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A BRIEF REVIEW ON DIFFERENT PAPR REDUCTION TECHNIQUES IN OFDM COMMUNICATION

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Abstract— In communication, Orthogonal Frequency Division Multiplexing (OFDM) is one of the attractive technique against the multipath fading channel for wireless communications. One of the challenging issues for Orthogonal Frequency Division Multiplexing (OFDM) system is its high Peak-to-Average Power Ratio (PAPR). PAPR is a major drawback of multicarrier transmission system which leads to power inefficiency in Radio Frequency (RF) section of the transmitter. So reduction o PAPR for proper and suitable communication is major challenge in communication. In this paper we review different PAPR reduction pre-coding techniques.

Keywords – BER, HPA, MC-CDMA, OFDM, PAPR, WHT.

I. INTRODUCTION

Initial days signals were send through Single carrier system. In this data transmission rate is slow. Thus Single carrier communication is replaced by multi-carrier communication. Multi Carrier CDMA (MC-CDMA) and Orthogonal Frequency Division Multiplexing (OFDM), plays a vital role in communication transformation. With this two multi carrier techniques face of communication changes. In MC-CDMA and OFDM, OFDM is dominant because of it is useful for both Wired as well as Wireless communication. OFDM offers a considerable high spectral efficiency, multipath delay spread tolerance, immunity to the frequency selective fading channels and power efficiency.

However some challenging issues are created in OFDM communication such as high Peak to Average Power Ratio (PAPR), high Bit Error Rate (BER), required High Power Amplifier (HPA) etc. Detection efficiency of OFDM receiver's is very sensitive to non-linear devices used in communication such as Digital-to-Analog Converter (DAC) and High Power Amplifier (HPA). These non-linear devices severely impair system performance due to induced spectral regrowth and detection efficiency degradation.

II. PAPR

OFDM is generated by first choosing the spectrum required, based on the input data and modulation scheme used. Each carrier to be produced is assigned some data to transmit. OFDM consists of lots of independent modulated subcarriers. This leads to problem of peak to average power ratio(PAPR). Then PAPR is defined as- the ratio period between the maximum instantaneous power and its average power during an OFDM symbol.

$$PAPR = \max [| x(t)|2] / [\{E(A)\}2] \ldots\ldots\ldots [1]$$

Where max [|x(t)|2] is maximum or peak power and[{E(A)}2] is average power of transmitted symbol. To get proper values of PAPR oversampling is necessary. Oversampling can be performed by padding IFFT source data with zeros. So PAPR is major drawback of OFDM system so in this paper we represent some PAPR reduction techniques.

III. PAPR REDUCTION TECHNIQUES

FOR PAPR reduction individual as well as combined techniques are used. The effect of each technique is different.

1] INDIVIDUAL TECHNIQUES

To reduce the PAPR, several individual techniques have been proposed, which can be divided into three categories.

a) SINGAL SCRAMBLING TECHNIQUES:

1. Block coding techniques

Different code words are used in block coding technique. In this code words are transmitted along with original OFDM symbol, but for better result selection of proper code word are essential. In block coding technique no need to transmit side information and received signal can be easily decoded. Error correction can be done in this technique. But this method results in distortion.

2. Sub block coding

In sub Block coding large input frames are divided into small sub blocks. The ¾ code rate of total code is added to last odd parity checking bit .For large input steam this method is more efficient than Block coding technique.

3. Selective mapping (SLM)

In this method selection of optimal combination of phase factors with lower PAPR is carried out. In selective mapping side information is passed only with selected signal. That means in SLM only chosen signal is mapped.

4. Partial Transmit Sequence (PTS)

In PTS the whole sequence is divided into non overlapping sub blocks. This sub blocks are assigned by independent rotation factor. This factor generates time domain data with lowest amplitude. This selection of lowest amplitude gives results in reduction of PAPR. PTS gives better performance than SLM.

5. Adaptive Interleaving

In adaptive interleaving early threshold termination is established So searching process is terminated when the value of PAPR reaches below the pre-defined threshold value. We can adapt the threshold value depending upon the application, so adaptation is done.

