A Survey on PAPR Reduction in MC-CDMA

Renu Devi[1], Jagtar Singh[2], Ajay Kumar Jaiswal[3]
[1]*M.Tech, ECE Deptt., NCCE, Israna, Panipat, India*
[2]*HOD, ECE Deptt., NCCE, Israna, Panipat, India*
[3]*Sr. Lecturer, ECE Deptt., NCCE, Israna, Panipat, India*

Abstract - Multi Carrier Code Division Multiple Access (MC-CDMA) could be a promising technology for 4G wireless communication systems. Orthogonal Frequency Division Multiplexing (OFDM) and Multi Carrier Code Division Multiple Access (MC-CDMA), that convert frequency selective channel to many flat attenuation channels thereby eliminating inter symbol interference and successively would like of equalization. Like all different multicarrier techniques MC-CDMA conjointly suffers from high Peak-to-Average Power (PAPR) drawback. To combat the matter of high PAPR, several techniques are projected. during this paper we've got surveyed those techniques and analyzed that PAPR reduction is that the non linear programming drawback that is resolved by optimisation algorithms. Later we have a tendency to found that a hybrid optimization algorithm rule is best suited rule supported previous study.

I. INTRODCUTION

In all multicarrier techniques Inverse Fast Fourier Transform (IFFT) is the main building block for generation of orthogonal subcarriers. Occasionally, all the subcarriers may get added to give a very high transmitted power. This high transmitted power may be significant in deviation from the mean power giving rise to high Peak-to-Average Power Ratio (PAPR) which is given as the ratio of maximum power to average power. This high PAPR may affect the orthogonality of the subcarriers. Once the orthogonality is lost many problems arise. High PAPR has been a bottleneck for multicarrier techniques. Like all multi-carrier techniques, STBC MC-CDMA suffers from high PAPR. The high PAPR of the transmitted signal which in turn results in high input-back-off (IBO) for the power amplifier, drives the power amplifier to operate in non-linear region generatinginter modulation (IM) products. IM causes out-of-band emissions and in-band distortions. Out-of-band emissions, or spectral regrowth, result an increased transmission bandwidth and causes Adjacent Channel Interference (ACI) and in-band distortion causes self-interference and degrades bit error rates performance at the receiver. So it is highly essential to alleviate this problem. To combat the problem of high PAPR, many techniques [5] have been proposed. The mathematical calculation of PAPR is as:

Let X denote data vectors such that$X = [X_0, X_1 \dots X_{N-1}]^T$ [1] where, being no of subcarriers. The time domain complex baseband representation of this data block for a multicarrier signal can be represented as

$$x_i = IFFT\{X\} = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} x_k e^{j2\pi k/N}$$

Since the multicarrier signal is a combination of large no of independent subcarriers it may exhibit high PAPR. The PAPR of the transmitted signal can be represented by

$$PAPR = \frac{\max_{0 \le i \le N-1} |x_i|^2}{{\sigma_x}^2}$$

From the central limit theorem, the in-phase and quadrature phase components of the time domain samples resemble Gaussian distribution with mean zero and variance of ${\sigma_x}^2$for sufficiently large no of subcarriers [6]. The numerator in the above equation represents the maximum power where the denominator is the average power which can also be termed as variance of the time domain samples. In literature review it has been notified that comparison of algorithms is done graphically between PAPR and CCDF (Complementary Cumulative Distribution Function). The Cumulative Distribution Function (CDF) of amplitude of a signal sample can be represented as

$$F(z) = 1 - e^{-z}$$

where z is pre-set threshold. Then the CCDF can be defined as

CCDF=1- CDF

Thus CCDF of the PAPR denotes the probability that the PAPR of a data block exceeds a given threshold. Mathematically,

$$CCDF: P(P\{APR > Z) = 1 - P(PAPR \le Z)$$
$$= 1 - F(z)^n$$

In the further section of paper, the previous work done is briefly classified in survey papers and research papers which all are dealing the PAPR reduction in OFDM or MC-CDMA. A total of 30 papers were studied out of which 8-10 papers were survey paper which give us an insight view of all previously used schemes. Last section is the conclusion section in which we concluded our analysis about the literature available.

