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PAPR REDUCTION in OFDM SYSTEM USING ANT COLONY OPTIMIZATION

Sonia Singla[1], Vikas preet tiwana[2]

Electronics & Communication Department[1]

University College of Engineering, Punjabi university Patiala, Punjab, India[2]

Abstract: In the fast growing communication world, orthogonal frequency division multiplexing modulation technique plays an important role in long distance communication. OFDM is a multi carrier modulation scheme which enables transmission of multiple signals, simultaneously over a single transmission path. But peak to average power ratio (PAPR) has become a challenge to this technique. Many methods proposed to reduce PAPR. In this paper, swarm intelligence based ant colony optimization technique is proposed to reduce the PAPR problem. Simulation results show that presented technique has effectively reduced the PAPR value and probability of having PAPR value.

Keywords: PAPR, OFDM, ACO, PSO

I. INTRODUCTION

Wireless communication systems has been developing and evolving with furious pace. In this high-speed wireless and mobile communications era, OFDM technology is a special Multi-Carriers Modulation transmission scheme which can be seen as either a modulation technology or a multiplexing technology enabling transmission of multiple signals simultaneously, over a single transmission path. The principle of OFDM is to divide a single high-data-rate stream into a number of lower rate streams that are transmitted simultaneously over some narrower sub channels. Hence it is not only a modulation (frequency modulation) technique, but also a multiplexing (frequency-division multiplexing) technique. The word “orthogonality" implies that there is a precise mathematical relationship between the frequencies of the individual subcarriers in the system [22]. It has been widely adopted for many telecommunication standards such as digital video broadcasting, WIMAX, Long Term Evolution and IEEE 802.11a/g WLAN. Nowadays, it has been adopted as a potential candidate for fourth-generation (4G) mobile communications systems, including the downlink radio transmission in long term evolution (LTE) [2]. It has simple implementation by FFT (fast Fourier transform) and has a low receiver complexity. By combining multiple low-data-rate sub- carriers, OFDM systems can provide a composite high-data-rate with long symbol duration. That helps to eliminate the ISI (inter-symbol interference), which often occurs along with signals of a short symbol duration in a multipath channel [22].

Despite of several advantages OFDM system has one biggest challenge i.e. peak to average power ratio. PAPR of OFDM leads to a high requirement of analog to digital or digital to analog converter and high power amplifier (HPA). Transmitting, filtering and D/A conversion further complicate the PAPR problem. However, since the appearance of peak power is random, the linear amplifier must not have been working in the most efficient state, resulting in low power efficiency. Power amplifier nonlinear distortion results in intermodulation distortion and adjacent channel interference, which reduce the performances of communication system directly [18].

Several techniques are proposed to reduce PAPR problem. These techniques are categorized as signal scrambling techniques and signal distortion techniques. Signal Scrambling Techniques include Block Coding Techniques[5][7][15], Selected mapping (SLM) [19][4],Partial Transmit Sequence (PTS) [16][12],Interleaving Technique[12], Tone Reservation (TR)[13], Tone Injection (TI)[12] etc are Signal Scrambling Techniques.Signal Distortion Techniques: Signal distortion techniques are Clipping and Filtering [10][14], Peak Windowing [12], Envelope scaling[12].

In this paper we have proposed techniques to reduce peak to average power ratio using ant colony optimization (ACO). ACO is a metaheuristic approach for solving hard combinatorial optimization problems. The inspiring source of ACO is the pheromone trail laying and following behavior of real ants which use pheromones as a communication medium.

The remainders of this paper are organized as follows. In Section 2, peak to average power ration is defined. Section 3

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explains the ant colony optimization algorithm. Section 4 explains the simulation results. Section 5 is conclusion.

II. Peak to average power ratio

Definition: The PAPR is the relation between the maximum power of a sample in a given OFDM transmit symbol divided by the average power of that OFDM symbol [1].

