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Performance Evaluation of Modified Clipping and Filtering Method for PAPR Reduction

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Abstract: For providing high-data-rate offerings over wireless channels, Multiple Input Multiple Output Orthogonal Frequency Division Multiplexing (MIMO-OFDM) gadget had been proposed in the latest beyond. This gadget affords the advantages of space-time coding and OFDM when its miles mixed with area time coding. The MIMO-OFDM gadget also suffers from the excessive peak-to-average power ratio (PAPR) trouble. This happens due to the inter-symbol interference between the subcarriers of the communicat^on system. Through the use of clipping and filtering the entire look for the number of sub-blocks and the rotation elements should be done, if you want to achieve top-rated PAPR discount. As the number of sub-blocks and rotation factors will increase, PAPR reduction improves. Because the quantity of sub-blocks will increase, the range of calculation additionally will increase. This case ends in growth the complexity exponentially which ends up inside the technique put off. PAPR reduction is collectively optimized in both the real and imaginary element by means of the use of Fast Fourier Transform (FFT) algorithm inside the modified Clipping and filtering scheme. In this work, a modified clipping and filtering approach is offered. This approach is combined with interleaving for PAPR reduction using Quadrature Phase Shift Keying Modulation (QPSK). The main objective of this technique is to keep away from the usage of any greater IFFTs and enhance PAPR reduction. Cumulative Distribution feature (CDF) of PAPR has been taken as an output parameter. The value of this parameter is plotted with respect to PAPR for present and modified techniques. MATLAB R2013a has been used as an implementation platform. Generalized MATLAB toolbox and wireless communication Toolbox has been used for implementation.

Keywords: OFDM, PAPR, Clipping, and Filtering, Selective Mapping (SLM), Partial Transmit Sequence (PTS), etc.

INTRODUCTION

The increased claims for wireless multimedia and interactive internet a service has enabled exhaustive research efforts on high-speed data transmission. The highest bit rates in commercially deployed wireless systems [1] are achieved by means of Orthogonal Frequency Division Multiplexing (OFDM) in wireless local-area networks (LANs) like Wi-Fi. OFDM has been adopted as the modulation method of choice for practically all the new wireless technologies being used and developed today.

Orthogonal Frequency Division Multiplexing (OFDM) [9] has been considered as one of the strong standard candidates for the next generation mobile radio communication systems. OFDM technique is spectrally efficient and very robust to wireless multipath fading environment. Therefore it has been adopted as many standards of DAB/DVB (digital audio/video broadcasting) IEEE 802.11x, 3G LTE, and Wi-MAX systems. One of the main drawbacks of OFDM is its high Peak to Average Power Ratio (PAPR) because it is inherently made up of so many subcarriers [3].

PAPR OF OFDM SIGNALS

In OFDM modulation technique, a block of N data symbols $X_k = (X_0, X_1, \dots, X_{N-1})$, is formed [4] [10] with each symbol modulating the corresponding subcarrier from a set of subcarriers [6]. The N subcarriers are chosen to be orthogonal, that is, T is the original data symbol period, and $f_0=1/T$ is the frequency spacing between adjacent subcarriers [4] [1] [2]. An OFDM carrier signal is the sum of a number of orthogonal subcarriers, with baseband data on each subcarrier being independently modulated commonly using some type of quadrature amplitude modulation (QAM) or phase shift keying (PSK). While it is promising to transmit more bits per symbol, if the energy of the constellation is to remain the same, the points on the constellation must be closer together and the transmission becomes more susceptible to noise. This results in a higher bit error rate than for the lower order QAM

variants. In this mode, there is a balance between achieving higher data rates and maintaining a satisfactory bit error rate for any radio communications system. The N subcarriers are chosen to be orthogonal.

The complex baseband OFDM signal for N subcarriers [3] [2] [6] can be written as

$$x(t) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_k e^{j2\pi k t / T}, \quad 0 \leq t \leq T \quad (1)$$

Replacing $t = n b T$, where $b T = T/N$, gives the discrete time version denoted by [7]

$$x(n) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_k e^{j2\pi k n / LN}, \quad n=0,1,\dots,NL-1 \quad (2)$$

Where, L is the oversampling factor [1].

