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TECHNIQUES TO CONQUER PAPR IN ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING (OFDM)

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Abstract

Orthogonal frequency division multiplexing (OFDM) has an efficient technique to remove all inter-symbol interference (ISI) caused by multipath fading in wireless communication. It is a promising technique for wireless communications. However it has some drawbacks which have to eliminate for reliable communication. This paper describes an overview of OFDM and its advantages/disadvantages. The paper mainly focused on peak to average power ratio (PAPR) reduction techniques for OFDM system.

***Keywords*— OFDM, PAPR, ISI, ICI.**

I. INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) is used extensively in broadband wired and wireless transmission systems. It proficiently diminishes the multi-path fading and enhances the bandwidth efficiency in wireless transmission. Correspondingly, it also enhances system capacity and provides a reliable communication [1]. Every sub-carrier frequencies of OFDM system are selected to ensure that the signals are linearly independent which means mathematically orthogonal over one OFDM symbol interval. The condition is attained by employing an inverse fast Fourier transform (IFFT) in system. Consequently, the waveforms of individual sub-carriers overlap, however due to orthogonality belongings, the sub-carriers can be retrieved accurately without interference. This thus does not require analog filtering to split the received sub-carriers. Fig. 1 shows spectra for OFDM.

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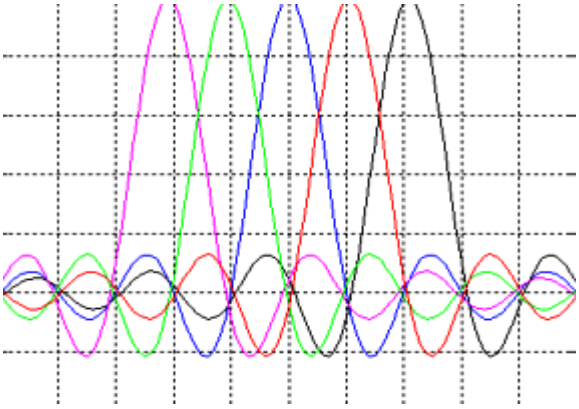

Figure 1: OFDM signal [1]

OFDM faces several challenges. The main confront are: inter-symbol-interference (ISI) due to multipath, high peak to average ratio (PAPR) due to non linearity's of amplifier, phase-noise troubles of oscillator, require frequency-offset rectification in the destination. The waveform of an individual OFDM sub-carrier has a shape; accordingly each sub-carrier has considerable side lobes over a frequency array which comprises lots of other sub-carriers. This is the cause of one of the major disadvantages of OFDM: that it is quite sensitive to frequency offset and phase noise [2]. Higher value of PAPR degrades the input signal if the transmitter has nonlinear equipments like power amplifiers (PAs). Therefore, reducing the PAPR is of practical interest.

II. PAPR REDUCTION TECHNIQUES

PAPR of generated OFDM symbols x(t) is calculated by dividing the upper instantaneous power to the average power and is given as:

$$\mathrm{PAPR}[x(t)] = \frac{P_{PEAK}}{P_{AVERAGE}} = 10\log_{10}\frac{\max\left[|X(n)|^2\right]}{E\left[|x_n|^2\right]}$$

P_{PEAK} symbolizes peak output power, $P_{AVERAGE}$ symbolizes average output power. E[·] symbolizes the probable value, x_n symbolizes the propagated OFDM symbols which are acquired with IFFT on modulated input symbols X_k [3].

The instantaneous outcome of an OFDM symbol continually has immense variations compared to single carrier systems. Consequently, requires large linear dynamic ranges of system equipments, like power amplifiers, A/D converters and D/A converters. The less dynamic range of equipments used results a series of unwanted interference. 'PAPR' attenuation schemes are consequently of immense significance for OFDM systems. Furthermore, because of the big fluctuations in power output, the high power amplifier (HPA) must provide huge dynamic range. This results in poor power efficiency. Various PAPR reduction schemes have been proposed in the literature [4, 5]. These techniques are divided broadly into two groups signal scrambling methods and signal

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distortion methods.

a) Signal Scrambling Techniques
- Block Coding Techniques
- Selected Mapping (SLM)
- Partial Transmit Sequence (PTS)
- Interleaving Technique
- Tone Reservation (TR)
- Tone Injection (TI)

b) Signal Distortion Techniques
- Peak Windowing
- Envelope Scaling
- Peak Reduction Carrier
- Clipping and Filtering

2.1 Clipping and Windowing: Clipping is simplest method for PAPR reduction in which signal above a pre-determined threshold level is clipping which introduces both in-band and out-of-band deformation which can demolish orthogonality of the subcarriers. Further, windowing of the clipped signal can be done which should be ideally as narrow as possible [6]. Clipping process is constantly executed on over-sampled signal to diminish in-band deformation.

2.2 Interleaving: This technique is also known as Adaptive Symbol Selection Method (ASSM). Numerous OFDM symbols are produced with bit interleaving of input data. The fundamental plan is to employ 'w' interleaving traditions and choosing one which have least PAPR.

