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COSINE TRANSFORM IN OFDM SYSTEM USING TURBO CODING AND SLM TECHNIQUE

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Abstract—*Orthogonal Frequency Division Multiplexing is a most efficient technology in wireless communication for high data rate. However, MIMO-OFDM suffers with the disadvantage of requiring highly efficient power amplifier due to the occurrence of Peak-to-Average Power Ratio (PAPR). In this paper, Turbo coded modified SLM technique with DCT is simulated which has shown better performance with the conventional system.*

Keyword *—MIMO-OFDM, DCT, IDCT, PAPR*

1. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) is a high speed wireless communication technology which has a demanding future in mobile communication system. It provides high data rates and high quality multimedia services to mobile users and also provides high data throughput and gives efficient wideband communication system. Due to all these advantages, OFDM plays an important role in various communication systems [1]. Multiple antennas are used to increase the competence of wireless communication systems. Space-time codes with OFDM results in wideband communication. By using multiple antennas at the transmitter and receiver, spatial diversity can be obtained as it does not increase the transmit power and signal bandwidth. Therefore, many high speed data transmission standards have been presented such as IEEE 802.16, IEEE 802.11a/g, digital video broadcasting (DVB) etc.

There are various studies that have focused on enhancing the performance of the communication system over conventional OFDM system. However, majority of the problems found to address in the research papers published during the year 2002-2015 are associated with conventional OFDM system pertaining to the problem of the PAPR issue. Interestingly, such attempts have made a better pathway for other categories of research works towards further advanced versions of OFDM-based networks in future. This section discusses about the research contribution pertaining to PAPR reduction in OFDM.

Foomooljareona and Fernando [2] have presented a solution towards PAPR problems using two different algorithms. The algorithm make use of the lookup table for choosing the sequences of the input as well as it also scales an envelope of an input pertaining to the subcarriers prior to an inverse operation of Fast Fourier Transform (FFT). The outcome of the study was evaluated with respect to Complementary Cumulative Distribution Function (CCDF) and also compared with some of the existing techniques to show reduced Bit Error Rate (BER) and PAPR. Wen et al. [3] have designed a very unique mechanism of minimizing PAPR in OFDM by using signal mapping scheme. The technique uses a selection criteria based on presence of signals with minimal PAPR value. The author has performed the numerical analysis considering both Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK) scheme. The outcome of the study was found to show better descending trend of its PAPR values. Deng and Lin [4] have presented a study where conventional clipping mechanism is upgraded to incorporate recursive function as well as filtering for accomplishing better PAPR reduction. The idea is to restrict the distortions for all the OFDM signals in order to achieve minimal error rate as well as PAPR. The outcome of the study was found to posses better reduction of BER, PSD (Power Spectral Density), as well as PAPR when subjected to QAM (Quadrature Amplitude Modulation) .Boonsrimuang et al. [5] have introduced a technique using replicated version of the sub-carriers in order to minimize the PAPR in OFDM signal. The technique performs optimization of sub-carriers by altering its prior phase coefficient over signal in time-domain. The technique also introduced an algorithm that switches between time and frequency domain. The outcome of the study show good PAPR reduction capability over Carrier to Noise Ratio (CNR).Zhang et al. [5] have carried out a study of PAPR minimization over communication channel with multiple carriers. The authors have developed the carriers based on wavelets modulation technique in order to minimize PAPR. The technique performs modulation of the signal which is then subjected to serial-to-parallel converter followed by multicarrier modulation. The processed signal is then subjected to parallel-to-serial converter which then meets its thresholding scheme for energy. The outcome of the study was found to posses better Mean

Square Error (MSE), Signal-to-Noise Ratio (SNR) and PAPR over different forms of discrete wavelet transforms. Jiang et al. [6] have introduced a technique of PAPR minimization over OFDM using a sear-based technique. The technique introduced by the author is highly equivalent to combinatorial optimization. The simulation outcome of the study has used Monte Carlo mechanism and is evaluated with respect to CCDR, PAPR, and cost. Zolghadrasli and M. H. Ghamat [7] [8] have discussed about the significance of the PAPR reduction over OFDM system. With an aid of Monte Carlo simulation model, the authors have performed simulation study using BPSK modulation over Gaussian Noise and fading path. The outcome of the study was evaluated to find better PAPR reduction over QAM in contrast to BPSK modulation. Jiang [9] have presented a very simple technique for reducing an adverse effect of PAPR in OFDM. The author has initially spoken about the significance of PAPR over wireless networking system followed by the discussion of a unique non-linear companding mechanism. With an aid of a simulation study, the author has carried out modulation using QPSK over FFT and IFFT with a size of 256. The outcome of the simulated study was tested with respect to compander input power of 3 dBm over CCDF and BER to justify the effectiveness of the presented technique. Hong et al. [10] have presented a method that is independent of performing multiple inverse operations in FFT for reducing the ongoing PAPR problems over OFDM. The technique basically uses single operation of FFT and prevents using multiple inverse operation of FFT and replaces using multiple all pass filters. The study outcome was found to posses better capability of addressing PAPR using simulation-based model of 16 QAM.