II. PREVIOUS WORK

The complexity of PTS method increases exponentially with the number of sub blocks and Parandoosh, A. [2] saw this problem as non linear problem and suggested particle swarm optimisation (PSO) algorithm as the solution to achieve the optimum value of number of sub blocks. In [2] the computational complexity of conventional PSO algorithm is also reduced with improved PSO. Results are analysed for QPSK modulations and different sub blocks length. Improved PSO promised improvement than conventional PSO. Hung, H. [5] presented the mathematical formulation of MC-CDMA along with PTS scheme. It has also converted the problem to non linear complex problem and solved iteratively. Electromagnetism-Like method was adopted by the author and comparison with conventional PTS scheme in term of PAPR vs CCDF was shown. Results have been compared with other iteration methods like PSO, GA with different number of sub blocks and proposed method was the winner. Since the computational complexity reduction ratio increases as the number of sub-carriers increases, the proposed scheme becomes more suitable for the high data rate multi-carrier transmission systems. Kaur,J. [6] presented a paper reviewing different techniques to reduce PAPR. Author has compared simulation results for different schemes like selective linear mapping (SLM), partial transmit sequence (PTS) and hybrid algorithms. Hybrid technique is combination of Partial Transmit Sequence and Selective Mapping Technique. Using 8, 16 and 32 users with Hadamard spreading algorithm, hybrid scheme proved to be minimising the PAPR most. As per the statistics published in the paper PTS reduces the PAPR to 2.9 dB, SLM to 2.2 dB and hybrid reduces to 1.5 dB form the original PTS PAPR. The same author presented a survey paper comparing the performance of PTS and SLM schemes only [8] and another survey paper for all PAPR reduction scheme is also published [12]. Wen [7] in his paper used PSO algorithm to reduce the PAPR iteratively. Weighting factors of sub blocks in PTS scheme were tuned by PSO and it analyzed the PAPR reduction performance which is derived by using adjacent, interleaved, and random sub block partitioning methods. Random sub block partitioning method has derived the most effective performance, and interleaved sub block partition method has derived the worst. because the range of subblocks is augmented, PAPR is more reduced. Simulations results show that PSO-based PTS methodology is an efficient methodology to compromise a much better trade off between PAPR reduction and computation quality. once more Gupta, N. [9] used the construct of nonlinear equations to minimise the PAPR and bio impressed microorganism hunting improvement (BFO) that is predicated on the motion of E. Koli bacterium in search of its food. Results ar compared with several alternative heuristic formulas like genetic algorithm (GA), simulated hardening (SA), PSO. EM etc and BFO looks to be activity well than rest. Kumar D. [10] once more printed a survey paper of PAPR reduction victimisation PTS theme and projected hymenopter Colony improvement will provide higher reduction. Singla K. [12] proceeded the work recommended in [10]. Teh author used the hymenopter colony improvement (ACO) formula to scale back PAPR. It calculated PAPR for various range of users victimisation BPSK and QPSK modulation. From MATLAB simulation it's over that BPSK modulation is best for PAPR reduction in MHz CDMA. PAPR reduction will increase as we tend to increase range of user. Mariano in [16] projected a PAPR reduction theme for space-frequency block committal to writing MC-CDMA downlink transmissions that doesn't need any process at the receiver aspect as a result of it's supported the addition of signals using the spreading codes of inactive users. more it analysed varied schemes for PAPR reductions considering it as a second order programming downside. R. Manjith [18] in 2013 use once more the microorganism hunting improvement theme that was conjointly utilized in paper [9]. Sajjad A. Memon [20] extended the antecedently projected selective mapping methodology for PAPR management in MCCDMA to error-control selective mapping committal to writing (EC-SLM) for each effective PAPR reduction and error management. many renowned European Community codes like convolutional codes, turbo codes and LDPC codes is adopted in new EC-SLM approach. Simulation results have shown that, the EC-SLM is simpler than the SLM in reducing the PAPR of MC-CDMA and avoid the requirement for the transmission of specific aspect info. Simulation results conjointly showed that the increasing number of PAPR management bits ends up in a lot of reduced PAPR worth however conjointly will increase the system complexity. R. Manjith [20] used 3 non linear companding algorithms owing to their least quality. These non linear companding algorithms rework the mathematician distributed OFDM signals to uniformly distributed signals. D. Narendra [21] extended the construct of PAPR reduction to 4G wireless technology. He compared varied reduction schemes like Clipping, Companding, Selective Mapping (SLM), Interleaving, Tone reservation (TR) Tone Injection (TI) and Partial Transmit Sequence (PTS) and eventually simulated PTS based mostly theme in MATLAB. Tanairat [22] did the work totally different kind antecedently studied. He used re ordering of clusters in frequency domain to scale back PAPR instead of any PTS based mostly theme. He projected the new PAPR reduction methodology supported the packet-switched transmission systems within which all the clusters within the sure range of OFDM symbols have the ordered cluster ID numbers embedded within the header of every cluster. The salient options of the projected methodology are to boost the PAPR performance each for knowledge and cluster ID numbers at the same time by re-ordering of clusters within the frequency domain at the transmitter and to reconstruct the first order of clusters by victimisation the cluster ID numbers embedded within the data information at the receiver. This paper conjointly proposes the computation quality reduction technique for the mythical monster methodology by victimisation the feature of IFFT process. The projected mythical monster methodology is totally totally different from the PTS methodology that is needed to tell the part coefficients obtained once the PTS process because the aspect info to the receiver singly. From this truth, The PTS methodology

