PAPR Reduction Techniques in OFDM System

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Abstract — orthogonal frequency division multiplexing is a technique for transmitting large data over radio waves. The main drawback of OFDM is Peak to average power ratio (PAPR). This paper present all proposed techniques to reduce PAPR. These proposed techniques show better performance to reduce PAPR.

Keywords — Orthogonal Frequency Division Multiplexing (OFDM), Peak to Average Power Ratio (PAPR), Techniques

I. INTRODUCTION

This technology was first conceived in the 1960s and 1970s during research. OFDM [1] is a method of digital modulation in which a signal is split into several narrowband channels at different frequencies. One of the major problem occur in OFDM is PAPR [2]. PAPR must be reduce for efficient transmission. This paper contains an overview of all the techniques to reduce PAPR in OFDM.

A. OFDM

OFDM is a 4G Wireless Communication Technology. The main idea of OFDM is to split data stream into N parallel streams of reduced data rate and transmit each on a separate subcarrier. When the subcarriers have appropriate spacing to satisfy orthogonality, their spectra will overlap. Figure 1 shows source schematic diagram of OFDM system and its various blocks. OFDM modulation is equivalent to the Inverse Discrete Fourier Transformation (IDFT).

B. PAPR PROBLEM

OFDM is one of the many multicarrier modulation techniques, which provides high spectral efficiency, low implementation complexity. Due to these advantages of the OFDM system, it is widely used in various communication systems. But the major problem that faces while implementing this system is the high PAPR of this system. A large PAPR [4] increases the complexity of the A/D and D/A converter and reduces the efficiency of the radio frequency (RF) [5] power amplifier. PAPR means randomly sinusoidal leads occurred during transmission of the OFDM signal.
PAPR is defined as the ratio of maximum value of power and the average value of power of a given signal.

Peak to Average Power Ratio (PAPR)
= (maximum power of a signal) / (Average power of a signal)

PAPR can be defined in db
PAPR (in db) = (10 log 10) * (maximum power of a signal) / (Average power of a signal)

C. PAPR TECHNIQUES

Many techniques have been used to reduce PAPR in OFDM. PAPR techniques can be classified into two categories:

1. Signal Scrambling Techniques
2. Signal Distortion Techniques

Signal Scrambling Techniques —

1) Block Coding Technique: Main objective of this technique is to reduce PAPR using different block coding and set of code words. This technique is used to reduce the peak to mean envelope power ratio. This technique is done in three stages. In first stage there is a selection of suitable set of code words for any number of carriers, any M-ary phase modulation scheme and any coding rate. In second stage there is the selection of set of code words that enable economical implementation of encoding or decoding. In third stage there is a selection of set of code words that offer error deduction and correction potential.

2) Sub-Block Coding Technique: To reduce PAPR more than 3db sub block coding technique is widely used. But this can be achieved at 3/4 code rate. The introduction of sub-block coding is based on the consideration that all 3/4 rate systematically coded block codes with the last bit as an odd parity checking bit show lowest peak envelope power. This coding scheme is termed as systematic odd parity checking coding(SOPC). When the frame size is large both SOPC and block coding schemes are not suitable in PAPR reduction.

3) Selective Level Mapping: This technique is probabilistic based and this technique is also very reliable. In this technique whole set of candidate signal represent the same signal and then the most favourable signal is chosen and then transmitted. The side information must be transmitted with the chosen signal. This technique can handle any number of sub carrier. The drawback of this technique is that side information is transmitted along with the chosen signal.

4) Partial Transmit Sequence: This technique is also probabilistic based. In this technique data block is divided into non overlapping sub block with independent rotation factor. This technique is a modified scheme of Selected level mapping(SLM) technique. Partial transmit sequence gives better performance than SLM. There is no need to transmit side information with the chosen signal.

5) Interleaving: In interleaving technique there is a terminating threshold i.e. search is terminated as PAPR value reaches below the threshold. The main thing of this technique is that it is less complex than PTS technique. This technique does not give the accurate result in PAPR reduction.

6) Tone Reservation: Tone reservation technique reserves small set of tones. The value of PAPR reduction depends on the number of reserved tones, their location within frequency vector and the amount of complexity. The goal of the tone reservation scheme is to find the optimal values of the Peak Reduction Carriers that minimize the PAPR of the transmitted OFDM signal.
Tone reservation technique has the following advantages:
- No need for side information
- No special receiver operation is needed
- More complex (use of extra IFFT operation)

7) Tone Injection: This technique can reduce PAPR of multicarrier signal without any loss of data. This is an additive method which carries multicarrier signal. The main idea of this method is to increase constellation size. It uses a set of constellation points for an original constellation points to reduce PAPR.

Tone injection technique has the following disadvantages:
- Need to transmit side information
- Receiver operation is needed
- More complex (use of extra IFFT operation)

Signal Distortion Techniques —

1) Clipping and Filtering: Clipping method is used to reduce high PAPR. Clipping is a non linear process which increases the band noise distortion and bit error rate (BER) [3]. It decreases spectral efficiency. Filtering gives better performance to reduce out of band radiation. If OFDM [6] signal is over sampled then correction method is suitable with the clipping so that each subcarrier generated interference.

2) PEAK Windowing: In this method different windows multiply with the large signal peaks such as cosine, Gaussian shaped window. Due to the addition of some self interference and increasing in the BER it gives better performance than clipping technique. It is very similar to clipping technique.

3) Envelope Scaling: As the name scaling used in technique name implies that it is related to scaling. Scaling means before signal sent to IFFT, all subcarrier is scaled in the input envelope. Envelopes of all subcarrier are equal. Subcarrier is scaled to achieve small amount of PAPR [7] at the output of the IFFT. The receiver of the system does not need any side information for decoding. This method is suitable for PSK modulation.

CONCLUSION

OFDM is a digital modulation technique in which orthogonal subcarriers are used to carry data. PAPR is the major drawback of OFDM system. In this paper different techniques are described to reduce PAPR. To reduce PAPR any one of the technique can be used.

REFERENCES