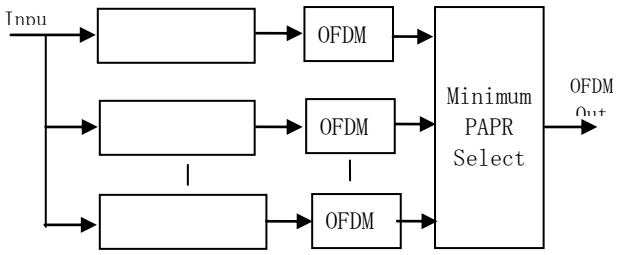

Figure 2: Interleaving

Figure 2 shows an inter-leaver method for PAPR reduction. The amount of inter-leaver employed decides the PAPR diminishes capability of the system. The accurate retrieval of the signals at receiver requires to know the inter-leaver used at transmitter [7].

2.3 Coding: Forward Error Correction (FEC) codes are used to diminish the effect of the errors. The FEC codes like Cyclic, Convolutional, Reed-solomon and turbo can significantly reduce PAPR [8].

2.4 Companding:. Companding are of two types- linear and non-linear. Linear companding works on growing tiny signals only whereas non-linear companding broaden tiny signals as well as condense the bulky ones in this manner acquiring uniform distribution of signals [9].

Consequently, the average power is enlarged which diminishes the PAPR thus enhancing the efficiency of the power amplifiers. Uniform companding can be achieved by using transforms like Hadamard transform, Discrete Cosine Transform, airy function, exponential companding.

2.5 Selective Mapping: SLM is most promising technique compared to other techniques for PAPR reduction because it introduces no degradation yet can achieve significant PAPR reduction [10]. The data symbols are propagated into numerous autonomous blocks. Hence the lesser PAPR block is propelling. The picked index known as side-information index should also be propagated to permit retrieval of the information block at the destination.

2.6 Partial Transmit Sequence (PTS): In this approach, the input information block of 'N' symbols is separated into displace sub-blocks. The chief parameter that may influence the PAPR diminishes performance is the sub-block separating, which is the method of division of the sub-carriers into multiple disjoint sub-blocks [11]. Mainly, the three categories of sub-block separating are: adjacent, interleaved and pseudo-random separating.

2.7 Tone Reservation (TR) and Tone Injection (TI): In this approach, a few clusters of tones are kept called as peak decrease carriers and these are added to the data signal to isolate energy to cancel large peaks. These tones do not bear any information and are orthogonal to each other [12] while Tone Injection technique reduces the PAPR without reducing the data rate.

The comparison of these techniques is depicted in table 1.

Table 1: Comparison of PAPR Reduction Methods

Method	Complexity	Degradation	Information Loss	Power Increase
Clipping	No	Yes	No	No
Interleaving	No	No	Yes	No
Coding	No	No	Yes	No
Companding	No	No	Yes	Yes
SLM	Yes	No	Yes	No
PTS	Yes	No	Yes	Yes
TR	No	No	No	Yes

III. CONCLUSION

Proficient PAPR reduction technique is one which minimize the PAPR without degrading the performance and also have low implementation cost. This paper describes several techniques of PAPR reduction with their advantages and disadvantages. Table 1 shows the comparison of numerous PAPR reduction methods for OFDM signal.

REFERENCES

[1] R. van Nee, and R. Prasad, OFDM for Wireless Multimedia Communications. London: Artech House Publishers, 2000.
[2] Suma M N, Kanmani.B, "Developments in Orthogonal Frequency Division Mutiplexing (OFDM) system – A Survey", IEEE, 2011.
[3] Seung Hee Han, Jae Hong Lee, "An overview of peak-to-average power ratio reduction techniques for multicarrier transmission", Wireless Communications, IEEE, Vol.12, Issue 2, pp.56–65, April, 2005.
[4] T.Jiang & Y.Wu, (2008)"An Overview: Peak-to-Average Power Ratio Reduction Techniques for OFDM Signals", IEEE Transactions on broadcasting, pp.257-68.
[5] T.Jiang & Y.Imai,(2008) "An overview: peak-to-average power ratio reduction techniques for OFDM signals," IEEE Transaction On Wireless Communications, pp.56-57.
[6] Deng Qing, Zhong Hong sheng, "An Improved Algorithm to Reduce PAPR Based Clipping-and-Filtering" IEEE Explore, 2008.
[7] Josef Urbaf, Roman Marsalek, "PAPR Reduction by Combination of Interleaving with Repeated Clipping and Filtering in OFDM" IEEE Explore, 2007.
[8] Dae-Woon Lim, Seok-Joong Heo, and Jong-Seon , "An Overview of Peak-to-Average Power Ratio Reduction Schemes for OFDM Signals", Journal of Communications and Networks, vol. 11, no. 3, June 2009.
[9] Yasir Rahmatallah, Nidhal Bouaynaya and Seshadri Mohan, "On the Performance Of Linear And Nonlinear Companding Transforms In OFDM Systems" IEEE 2011.
[10] G.Sikri, Rajni & S.Sahai,(2012) , "A Study of PAPR reduction technique for orthogonal frequency division modulation" ,International conference on advance computing technology,gurukul,pp.1-9.
[11] L.Wang and C.Tellambura, (2006) "An Overview of Peak-to-Average Power Ratio Reduction Techniques for OFDM systems", IEEE International Symposium on Signal Processing Processing and Information technology, pp.840-845.
[12] Son, C.H. Nam & H.S. Lee,(2009) "An approach for PAPR Reduction based on Tone Reservation Method", IEEE Conference on Consumer Communications and Networking, pp.1-2.