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A GENETIC-SIMULATED ANNEALING ALGORITHM BASED ON PTS TECHNIQUE FOR PAPR REDUCTION IN OFDM SYSTEM

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ABSTRACT

Orthogonal frequency division multiplexing (OFDM) is widely used multiplexing technique, it is one of the parallel transmission schemes that reduce the effect of multipath fading, but it also have a major drawback which causes saturation in power. And this problem is known as high peak to average power ratio (PAPR), High peak to average power ratio can be reduce by many techniques. The promising technique which help in reducing PAPR is partial transmits sequence (PTS), because it does not deteriorate the orthogonality of subcarrier. But in this scheme the complexity for searching the phase factor is increased with increase in number of sub blocks. In this paper, genetic algorithm have been used which reduces complexity arises during calculating phase factor in the PTS technique.

Key words: Orthogonal Frequency Division Multiplexing (OFDM), Peak–to-Average Power Ratio (PAPR), Partial Transmit Sequence (PTS), Genetic Algorithm (GA), Advanced Genetic Algorithm (AGA)

(I)INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) is multi-carrier modulation technique. OFDM is combination of two well known processes, Modulation and Multiplexing. Modulation is process in which mapping of information is done on change in carrier phase, amplitude, frequency or combination. And Multiplexing is method of sharing bandwidth with other independent data channels. In recent year, OFDM is mainly used in digital audio broadcasting (DAB), digital video broadcasting-terrestrial (DVB-T), etc. Advantage of OFDM signal are, it is robust against ISI and fading as well as provide high spectral efficiency. But OFDM signal still have some drawback, one major drawback is high peak to average power ratio (PAPR) of time domain signal. High PAPR degrades efficiency of linear power amplifier. Therefore, main requirement is to reduce PAPR in OFDM signal. PAPR of original OFDM signal is approximately 11.5 dB.

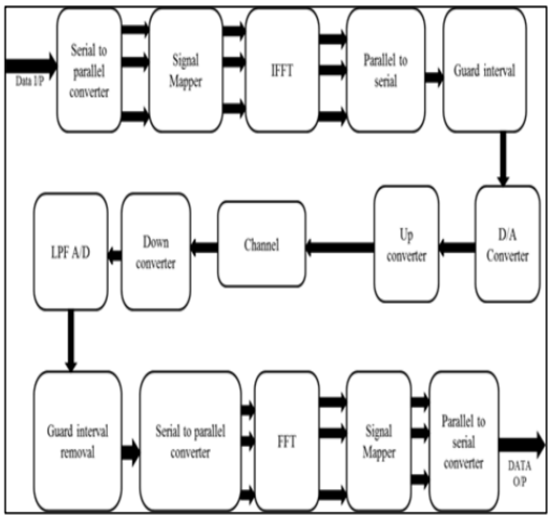

Fig. 1: Block diagram of OFDM signal

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To reduce PAPR there are various technique such as clipping , block coding , tone rejection (TR) , tone injection (TI) , selective mapping (SLM), partial transmit sequence(PTS) etc. Among this technique, PTS is promising and widely used optimization technique,

In this technique, an input data block of N symbol is partitioned into disjoint sub-blocks and then multiplied by appropriate phase factor to reduce PAPR. Using PTS need an exhaustive search of the possible phase factor to obtain optimal PAPR performance. Moreover the computational load becomes impractical while the number of sub-block and phase factor increased. So to reduce computational complexity the optimization algorithm such as genetic algorithm (GA) is used. Genetic algorithms (GA) (a type of evolutionary computing), are search techniques based on probabilities that reflect natural genetics. These algorithms are widely used to search for a global optimum in combinatorial problems due to their simplicity.

In this paper we present a novel technique for resource allocation in Multiuser Orthogonal Frequency Division Multiplexing (MU-OFDM) Systems with proportional rate constraint. The subcarrier allocation is tackled using a novel algorithm which combines the aspects of both deterministic and advanced genetic algorithms (AGA). For the calculated subcarrier allocation, bit-loading is done using the standard Water-filling Algorithm. This modified GA gave very encouraging results as can be seen from the simulation results shown. The simulation results show a marked improvement in the performance of the algorithm as the number of users increase. The capacity attained from the subcarrier allocation scheme generated by our algorithm is found to be comparable to that attained by previous algorithms.

