Impression of PAPR Reduction Techniques in MC-CDMA

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ABSTRACT

Multicarrier communication systems are facing a significant trouble in reality.Multi-Carrier Code Division Multiple Access and Orthogonal Frequency Division Multiplexing be the pattern of multicarrier modulation systems. The difficulty in veracity is owing to the existence of huge quantity of subcarriers. As a result it outcome with high Peak to Average Power Ratio which introduce solemn disturbances for instance lower resolution and reduction in battery life. Thus it is essential to diminish this high Peak to Average Power Ratio. Reduction in PAPR have showed the way of consuming less power, low bit error rate, improvement in spectral bandwidth, lesser amount of complexity and cost. In this paper different PAPR reduction techniques was investigated and in addition the principles for choosing the PAPR reduction technique were also analyzed.

Keywords

PAPR, OFDM, MC CDMA, BER

1. INTRODUCTION

The combination of OFDM and Code Division Multiple Access (CDMA) results in MC-CDMA system. The remuneration of the above mentioned performances has been gathered by Multi carrier Code division Multiple Access. The modulated bits present in data symbols get spreaded by spreaded codes in MC CDMA.Subsequent to spreading the bits are represented in frequency domain. This method results in transmission of high speed signals, enhancement in security and diminishing multipath effects such as Inter Carrier Interference (ICI) and Inter symbol Interference (ISI).MC-CDMA can be extensively used in wireless networks of the accessible 3rd and4th generation. It also serves as an excellent applicant for personal and broadband communications.MC-CDMA can also be comprehensively used for WiMAX, Long Term Evaluation and Digital TV transmission. Dispersion in time, subcarrier selection of phase and frequency offset, high PAPR and synchronization are some of the practical concern in MC CDMA.Digital television, Digital audio broadcasting, Transmission of Digital data over the Telephone system are some of the relevance of Multicarrier modulation system. Despite Multicarrier modulation system is used in number of applications it suffer from innate trouble of high PAPR.High PAPR results in corruption of the transmitted signal, increase in Bit Error Rate, ensuing in-band radiation (IBR) and out-of-band radiation (OBR) when peak of the signal penetrates into saturation region. Out-of-band radiation in turn outcome with Adjacent Channel Interference (ACI).Additional drawback due to high PAPR results in complexity of converter design, raise in interference, elevated cost, more power consumption and reduction in battery life. Loss of orthogonality in subcarrier and increment in spectral growth arises owing to non-linear distortion in High Power amplifiers are also added as a negative aspect.Inspite of all these concern high PAPR should be completely reduced. Reduction of high PAPR results in consumption of low power and enrichment in battery life and bandwidth.

Numerous methods are projected for reduction of high PAPR [1].These methods include windowing, peak cancelling, companding, clipping and filtering. The different types of companding method include μ-Law [2], modified exponential, linear companding [4] and exponential [3].The concept beyond companding method is compressing signal at transmitter and expanding signal at receiver end. Although clipping is straightforward and efficient it introduces enlarged BER. Since distortion can be considerably reduced by companding method companding transforms are superior with respect to clipping. Enhancement of BER can be accomplished by an algorithm using a special airy function [1] which in turn reduces PAPR in an effective manner.

Explicit side information and multiple signals representations are the techniques anticipated for signal scrambling. Linear block codes are used for scrambling the signal with explicit side information. Tone Reservation (TR), Selective Mapping (SLM), interleaving and Partial Transmit Sequence (PTS) schemes [5] comes under the category of multiple signal representations. Block coding, dummy sequence insertion method, Hadamard transform method, Golay complementary codes, Reed Muller codes etc are the various format planned without side information. Storing look up table which are larger for encoding and decoding, executing in-depth search to discover best codes and increase in complexity are some of the issues of signal scrambling system that does not affect the concert of the method. Moreover error corrections are not maintained by signal scrambling. Without side information PAPR can be reduced by Error control selective mapping and Tone Reservation. On the other side, Tone Reservation increases BER and Error control selective mapping increases complexity. Complexity can be reduced by Pilot tone method and signal constellation in which baseband signal gets separated for all modulations. In addition pulse shaping schemes also reduces PAPR without side information. Furthermore pulse shaping schemes has the following merits such as flexibility, efficiency and less implementation complexity.