The symbol-spaced sampling sometimes misses some of the signal peaks and results in optimistic results for the PAPR. The sampling can be implemented by an inverse fast Fourier transform (IFFT)[4].

The PAPR of the transmitted OFDM signal, $x(t)$, is the ratio of the maximum to the average power and is given as

$$PAPR = \frac{\max_{0 \leq t \leq T} |x(t)|^2}{E \left[|x(t)|^2 \right]} \quad (3)$$

Where E is the expectation operator.

A High PAPR Is Undesirable, As It Requires A Large Dynamic Range Of The D/A And A/D Converters And The Amplifiers Used. Consequently, They Are Used Very Inefficiently, As Most Of The Signal Amplitudes Are Only A Fraction Of This Dynamic Range. In Order To Keep The Quantization Noise At An Acceptable Level, A Large Precision Is Required, Meaning A Large Number Of Bits [5].

REDUCTION OF PAPR

In order to reduce the PAPR of an OFDM signal, many techniques are proposed, which can be organized into three classes: signal distortion, block coding, and signal scrambling. The simplest class of techniques to reduce the PAPR is signal distortion, including clipping and peak windows [5]. To clip the signal, the peak amplitude is limited to some desired maximum level. It can give a good PAPR. But the BER performance becomes very worse due to many detected signals. Another method for APR reduction is based on the use of coding schemes, where the original data sequence is mapped onto a longer sequence with a lower PAPR in the corresponding OFDM signal. Basically, a coding scheme would involve a large look-up table and is more suitable for those OFDM systems with a small number of subcarriers [5]. Signal scrambling includes SLM, DSI and PTS techniques.

INFLUENCING FACTORS OF PAPR

PAPR is closely related to phase factor, the number of subblocks, the number of sub-carriers and oversampling rate.

Phase factor

Partial Transmit Sequence technique is distortion less technique because it divides the frequency vector into a number of sub-blocks before applying the phase transformation. In this method, the phase factor parameter is important and the searching process for finding the optimal phase factors. As a result, the signal with lowest PAPR for transmission is chosen from the selected OFDM symbols.

Number of sub-carriers

A different number of sub-carrier results in different PAPR performances due to the varying information carried. When the number of subcarriers increases, the PAPR also increase. Therefore, the number of sub-carrier is a very important influence factor on the PAPR [11].

Oversampling rate

In a real implementation, continuous-time OFDM signal cannot be described precisely due to the insufficient N points sampling. Some of the signal peaks may be missed and PAPR reduction performance is unduly accurate. To avoid this problem, oversampling is usually employed, which can be realized by taking L·N point IFFT/FFT of original data with (L-1)· N zero-padding operation. Over-sampling plays an important role in reflecting the various features of OFDM symbols in time domain.

No. of symbols

In this, we are discussing PAPR variation by varying no. of subcarriers and symbols.

ADVANTAGES OF OFDM [8]

Computationally efficient: because of using FFT techniques to implement the modulation and demodulation process.

Fading Resistant: because of the parting the channel into narrowband flat fading sub-channels.

Symbol recovery: because of the use of adequate channel coding and interleaving.

Power efficient: due to use power allocation algorithms.

Bandwidth efficient: because of having the advantages of mitigating ISI in frequency selective fading channels

Noise resistant: because of protection against co-channel interference and impulsive parasitic noise.

ISI elimination: because of use of a cyclic prefix.

REPEATED CLIPPING AND FILTERING FOR REDUCTION OF PAPR

First updation of signal

$$X(t)_{temp} = X(t) \quad \text{if } S_{pow} > C_R * \mu$$

Where,

$X(t)_{temp}$ is clipped (selected) signal at 1st stage

$X(t)$ is time domain complex signal

S_{pow} is signal power

C_R is clipping ratio

μ is mean power

2nd updation of signal

$$X(t)_{temp2} = \sqrt{C_R * \mu} (X(t)_{temp}) / |X(t)_{temp}|$$

Where

$|X(t)_{temp}|$ is absolute values of clipped (selected) signal at 1st stage

$X(t)_{temp2}$ is updated signal at 2nd stage

final updation of signal

$$X(t)_{final} = X(t)_{temp2} \quad \text{when } t = S_{pow} > C_R * \mu$$

EXPERIMENTAL RESULTS

MATLAB R2013a has been used as an implementation platform. Generalized MATLAB toolbox and Wireless Communication Toolbox has been used for implementation. In this work, a modified clipping and filtering method is presented. This method is combined with interleaving for PAPR reduction using Quadrature Phase Shift Keying Modulation (QPSK). The main objective of this method is to avoid the use of any extra IFFTs and improve PAPR reduction. To implement the proposed method, we have taken following parameters are given in Table 1.