Mathematically

Let *N* symbols in OFDM are defined by {*Xn*, *n* = 0,1,2,..., *N* -1}.A set of *N* sub-carriers, i.e., { *fn* ,*n* = 0,1, 2,..., *N* -1} , is used for these symbols in OFDM. The *N* sub-carriers are chosen to be orthogonal, that is, *fn* = *n*Δ*f* in frequency domain, where Δ*f* =1/ *NT* and *T* is the OFDM symbol duration. The OFDM signal is expressed as

$x(t) = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} X_n e^{j2\pi f_n t}$ t= 0, 1, 2 …..N-1

The PAPR is defined by

$$PAPR = \frac{\max|x(t)|\text{^}2}{E[|x(t)|\text{^}2]}$$

where *E*[.] denotes expectation [3].

An OFDM signal consists of a number of independently modulated sub-carriers which can give a large PAPR when added up coherently. When N signals are added with the same phase they produce a peak power that is N times the average power of the signal. So OFDM signal has a very large PAPR, which is very sensitive to nonlinearity of the high power amplifier [1].

The Cumulative Distribution Function (CDF) is one of the most regularly used parameters, which is used to measure the efficiency of any PAPR technique [6]. Complementary CDF curve shows how much time the signal spends at or above a given power level. In other words the CCDF of PAPR denotes the probability that the PAPR of an OFDM symbol exceeds a given threshold PAPR0, that is, the CCDF of PAPR can be written as[19]

$CCDF$ (PAPR0) = (PAPR > PAPR0)

The power level is expressed in dB relative to the average power. A CCDF curve is basically a plot of relative power levels versus probability. The CCDF is the

Complement of the CDF or CCDF = 1 – CDF [17]

III. Ant colony optimization

ACO was proposed by Marco Dorigo in 1992 in his PhD Thesis [20]. The model proposed by Deneubourg and co-workers for explaining the foraging behavior of ants was the main source of inspiration for the development of ant colony optimization [9]. Ant colony optimization is based on the technique known as Swarm Intelligence, which is a part of Artificial Intelligence. Artificial Intelligence is the science and engineering of making intelligent machines, especially intelligent computer programs [20].

Ant Colony Optimization (ACO) is a metaheuristic approach for solving hard combinatorial optimization problems. The inspiring source of ACO is the pheromone trail laying and following behavior of real ants which use pheromones as a communication medium. In analogy to the biological example, ACO is based on the indirect communication of a colony of simple agents, called (artificial) ants, mediated by (artificial) pheromone trails. The pheromone trails in ACO serve as distributed, numerical information which the ants use to probabilistically construct solutions to the problem being solved and which the ants adapt during the algorithm's execution to reflect their search experience [11].

A classic example of the construction of a pheromone trail in the search for a shorter path is shown in Figure 1 .In Figure 1A there is a path between food and nest established by the ants. In Figure 1B an obstacle is inserted in the path. Soon, ants spread to both sides of the obstacle, since there is no clear trail to follow (Figure 1C). As the ants go around the obstacle and find the previous pheromone trail again, a new pheromone trail will be formed around the obstacle. This trail will be stronger in the

shortest path than in the longest path, as shown in Figure 1D [21]

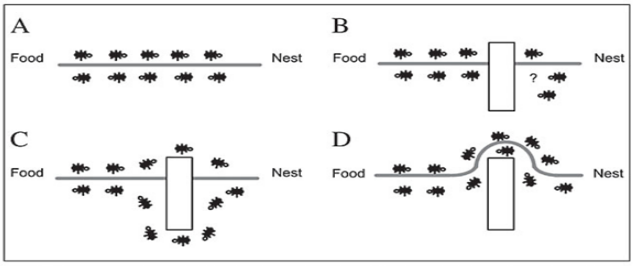

Figure 1:A. Ants in a pheromone trail between nest and food; B. an obstacle interrupts the trail; C. ants find two paths to go around the obstacle; D. a new pheromone trail is formed along the shorter path.