encompasses a problem to enter the part coefficients of PTS into the data information singly while not the degradation of PAPR performance. After reviewing such a lot of papers we have a tendency to found that PAPR reduction drawback may be a non applied math drawback that is minimised iteratively. most iteration strategies used ar either PSO or variant of PSO. thanks to this we've studied some paper on PSO too. we've come upon several blessings of PSO algorithmic program love it may be a quite versatile algorithmic program which might be fitted to any scientific and analysis drawback [14]. Compared to different optimization algorithms it's an outsized looking house. Even owing to several blessings and sensible optimization capability of PSO, it's a disadvantage that it falls into native minima simply. That's why for additional complicated issues it's going to skip the optima purpose typically. to get rid of it we have a tendency to searched a additional economical algorithmic program that is intended on PSO platform however not the variant of PSO. Firefly algorithmic program is that the algorithmic program that came to get rid of the drawbacks of PSO with PSO's blessings. Firefly algorithmic program has 2 major advantages: automatical subdivision and also the ability of addressing multimodality [26].

III. CONCLUSION

We have studied many papers related to PAPR reduction, published in between 2010-16. After studying 27 papers for insight view of what till now has been done for PAPR reduction in wireless communication, it has been noticed that every author has termed as PAPR reduction scheme as non linear problem and used optimisation schemes to reduce that. Many optimisation algorithms have been used by different authors and these are categorised as in table 1 in appendix. Most of the algorithms are based on PSO optimisation or it's variant but due to drawback falling in local optima, we have found hybrid algorithm which is a combination of PSO and GSA (gravitational Search Algorithm), most efficient than PSO.

IV. REFERENCES

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Table 1 PAPR reduction techniques comparison

Technique name	Power increase	Distortion-less	Loss in data rate	Computational Complexity
Amplitude clipping & filtering	No	No	No	Low
Coding	No	Yes	Yes	Medium
Partial Transmit Sequence	No	Yes	Yes	Very High
Selected Mapping	No	Yes	Yes	High
Interleaving	No	Yes	Yes	Medium
Tone Reservation	Yes	Yes	Yes	Medium
Tone Injection	Yes	Yes	No	Medium
Active constellation extension	Yes	Yes	No	Medium