSK scattering of modulated input

CCDF vs PAPR curve for these different modulation techniques is shown in figure 5.

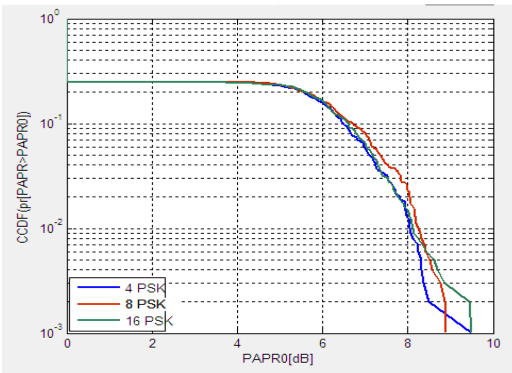


Figure 5: PAPR vs. CCDF curve for different modulation schemes

If number of sub carriers in OFDM scheme is changed keeping other variables fixed, then CCDF vs PAPR curve for 8,16,32,64,128 sub carriers is show in figure 6. We have compared the results of GSA with previously done work with firefly algorithm. It has been observed that GSA is performing better in all case than firefly algorithm.

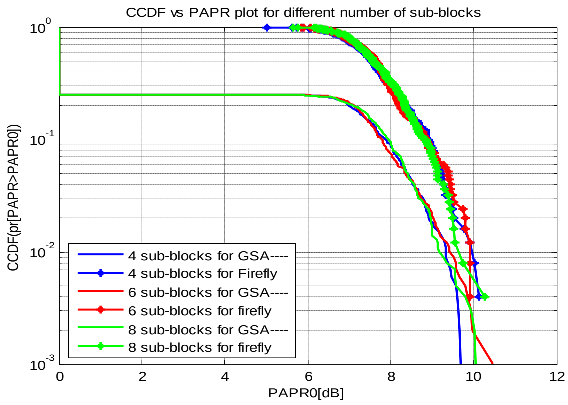


Figure 6: PAPR vs. CCDF for proposed scheme only by varying subcarriers' numbers

In the last case only length of sub blocks in PTS is changes and other conditions are same as previous discussed cases. The comparison curve for this case is shown in figure 7 below. The graph shows that our proposed scheme for PAPR improvement works well when length of sub blocks of PTS increases. If length of sub block is taken 16 then improvement in PAPR is above 2 dB. Best improvement in CCDF is also visible in this case as slop of curve is less as compared to other cases. Highest CCDF slope is visible in different modulation scheme.

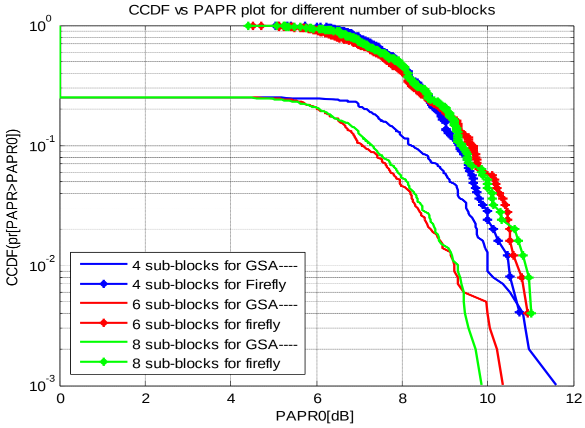


Figure 7: PAPR vs. CCDF for different number of sub blocks of PTS

Now at this stage where all possible cases are discussed, a collective representation of PAPR is required to get the parameters which gives best PAPR reduction. For this purpose a bar graph for all cases is itself which is shown in figure 8. This bar graph is only for PAPR using proposed method as PAPR always improved than PTS. From this figure it is concluded that at highest number of sub blocks of PTS the PAPR reduction is highest.

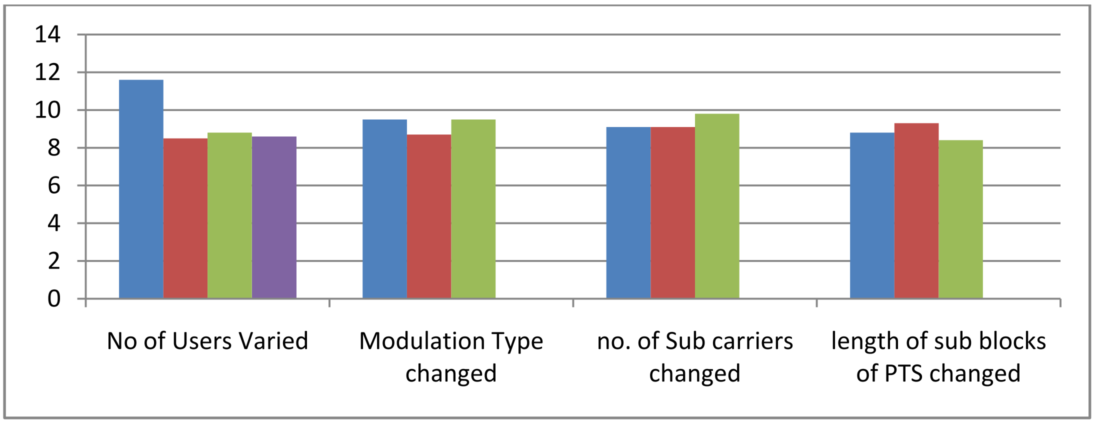


Figure 8: Bar graph for proposed scheme PAPR

4. Conclusion

In this work, a graphical user interface in MATLAB is developed to allow user change the MC CDMA and PTS parameters. Results have been checked for different number of users, various modulation schemes and different sub carriers in MCCDMA. It has been found that in every case the proposed algorithm reduces the PAPR than only PTS. When size of blocks in PTS is varied then at large size block provides best improvement in PAPR. So it is finally concluded that large number of PTS blocks improves PAPR. Finally best parameters for achieving minimum PAPR are collected from all the cases discussed and a plot between CCDF and PAPR is drawn.