Fig. 1: Construction of pheromone trail

A.Biological analogy

In many ant species, individual ants may deposit a pheromone (a particular chemical that ants can smell) on the ground while walking. By depositing pheromone they create a trail that is used to mark the path from the nest to food sources and back. In fact, by sensing pheromone trails foragers can follow the path to food discovered by other ants. Also, they are capable of exploiting pheromone trails to choose the shortest among the available paths taking to the food [11].

IV. Simulation results and comparisons

We have used ant colony optimization to reduce the PAPR of the OFDM system. We have calculated PAPR of the original signal and processed signal.

Simulation parameters are:

a) Number of bits transferred =10000

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b) Modulation technique used=QPSK
c) FFT length= 500
d) Subcarrier =52
e) Number of FFT point = 64
f) Channel model = Rayleigh fading channel

Figure 2 shows the discrete data received using ant colony algorithm.

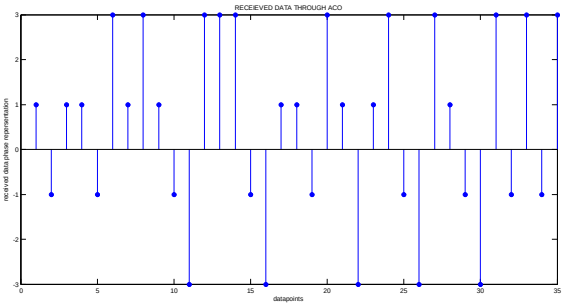

Fig2. Discrete data using ant colony algorithm

Figure 3 shows the PAPR of original signal and processed signal. Original signal has the PAPR value of 9 dB and the maximum probability of having PAPR greater than threshold value is 0.24. When the signal is processed using ant colony optimization, it reduces the probability of PAPR to 0.16. Decrease in probability of PAPR means possibility of having PAPR is reduced and thus PAPR is reduced using ant colony optimization.

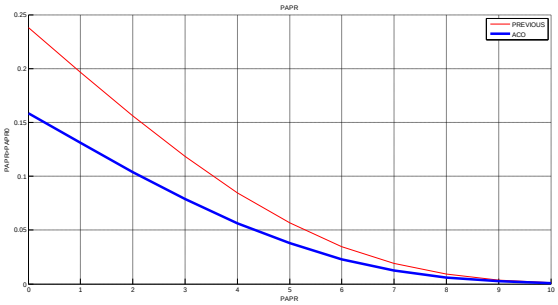

Fig 3. PAPR of signal using ACO

Conclusion

OFDM system plays and important role in today's high speed communication world. PAPR is one of the problems of OFDM system. In this paper we have presented an ant colony optimization algorithm which is inspired by the behavior of ants. Simulation results show that this technique has reduced the PAPR value. It has also reduced the probability of having PAPR value. A decrease in probability means there is less possibility of presence of PAPR and thus decreases in PAPR.