Table1. Input parameters with respective values

Sl.No.	Parameter	Value
1.	OFDM Size	256
2.	Sampling Factor	2
3.	FFT Size	516
4.	Clipping ratio	4
5.	QPSK Set	[1 -1 j -j]
6.	Number of Iterations	4
7.	Number of Symbols	1000

As mention in the table, we have repeated the clipping process 4 times along with advanced filtering method. Cumulative Distribution Function (CDF) of PAPR has been taken as an output parameter. We have plotted the value of this parameter with respect to PAPR for existing and modified methods. We have plotted the Cumulative Distribution Function (CDF) of PAPR for 1, 2, 3 and 4 iterations, individually, as shown in Table 2. We have also given the graphical representation of both methods as shown in figure 1. It's been very clear from table and figure that proposed method is doing very well as compared to the existing method in terms of PAPR reduction. Also, as the number of iteration increases i.e. a number of clipping and filtering increases PAPR reduces gradually.

Table 2 Comparative analysis of Existing and propose method through CDF of PAPR

S. No.	PAPR for Existing method	PAPR for Proposed Method			
		With one iteration	With two iteration	With three iteration	With four iteration
1	6.111	6.066	6.044	6.032	6.026
2	6.111	6.066	6.044	6.032	6.026
3	6.268	6.149	6.084	6.053	6.037
4	6.276	6.154	6.086	6.054	6.038
5	6.315	6.172	6.090	6.057	6.039
6	6.326	6.174	6.100	6.061	6.041
7	6.329	6.174	6.100	6.062	6.042

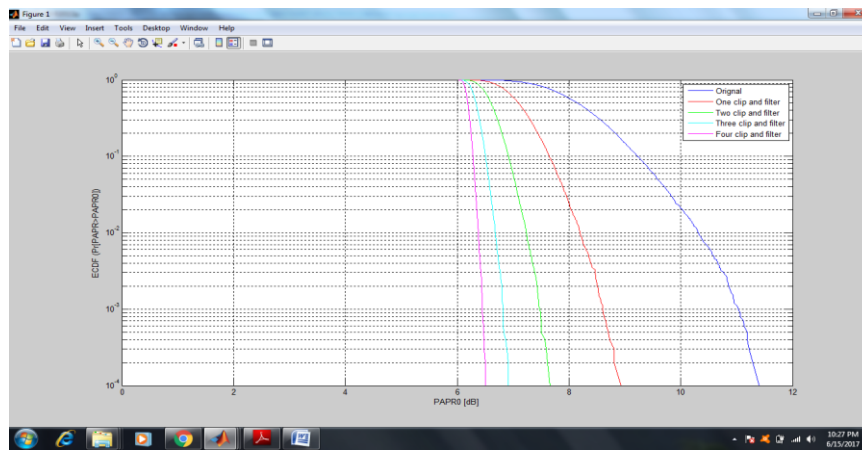


Figure 1 Snapshot of CDF vs. PAPR for existing and proposed method

CONCLUSION

In end, OFDM technology summed up a number of subcarriers modulated with the aid of a set of the data symbols. Therefore, transmitted signal may have a particularly large top strength which ends up in high PAPR. The primary drawback of OFDM is that the height transmitted power can be extensively large than the average energy. We examine that the PAPR-reduction hassle for OFDM has obtained a notable deal of interest lately. In this work, it is able to be determined that OFDM sign has higher PAPR and after applying proposed method, PAPR has reduced drastically. The evidence of above announcement is the table and graph given in the last chapter. It could be concluded that proposed method is doing very well in comparison to the present approach in phrases of PAPR reduction. Additionally, because the range of iteration increases i.e. a number of clipping and filtering increases PAPR reduces step by step. The PAPR decreases because the number of clip and filtering is increased from one to four levels. That is due to the fact; the clipping is observed by using filtering to reduce out of band strength.

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