A Novel ZCT-R-OFDM Based PAPR Reduction Technique with RRC

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Abstract - This proposed algorithm combines the selected mapping exchange of various partial transmit sequences (PTS) sub blocks to create more alternative OFDM signal sequences to provide optimum PAPR (Peak to average power ratio) reduction performance with lower complexity. In this algorithm we are dealing different reduction techniques like SLM with IFFT, ZCT and other clipping methods to reduce PAPR in OFDM system. Apart from the other clipping techniques ZCT (Zadoff-chu matrix Transform) plays vital role in this algorithm. The Zadoff-chu sequences by filling ZCT kernel row wise or column wise. Row wise filling gives rise to constant envelope OFDM (CE-OFDM) system with 0dB PAPR. Similarly column wise gives rise to 7.8dB at a clip rate of 10-3 with system subcarriers N=64 for QPSK modulation. The simulations results are observed in the Mat-lab for different clipping techniques.

Keywords—PAPR, SLM, OFDM, ZCT, CE-OFDM, PTS.

I. INTRODUCTION

In recent trends ZCT based OFDM systems are giving better performance reductions in power rails. OFDM has been attracting substantial attention due to its excellent performance under severe channel condition. For rapid growing applications of OFDM includes Wi-max DVB/DAB and 4G wireless systems [1]. We use pre coded sequence or cyclic prefixed codes for multiple sub carrier systems [2],[6],[9], based on different kinds of clipping techniques to reduce the PAPR factor [3]. It allows the sub carriers, which are orthogonal to each other, meaning that cross talk between co-channels is eliminated and inter-carrier guard bands and a separate filter for each sub channel is not required [4],[8]. Each sub-carrier is modulated with a conventional modulation scheme (such as quadrature amplitude modulation) at a low symbol rate, maintaining data rates similar to conventional single carrier modulation schemes in the same bandwidth [5]. The system capacity is expected to be increased to over ten time’s original systems. This is going to be achieved by using complex multiple access techniques such as Code Division Multiple Access (CDMA), or an extension of TDMA. Time Code Division Multiple Access (CDMA) is a spread spectrum technique that uses neither frequency channels nor time slots [11]. The Zadoff-chu sequences by filling ZCT kernel row wise or column wise. Row wise filling gives rise to constant envelope OFDM(CE-OFDM) system and discrete cosine transformation(DCT) pre-coded SLM(selective mapping) reducing PAPR [7],[10]. One critical problem is its high peak-to-average power ratio (PAPR). High PAPR increases the complexity of analog-to-digital (A/D) and digital-to-analog (D/A) converters, and lowers the efficiency of power amplifiers. Over the past decade various PAPR reduction techniques have been proposed, such as block coding, selective mapping (SLM). This paper proposes and evaluates a new companding algorithm. In this algorithm we are using special airy functions and is able to offer an improved bit error rate (BER) and minimized OBI while reducing PAPR effectively. The following sections II describes about operation of ZCT based PAPR reduction in OFDM system. The section III presents the simulation results in order to verify the different type of algorithms by using Mat-Lab software.

II. DESCRIPTION AND OPERATION PRINCIPLE OF ZCT BASED PAPR REDUCTION IN OFDM

In the communication system all the wireless systems are getting affected when the signal is transmitted through the channel, for example in mobile communications signal may transmit in the different paths, at the receiver the signal which is having the less distance that will be consider as the final signal, because of these changes we can’t reconstruct the original signal at the receiver with less errors. If the signal is transmitted through the channel it will be effect by the different types of distortions like attenuated, reflected, refracted and diffracted.
Apart from these effects there is a big effect in the signal by the noise and it can cause a change in the carrier frequency if the receiver or transmitter is moving. By transmitting a wide bandwidth signal or spread spectrum as CDMA, any dips in the spectrum only result in a small loss of signal power, where as in proposed method is by using COFDM/OFDM transmission, to split the transmission up into \( N \) number of small bandwidth of subcarriers.

The complex baseband ZCT-R-OFDM signal with \( L \) subcarriers can be written as:

\[
x_a = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_k e^{j2\pi \frac{n}{N}} , n = 0,1,2,\ldots,N-1 \tag{1}
\]

Here we reduce the peak to average power ratio of the system by applying different techniques block coding, SLM with IFFT, ZCT (Zadoff-chu matrix Transform) and row wise of the matrix.

The complex pass band transmit signal, \( x(t) \) of ZCT-ROFDM after Root Raised Cosine (RRC) pulse shaping and D/A:

\[
x(t) = e^{j2\pi \frac{t}{T}} \sum_{n=0}^{N-1} x_n r(t-nT) \tag{3}
\]

The RRC pulse shaping filter can defined as:

\[
r(t) = \sin\left(\frac{nt}{T}(1-\alpha)\right) + 4\alpha \frac{t}{T} \cos\left(\frac{nt}{T}(1+\alpha)\right) \tag{4}
\]

\[
0 \leq \alpha \leq 1
\]

Where \( \alpha \) is the roll off factor. We are observed the PAPR reduction values with and without pulse shaping. We can calculate the ZCT-R-OFDM peak to average power reduction values separately first equation gives the with pulse shaping PAPR:

\[
\text{PAPR}_{\text{P}} = \max_{0 \leq t \leq NT} \left[\left| x(t) \right|^2 \right] \tag{5}
\]

The PAPR of ZCT-R-OFDM signal without pulse shaping is:

\[
\text{PAPR}_{\text{NP}} = \frac{1}{M} \sum_{n=0}^{N-1} \left| x_n \right|^2 \tag{6}
\]

The Zadoff-chu sequences by filling ZCT kernel row wise or column wise. Row wise filling gives rise to constant envelope OFDM (CE-OFDM) system with 0dB PAPR. At a clip rate of 10-3 with system subcarriers \( N=64 \) for QPSK modulation.

III. SIMULATION RESULTS

The proposed OFDM system with PAPR has been simulated by MATLAB. This considered simulation parameter of the converter is given as follows.

- Over sampling factor : 4
- System Subcarriers : 64,512
- Pre-coding : WHT and ZCT
- Modulation : QPSK
- Pulse shaping : Root Raised Cosine (RRC)
- Roll of factor RRC : \( \alpha = 0.22 \)
- CCDF clip rate : \( 10^{-3} \)

The proposed results are observed in the mat lab for all sub carriers of the system. The PAPR analysis of the ZCTR-
OFDM system, the data is generated randomly then modulated by QPSK. All the simulations have been performed based on 105 random OFDM blocks.

Fig. 3. OFDM Time signal

Fig. 4. OFDM Time Signal, one Symbol Period

Fig. 5. OFDM Signal Spectrum

Fig. 6. OFDM Receiver spectrum, Phase

Fig. 7. OFDM Receiver spectrum, Magnitude

Fig. 8. Clipped Signal

Fig. 9. OFDM Carrier phase

Fig. 10. PAPR waveforms
IV. CONCLUSION

In this paper, we present a PAPR analysis of the ZCT-ROFDM system with RRC pulse shaping. The ZCT-R-OFDM system has lower PAPR than the ZCT-C-OFDM system, the WHT pre-coded OFDM systems and the conventional OFDM systems. Another important factor is pulse shaping increase the PAPR of the ZCT-R-OFDM system from 0 dB to 5 db. The ZCT-R-OFDM system does not require any power increase, complex optimization and side information to be sent for the receiver. This system also take advantage of the frequency variations of the communication channel and can also offer substantial performance gain in fading multipath channels. The proposed work can applicable for channel estimation, timing offset and frequency offset estimation can be utilized for MIMO OFDM System.

REFERENCES