2. PAPR OF MC CDMA SIGNAL

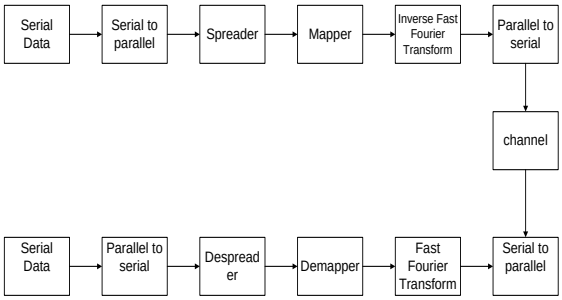

Fig 1: Obstruct illustration of MC-CDMA

Fig 1 illustrates the obstruct description of MC-CDMA.Data symbols are transmitted simultaneously on several narrow band sub channels. The spreading of data symbols is done using Inverse Fast Fourier Transform which are then modulated and mapped in frequency domain. Using spreading sequence, the data gets spreaded by the spreader in time domain which is then applied to mapper followed by conversion. Single chip are used to modulate orthogonal overlapping subcarriers obtained by the division of bandwidth using IFFT.Inter Symbol Interference can be overcome by inserting guard interval or cyclic prefix prior converting the data into serial form. The reverse operation takes place at the receiver.

Generally, PAPR of MC CDMA signal p (t) can be defined as "the ratio between maximum power to the average power".

$$\text{PAPR} = \frac{\max[|p(t)|^2]}{E[|p(t)|^2]} \qquad (1)$$

Where E [.] represent expectation of average power

Mathematical representation of MC CDMA signal is defined as

$$\text{PAPR} = 10\log_{10}\frac{\max[|p(t)|^2]}{\frac{1}{T}\int_0^T |p(t)|^2\,dt} \quad \text{dB} \qquad (2)$$

3. CCDF OF PAPR

The concert of MC CDMA system can be measured by means of Complementary Cumulative distribution Function. The likelihood that PAPR of the data block which goes beyond the given threshold can be represented by means of CCDF.

The CCDF of PAPR of the data block with Nyquist rate sampling was given by

$$P(\text{PAPR} > Z) = 1 - P(\text{PAPR} <= Z) \qquad (3)$$

$$= 1 - F(Z)\,N_c \qquad (4)$$

$$= 1 - (1-\exp(-Z))\,N_c \qquad (5)$$

N_c represents orthogonal overlapping subcarriers.

4. PAPR MODELS

4.1 Clipping and Filtering

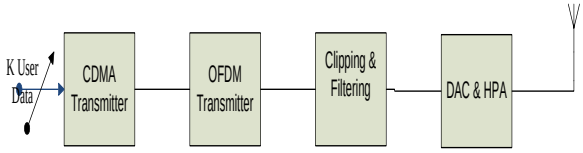

Fig 2: Representation of MC-CDMA with Clipping and Filtering

Fig 2: illustrate the combination of OFDM and CDMA transmitters. The data from the user is fed to the combination of CDMA and OFDM transmitter. Then the signal from the transmitter is supplied to Clipping and filtering which is then progressed through Digital to analog converter and High Power Amplifier. Optimum clipping ratio can be selected to remove high amplitude peaks and hence clipping is straightforward and efficient. However Inter block Interference and Out-of-Band radiation is initiated which corrupt method concert. This corruption can be reduced by filtering. On the other hand transmitted signal results in deformation due to filtering and this deformation can be concentrated by filtering and clipping repeatedly. In-Band Radiation can be improved without eroding Bit-Error Rate by means of filtering method. These techniques results in modification at the transmitter which leads to the addition of introducing additional blocks, without modifying the receiver section. Addition of IFFT results in complexity of the transmitter and hence this technique is expensive.

4.2 Companding

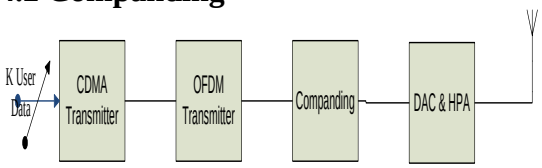

Fig 3: Replica of MC-CDMA with companding

Fig 3 illustrate the companding technique of MC CDMA.PAPR can be reduced by applying the companding transformation subsequent to IFFT block on the transmitter. Low amplitude signal are strengthened and high peaks are attenuated using companding transformation. The original signal can be recovered by means of inverse companding function prior to FFT block at receiver. High Power Amplifier is used for amplifying transmitted signal power. Due to fluctuations the linearity of signal gets disturbed. To maintain linearity in turn results in expensive HPAs. Companding reduces PAPR in simple and effective way. Compressing at transmitter and expanding at receiver results in companding. Exponential companding, μ-law companding are the types of companding technique.

The characteristics of exponential companding are constant average power and less spectrum of side lobes. On the other side μ-law companding does not maintain constant average power and also it results in generation of side lobes. On comparing exponential companding with μ-law companding, exponential companding suggest improved PAPR reduction, BER, phase error performance. Low implementation complexity, better Power spectral density, reduced PAPR, no

constraints on modulation format and subcarrier size [6, 7] and less complexity are the merits of companding technique.