References

[1] Sarala, B., Venkateswarulu, D. S., & Bhandari, B. N. (2012). Overview of Mc Cdma PAPR Reduction Techniques. *arXiv preprint arXiv:1204.3874*.

[2] Sarala, B., Venkateswarulu, D. S., & Bhandari, B. N. (2012). Overview of Mc Cdma PAPR Reduction Techniques. *arXiv preprint arXiv:1204.3874*.

[3] Izakian, H., Ladani, B. T., Zamanifar, K., & Abraham, A. (2009, March). A novel particle swarm optimization approach for grid job scheduling. In *International Conference on Information Systems*, *Technology and Management* (pp. 100-109). Springer Berlin Heidelberg.

[4] Popovic, B. M. (1999). Spreading sequences for multicarrier CDMA systems. *IEEE Transactions on Communications*, *47*(6), 918-926.

[5] Hung, H. L., & Huang, Y. F. (2011). Peak to average power ratio reduction of multicarrier transmission systems using electromagnetism-like method. *Int J Innov Comput Inf Control*, *7*(5A), 2037-2050.

[6] Kaur, J., & Arora, K. (2013). Performance analysis of PAPR reduction techninques for MC-CDMA system. *International Journal of Scientific & Engineering Research*, *4*(8), 208.

[7] Wen, J. H., Lee, S. H., Huang, Y. F., & Hung, H. L. (2008). A suboptimal PTS algorithm based on particle swarm optimization technique for PAPR reduction in OFDM systems. *EURASIP journal on wireless communications and networking*, *2008*(1), 1-8.

[8] Kaur, G., & Kaur, R. (2012). Comparative study of SLM and PTS techniques for PAPR Reduction of an MC-CDMA system. *International Journal of Engineering Research and Applications*, *2*(4,779-784).

[9] Gupta, N., & Saini, G. (2012). Performance Analysis of BFO for PAPR Reduction in OFDM. *Int. J. Soft Comput. Eng*, *2*(5), 127-133.

[10] Kumar, D., Singh, P., & Singh, J. (2013). Complexity Reduction in PTS based OFDM System: A Survey. International Journal of Computer Applications, 69(13).

[11] Singla, K., & Kaur, R. Ant Colony Optimization Algorithm For PAPR Reduction In Multicarrier Code Division Multiple Access System.

[12] Sumala, Prasanth R., Bharadwaj R.A.S., Shaik Azeez. (2014). Performance Analysis Of Multicarrier Cdma Systems. IJIRCCE, 2(1).

[13] Bai, Q. (2010). Analysis of particle swarm optimization algorithm. Computer and information science, 3(1), 180.

[14] Kaur, G., & Kaur, R. (2012). PAPR Reduction of an MC-CDMA System through PTS Technique using Suboptimal Combination Algorithm. International Journal of Engineering Research and Applications (IJERA), 2, 1192-1196.

[15] García-Otero, M., & Paredes-Hernández, L. A. (2011). PAPR reduction in SFBC MIMO MC-CDMA systems via user reservation. EURASIP Journal on Advances in Signal Processing, 2011(1), 1.

[16] Gupta, N., & Saini, G. (2012). Performance Analysis of BFO for PAPR Reduction in OFDM. Int. J. Soft Comput. Eng, 2(5), 127-133.

[17] Manjith, R., & Suganthi, M. (2013). A SUB-OPTIMAL PTS ALGORITHM BASED ON BACTERIAL FORAGING OPTIMIZATION TECHNIQUE FOR PAPR REDUCTION IN MIMO-OFDM SYSTEM. Journal of Theoretical & Applied Information Technology, 57(2).

[18] Fedra, Z., Marsalek, R., & Sebesta, V. (2007). Chip Interleaving and its Optimization for PAPR Reduction in MC-CDMA. Radioengineering, 16(4), 19-23.

[19] Memon S.A., Umrani W.A., Umrani F.A., & Baloch A.K. (2011) A Peak to Average Power Ratio Reduction of Multicarrier CDMA System Using Error Control Selective Mapping. Progress In Electromagnetics Research Symposium Proceedings, Marrakesh, Morocco.

[20] Manjith, R., Ramesh, S. C., & Majeed, M. M. I. (2010, July). PAPR reduction in OFDM & MC-CDMA system using nonlinear companding techniques. In Computational Technologies in Electrical and Electronics Engineering (SIBIRCON), 2010 IEEE Region 8 International Conference on(pp. 274-278). IEEE.