6. Tone Reservation

In tone reservation, reserved tones can be used to minimize the PAPR. When there are number of tones are small then there will be small PAPR reduction and vice-versa. In this method no need of decoding at the receiver end.

b) SIGNAL DISTORTION TECHNIQUES

1. Clipping and filtering

This is effective method for PAPR reduction in which initially clipping is done and then filtering is Carried out. Since clipping is non-linear process which increase the band noise distortion, Bit Error Rate(BER) and decrease spectral efficiency. Filtering after Clipping reduces out of band distortion. For PSK Modulation this method is more effective.

2. Peak Windowing

In Peak Windowing technique different windows having large signal peaks like Cosine window, Kaiser window, Hamming window, Hanning window, Gaussian window etc. are multiply with original OFDM signal. The resultant spectrum is nothing but convolution of applied window and original OFDM signal. Depending upon the application, we can use the standard window.

c) PRE-CODING TECHNIQUES

1. Modifying FFT and IFFT algorithms

This is pre-processing method for PAPR reduction. In this method slight modification is done in matrix coefficient of IFFT matrix at transmitter and FFT matrix at receiver. In this method two columns of IFFT matrix are replaced with their linear combination in order to reduce PAPR. These columns correspond to maximum and minimum value of OFDM signal. Also with the slight change in FFT matrix we get better PAPR reduction.

2. Golay complementary sequence

In Golay complementary sequence two sequences whose aperiodic autocorrelations sum becomes zero in all out-of phase positions are used for PAPR reduction. These sequences are called Golay complementary sequences. This sequences are often defined over an alphabet of size 2(binary), 4(quanternary) or 8(octary). In this, PAPR reduction is valid only for OFDM signals without guard frequencies. With guard frequencies the PAPR reduction is not so good.

3. Reed Muller code

Reed Muller code is efficient way for PAPR reduction. In this Reed Muller code is applied to given OFDM signal but bandwidth expansion and power loss occurs.

4. Walsh Hadamard Transform (WHT)

The Walsh Hadamard Transform (WHT) is a non sinusoidal, orthogonal linear transform. WHT decomposes a signal into set of basic functions. These functions are Walsh functions, which are square waves with values of +1 or -1. The proposed Hadamard transform scheme may reduce the occurrence of the high peaks comparing the original OFDM system. The idea to use the WHT is to reduce the autocorrelation of the input sequence to reduce the peak to average power problem and it requires no side information to be transmitted to the receiver.

In Walsh Hadamard Transform (WHT) is more efficient way because in WHT no bandwidth expansion, no power increase, no data rate loss occurs. Also no Bit Error Rate (BER)degradation happens and it is distortion-less. Thus implementation of Walsh Hadamard Transform(WHT) pre-coding to reduce Peak to Average Power Ratio (PAPR) in conventional Orthogonal Frequency Division Multiplexing (OFDM) system is more effective than other techniques. WHT is becomes more effective when it is combined with other techniques.

2] COMBINED TECHNIQUES

A combined technique shows much better performance than individual techniques. Combined techniques are like as:

1. Joint companding transform with Hadamard transform In this method Joint companding transform and Hadamard Transform both are used to reduce PAPR of OFDM signal. In this Hadamard Transform is applied before the IFFT and companding transform is applied after IFFT at the transmitting end while Inverse Companding Transform is applied before FFT and Inverse Hadamard Transform is applied after FFT at the receiver end. This method maintain good performance in BER as compared to ordinary companding techniques, also PAPR reduction performance is also improved.

2. Double WHT

In this method two times WHT applied to achieve better performance than WHT PAPR reduction technique. This method is more robust than WHT against nonlinearity. It have lower clipping probability than conventional OFDM.

3. DCT combined with SLM

In this method, DCT is combined with SLM using Riemen sequence. This is more effective than both individual PAPR reduction methods. If DCT is carried out before SLM then we can achieve 1.8 db PAPR reduction while if SLM is carried out before DCT then we get 1.2 db PAPR.

4. SLM combined with WHT and dummy sequence insertion

In this method, SLM is combined with WHT and dummy sequence is inserted into resultant signal. Better performance is achieved by this method.

IV. CONCLUSION

OFDM is very attractive technique for communication in both wired as well as wireless. PAPR is very serious drawback in OFDM communication. Thus for PAPR reduction in OFDM different individual and combined methods are used. The effect of each method is different. Depending upon application or depending upon performance we can use appropriate method.

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