4.3 Partial Transmit Sequence

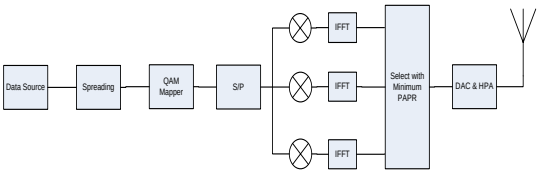

Fig.4: Representation of MC-CDMA with PTS

Minimization of PAPR using phase rotation of signal is the concept employed in Partial Transmit Sequence which results in reduction of signals and computational complexity. Where as in novel PTS scheme, complexity gets reduced without reducing the number of signals and in addition it also simplifies the calculation for every applicant signal. Fig.4:illustrate the MC-CDMA with PTS scheme [5].In this method input data progression gets separated into an amount of disjoint sub blocks, which are weighted down by phase factors to generate a set of applicant signals and finally the applicant with lesser PAPR was chosen for transmission.

Search complexity gets increased with increase in number of subcarriers by the selection of optimum set of phase factors in exhaustive search method. On the other side if number of subcarriers gets reduced it results in the reduction of search complexity.QAM mapper and arbitrary number of sub carriers are the requirements of PTS system. The concept beyond PTS is it uses Nc subcarriers which gets divided into Nc/2 sub blocks, and requires Nc/2 IFFTs.The outcome of PTS results in increased cost, complexity of circuit, reduction in data rate, requirement of additional side information [8] to pick up the creative data. If the number of blocks gets increased it results in increasing computational complexity.

4.4 Selective Mapping

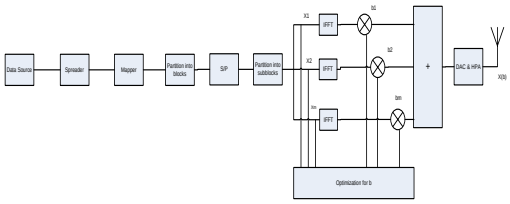

Fig 5: Replica of MC-CDMA with SLM

In selected mapping phase alignment is avoided by adding a set of phases in the transmitted signal. Fig.5: Illustrate the selected mapping technique [5] in MC CDMA.Signals are generated randomly by the rotation of phase sequences. In SLM all blocks represent same information which selects minimum PAPR block for transmission. Different phase sequences get multiplied with each data block comprising of length N which includes modified and unmodified data blocks. For transmission, block with lowest PAPR is preferred and to improve the creative data side information is transmitted. To find optimum phase factor number of iterations are required for reducing PAPR of the transmitted signal. To diminish the number of iterations Adaptive PTS method was proposed by setting a desired threshold. But in this technique the problem arises due to the presence of noise in the receiver side. Even though it has drawbacks it also possesses several merits which include absence of complex optimization techniques, distortion and dependency of signal. The drawbacks include side information and number of IFFTs.

4.5 Precoding Transform techniques

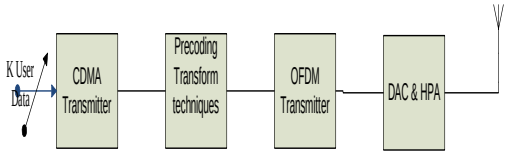

Fig 6: Representation of MC-CDMA with Precoding Transform Techniques

Fig 6: illustrate reduction of PAPR in MC CDMA can be also reduced using Precoding Transform Techniques **(**PTT**).**Using Precoding Transform Techniques data gets altered into a new personalized data for reduction of PAPR in MC CDMA transmitted signal. The CDMA transmitted signal is fed to precoded transform then followed by IFFT of the OFDM transmitter to reduce PAPR of MC CDMA transmitted signal. Several important Precoded Transforms Techniques are DCT, DWT and DHT.

5. CRITERIA FOR SELECTION OF PAPR REDUCTION TECHNIQUES

Reducing data rate which in turn increase BER at receiver is the practice employed in PAPR reduction scheme. While selecting PAPR reduction method several issues should be considered on the following technical issues such as loss in data rate, increase in BER at receiver, complexity in computation and PAPR reduction ability. Among all these issues PAPR reduction ability is very significant aspect in deciding PAPR reduction technique. If side information is received inaccurately the entire data block is lost in Partial Transmit Sequence, Selected Mapping and Interleaving.PAPR reduction method is chosen based on design requirements.

6. CONCLUSIONS

MC CDMA is an extremely fascinating arrangement for broadband wireless networks, Long Term evaluation and personal communication ahead of 4G. This paper compact with PAPR reduction techniques for Multicarrier modulation transmission systems. PAPR can be reduced using these techniques but it outcome with increase in transmit signal power, BER, defeat in data rate and computational difficulty.PAPR of MC CDMA signal can be substantially high. The PAPR can be reduced by using clipping and filtering, and companding which introduces IBR. PTS, SLM and interleaving techniques reduce PAPR with side information and an increased complexity at the receiver and with data loss. Using PTT PAPR is reduced substantially by increasing a little amount of the complexity at the receiver. The PAPR technique of MC CDMA signal transmission should be chosen judiciously. The critical parameters to be optimized are to improve BER and power spectral enhancement with low cost, low complexity, and save bandwidth without losing data.

7. REFERENCES

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