(II) LITERATURE REVIEW

Many PAPR reduction techniques are proposed in the literature to reduce the PAPR of the OFDM signal. The PAPR reduction schemes are majorly divided into two categories

a) Distortion based Techniques
b) Non-distortion Techniques

The schemes that introduce spectral re-growth belong to distortion based category. These techniques are the most straightforward PAPR reduction methods. The clipping is one of the simplest distortion based technique to reduce the PAPR of OFDM signal. It reduces the peak of the OFDM signal by clipping the signal to the desired level but it introduces both in-band distortion and out-of-band radiation. To limit out-of-band radiation and PAPR, Jean Armstrong proposed iterative clipping and filtering scheme.

Companding is another popular distortion based scheme for PAPR reduction in OFDM system. In Wang et al. proposed a scheme based on μ-law companding to reduce the PAPR of OFDM signal. In μ-law companding scheme the peak value of the OFDM signal before and after companding remains same, which keeps peak power of the OFDM signal unchanged but the average power of the OFDM signal after companding increases and therefore the PAPR of the OFDM signal gets decreased. But due to increase in the average power of the OFDM signal the error performance of μ-law companding scheme degrades.

In Zhou et al. proposed MPSM-PTS scheme which extends the QPSK constellation points to disjoint points of 16-QAM constellation and eliminates the requirement of side information. The MPSM-PTS scheme is completely free from SI, i.e. extraction of SI from the received signal is not required. Hence the receiver structure of the scheme proposed is computationally less complex.

In wireless standards like LTE, OFDM is used in downlink, where mobile station acts as receiver. The mobile stations have limited computational resources; therefore, a PAPR

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reduction scheme with less computational complexity at receiving end will be more beneficial. As discussed above, the schemes proposed have computationally complex receiver in comparison to the schemes proposed. Hence, MPSM-PTS scheme is a viable choice for PTS-OFDM system.

(III) PROPOSED CONCEPT

The drawback of PTS is the high computational load. In [8], the genetic algorithm is combined with PTS technique to solve this problem. GA-PTS uses genetic algorithm as selection operator to search the best phase factors for PAPR reduction. Compared to PTS scheme, GA-PTS is a suboptimal approach but reduces the computational complexity. The procedure of GA-PTS for PAPR reduction is presented as follows: First, an initial population is generated randomly, the chromosomes in population are represented by binary vectors, and the bits in chromosomes are corresponding to phase factors of PTS technique. The PTS multiply by the phase factors that are transformed from the chromosomes to calculate the PAPR of OFDM signals. The fitness value of each chromosome in the population is calculated by a fitness function chosen by the user. The selected chromosomes directly enter the next generation of the population are generated by employing the Roulette wheel algorithm. Then, new chromosomes in the next generation of the population can be generated through crossover operator, mutation operator..

When the maximum number of generation iterates over, we can find the set of chromosomes that has the minimum PAPR. However, how to improve the performance of GA-PTS is still a popular research. In this paper, a new method named GSAA-PTS is proposed based on GA PTS to further improve the performance of PAPR and described in the next section.

(IV) PROPOSED GSAA-PTS ALGORITHM

In the paper, we add the annealing operator into the genetic algorithm to search the optimal combination of phase factor for PTS technique. In GSAA-PTS, the chromosomes represented by binary vectors in the initial population are generated randomly. One chromosome is transformed into a set of phase factors by associating each log2W bits of it. We give the coding rule when W=4 and M=4. In this case, b=(b1,b2,b3,b4)=(1,j,-1,-j), two bits of a chromosome are corresponding to a phase factor. The procedure of GSAA-PTS scheme is presented as follows:

1) Initialize the population: In GSAA-PTS, the population is generated randomly, which can be represented as P= [h1,…,hR].
2) Evaluation: We will calculate the fitness value of each chromosome using the fitness function [8]:
3) Selection: In this generation of the population, we use the Roulette wheel algorithm to select (1-pc)/R individuals and add them into Ps directly, the probability of selection of hi is
4) Crossover: We take the one-point crossover with probability pc to the pcR/2 pairs of chromosomes which are not selected in step (3), and then add the offspring into Ps.
5) Mutation: Each chromosome of Ps mutates with the mutation probability pm. Mutation means flipping a bit of the chromosome randomly.
6) Update the population P P s .
7) Calculate the fitness value: We calculate the fitness value fi of hi (i=1,…,R) in the new population, then generate a new chromosome randomly, and calculate the fitness value fi’ of it. If fi' > fi , replacing hi with the new chromosome, otherwise, replacing hi with the new chromosome according to the probability .
8) Update the annealing temperature T Tα , where α is usually chosen in the range 0.8<α<1.

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9) Return to step (2) if not achieve the maximum number of generations G.
10) The chromosome with highest fitness value is picked out from the G×R chromosomes, and the chromosome is decoded according to the coding rule to obtain the phase factor vector.

(V) AGA ALGORITHM

The advent of new generation of communication technologies has ushered in an era of high data rates and better reliability. MU-OFDM is a promising modulation technique which mitigates the effect of frequency selective fading and combat inter-symbol interference which is inherent in high data rate environments. MU-OFDM is used in wireless LANs, and can support high data rate transmission. It can also be used for multiple accesses. Resource allocation in multiuser OFDM includes subcarrier allocation, power allocation, and bit loading. Developing efficient resource management techniques for such a setup has drawn enormous attention in recent years.
Solution to the resource allocation problem in multiuser OFDM has been broadly divided into two categories: Margin Adaptive (MA) and Rate Adaptive (RA). Resource allocation was tackled in using margin-adaptive scheme, wherein an iterative subcarrier and power allocation algorithm was proposed to minimize the total transmit power given a set of fixed user data rates and the Bit Error Rate (BER) requirements. In rate adaptive method was used wherein the objective was to maximize the total data rates over all users, subject to power and BER constraint. It was shown in that in order to maximize the total capacity each subcarrier should be assigned to the user with best gain on it. The MA Optimization technique has been dealt with efficiently. Genetic algorithm has been used here for resource allocation and the algorithm has shown better results than normal iterative algorithms. In it was shown that RA optimization can be solved sub-optimally by separating Subcarrier allocation and Bit Loading. The RA optimization problem is a mixed binary integer programming problem.
In the proportional rate constraint is added to the existing RA optimization problem. However, the introduction of this constraint makes the optimization problem non-linear thus increasing the difficulty in finding the optimal solution because the feasible set is not convex.
Rate maximization and satisfying total power constraints are two seemingly conflicting objectives with a lot of trade-offs. To simplify the problem, both of them are dealt separately. In this paper, we propose using a modified GA and Water-filling algorithm to optimize the RA. The proposed GA is used to generate the subcarrier allocation assuming equal power to all users. After the subcarrier allocation, the bit loading can be performed using the water filling algorithm. The inspiration for the genetic approach comes from the fact that GAs are ideal for optimization problems with a large feasible solution space where a quick sub-optimal solution will suffice. Also, the fact that GAs is seldom used to solve RAs further deepened our inquisitiveness to explore this option.
This paper presents a new method to solve the rate adaptive resource allocation problem with proportional rate constraint for OFDMA systems. It improves on the previous work in this area by developing a novel GA for subcarrier allocation scheme that achieves approximate rate proportionality while maximizing the total capacity. This scheme was also able to exploit the special linear case, thus allowing the optimal power allocation to be performed using a direct algorithm with a much lower complexity versus an iterative algorithm. It is shown through simulation that the proposed method performs better than the previous work in terms of achieving higher total capacities, while being applicable to a more general class of systems. However, the algorithm presented is slightly demanding computationally. The future scope of this paper is to try and bring down the computational demands of the algorithm presented