2. PAPR Technique

The PAPR of OFDM is formulated as follows:

$$PAPR = \frac{\max\left|c(t)\right|^2}{E\left[\left|c(t)\right|\right]^2} \qquad (1)$$

.

Where c (t) denotes amplitude of OFDM signals, and E [.] denotes expectation. The complex baseband OFDM signal for N subcarriers can be represented as,

$$s(t) = \frac{1}{\sqrt{N}} \sum_{k=1}^{N-1} X_k e^{j\pi k \Delta f t} \qquad (2)$$

here X_k is the data symbol carried by the k^{th} subcarrier.

The Cumulative Distributed Function (CDF) of the signal is formulated as follows,

$$F(z) = 1 - \exp(-z) \qquad (3)$$

If there are N subcarriers in an OFDM system and all the sampling values are completely independent, the CDF of the system is given by the equation:

$$P(PAPR \le z) = \left(f(z)\right)^N = \left(1 - e^{-z}\right)^N \qquad (4)$$

The CCDF for the PAPR of an OFDM system is given by,

$$P(PAPR > z) = \left(f(z)\right)^N = \left(1 - e^{-z}\right)^N \qquad (5)$$

SLM is one of the probabilistic techniques adopted to reduce the PAPR of the OFDM signal. Hence it can achieve PAPR reduction without distorting the signal and will not cause any loss of data. The main disadvantage of SLM is that the complexity is high. Now there are many extension schemes for reducing the complexity of SLM [13-16].

3. Selective Level Mapping

In SLM technique, the data bits are converted into parallel manner and then multiplied with phase sequences. Then those data are sent to IFFT to convert it into OFDM signals. Those signal whose PAPR is less is used for transmission. The block diagram of SLM is given below in Fig. 1.In modified SLM the neighborhood search algorithm is used for finding out the lowest PAPR OFDM signal.

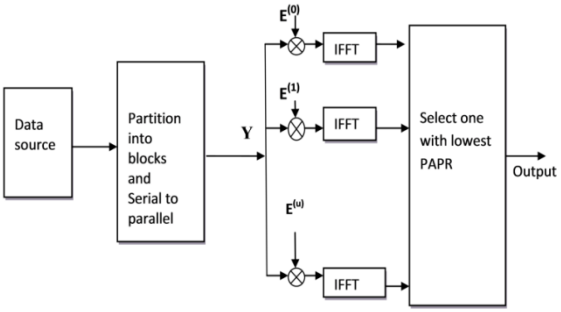

Fig. 1.SLM TECHNIQUE

4. Proposed Method

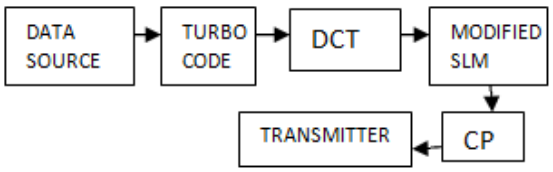

Figure 2 Proposed Systems

In the proposed system, DCT is used with modified SLM technique to reduce autocorrelation between data sequences. Turbo coder is one of the efficient coding techniques which also reduce the similarity among the data sequences. Then these data sequences undergo modified SLM technique where neighborhood search is used to find the lowest PAPR signal. Cyclic prefix is added and the OFDM signal is further processed.

5. Simulation Results

In the proposed system, before the modified SLM technique DCT and Turbo coding is incorporated to reduce PAPR of the system. Conventional SLM technique gives PAPR of nearly 7 dB. In the simulation the proposed system is manipulated for different subcarriers such as 64,128,256,512 & 1024. When number of subcarriers increases, the value of PAPR also get increased because of orthogonality condition not satisfied. In Table (1), PAPR for different subcarriers for proposed system is shown. The proposed system efficiently reduces PAPR henceforth.

Table (1) PAPR of different subcarriers at CCDF 10^{-2}

No of Subcarriers	PAPR (dB)
64	3.25
128	3.5
256	4
512	4.78
1024	5

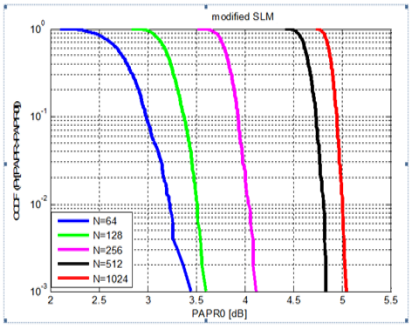

Fig. 3.CCDF of Proposed System with different Subcarriers

6. Conclusion

The proposed method for OFDM system reduces PAPR in efficient manner. The DCT and Turbo coding helps the system to reduce the similarity among the data sequences which is the main reason for occurrence of PAPR. The simulated results represent the PAPR value for different subcarriers. Even though system has many merits, the proposed system has system complexity and computation complexity.

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