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REFERENCES

[1]Arun Gangwar, Manushree Bhardwaj, "An Overview: Peak to Average Power Ratio in OFDM system & its Effect" at International Journal of Communication and Computer Technologies Volume 01 – No.2, Issue: 02 September 2012
[2] Badreddin Koussa, Smail Bachir, Clency Perrine, Claude Duvanaud, Rodolphe Vauzelle, "A Comparison of Several Gradient Based Optimization Algorithms for PAPR Reduction in OFDM Systems" IEEE 2012
[3]C.Pradabet, S.Yoshizawa, Y. Miyanaga "searching phase optimize in PTS-PAPR method by GA for PAPR reduction in OFDM-WLAN system" IEEE 2009.
[4]C. Pradabpet,K. Eupree,S. Chivapreecha,K. Dejhan , "New PAPR Reduction Technique for OFDM-WLAN in 802.11a Systems"at Ninth ACIS International Conference on Software Engineering, Artificial Intelligence, Networking, and Parallel/Distributed Computing IEEE 2008
[5]Curt Schurgers Mani B. Srivastava, "A Systematic Approach to Peak-to-Average Power Ratio in OFDM"
[6]Er. Sahibinder Singh, Er. Devesh Mahor , "Hybrid Evolutionary Algorithm Based on PSO to Reduce Non linear effect for 802.11a High Speed Network" at International Journal of Scientific & Engineering Research Volume 3, Issue 4, April-2012 ISSN 2229-5518
[7]Filbert H. Juwono and Dadang Gunawan,"The Effectiveness of Using Source Coding to Reduce PAPR in OFDM System" Senior Member, IEEE 2010
[8]Jia-Chyi Wu, Chi-Min Li and Chao-Chin Tseng, "A PDSI with STBC Scheme for PAPR Reduction in OFDM System" IEEE 2011
[9]Marco Dorigo, Mauro Birattari, and Thomas Stutzle, "Ant colony optimization, artificial ants as computational intelligence unit" in ieee computational intelligence magazine, november 2006
[10]Masaki Ojima and Takeshi Hattori "PAPR Reduction Method using Clipping and Peak-windowing in CI/OFDM System" IEEE 2007
[11] Marco Dorigo and Thomas Stutzle, "The Ant Colony Optimization Metaheuristic: Algorithms, Applications, and Advances"
[12]Md. Ibrahim Abdullah, Md. Zulfiker Mahmud, Md. Shamim Hossain, Md. Nurul Islam," Comparative Study of PAPR Reduction Techniques in OFDM" at ARPN Journal of Systems and Software VOL. 1, NO. 8, November 2011
[13]Malhar Chauhan, Prof.Abhishek Chobey ,"PAPR Reduction in OFDM system Using Tone Reservation Technique" at International Journal of Computer Technology and Electronics Engineering (IJCTEE) Volume 2, Issue 4, August 2012
[14]Md. Mahmudul Hasan and S. S. Singh, "An Overview of PAPR Reduction Techniques in OFDM Systems" International Journal of Computer Applications Vol 60– No.15, December 2012
[15]NNgajikin, N.Fisal and S.K. Yusof , "PAPR Reduction in WLAN-OFDM System Using Code Repetition Technique" IEEE 2003
[16]P. Mukunthan and P. Dananjayan, "PAPR Reduction of an OFDM Signal using Modified PTS Combined with Interleaving and Pulse Shaping Method" at European Journal of Scientific Research ISSN 1450-216X Vol.74 No.4 (2012), pp. 475-486 © EuroJournals Publishing, Inc. 2012
[17] Parneet Kaur , Ravinder Singh, "Complementary Cumulative Distribution Function for Performance Analysis of OFDM Signals" IOSR Journal of Electronics and Communication Engineering (IOSRJECE) ISSN : 2278-2834 Volume 2, Issue 5 (Sep-Oct 2012), PP 05-07
[18]Si Wang,Yulong Gao,XiuZhi Guan, "The Performance Analyses of PAPR Reduction Schemes for OFDM and Improvement" IEEE 2012
[19]Tung-chun Hsueh, Ping-you Lin and Jung-Shan-Lin, "PAPR reduction techniques with cross SLM schemes for MIMO-OFDM system" IEEE 2012.
[20]Utkarsh Jaiswal, Shweta Aggarwal, "Ant Colony Optimization" at International Journal of Scientific & EngineeringResearch Volume 2, Issue 7,July-2011 ISSN 2229 5518
[21]http://www.funpecrp.com.br/gmr/year2005/vol3-4/wob09_full_text.htm
[22]Zhongshan Wu,"MIMO-OFDM COMMUNICATION SYSTEMS: CHANNEL ESTIMATION AND WIRELESS LOCATION", thesis report submitted at the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College