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(VI) RESULTS

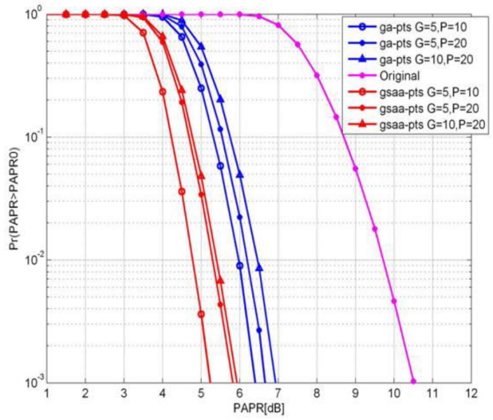

Fig 2 : Comparison of PAPR CCDF of GA-PTS and GSAA-PTS with 64 subcarriers

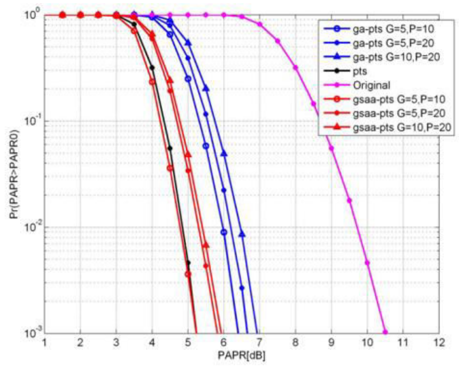

Fig 4: Comparison of PAPR CCDF of GA-PTS and GSAA-PTS with original PTS having 64 subcarriers

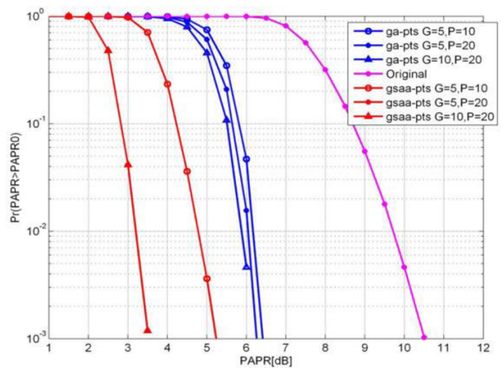

Fig 3 : Comparison of PAPR CCDF of GA-PTS and GSAA-PTS with 128 subcarriers

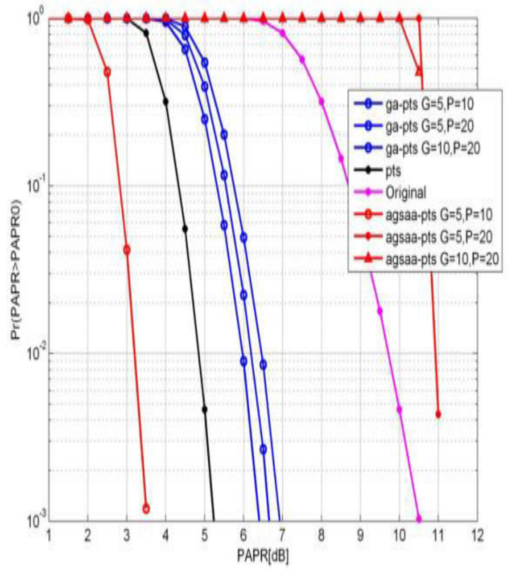

Fig 4: Comparison of PAPR CCDF of GA-PTS and AGSAA-PTS with original PTS having 128 subcarriers

VI. CONCLUSION

This paper presents a new method to solve the rate adaptive resource allocation problem with proportional rate constraint for OFDMA systems. It improves on the previous work in this area [8] by developing a novel GA for subcarrier allocation scheme that achieves approximate rate proportionality while maximizing the total capacity. This scheme was also able to exploit the special linear case, thus allowing the optimal power allocation to be performed using a direct algorithm with a much lower complexity versus an iterative algorithm. It is shown through simulation that the AGA proposed method performs better than the previous work in terms of achieving higher total capacities, while being applicable to a more general class of systems. However, the AGA algorithm presented is slightly demanding computationally. The future scope of this paper is to try and bring down the computational demands of the algorithm presented.

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