Efficient Papr Reduction in OFDM Using Segmental Partial Transmit Sequence Technique

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Abstract – Orthogonal Frequency Division Multiplexing (OFDM) by Offset Quadrature Amplitude Modulation (QAM) technique has drawn significant interests in recent years. Mainly, it has been accepted as a potential technique for many digital broadcasting systems. The major drawback is high Peak to Average Power Ratio (PAPR). Many techniques are available to reduce high PAPR such as Partial Transmit Sequence technique, Selective Mapping technique, Clipping technique and so on. But, it is not very effective to directly employ these methods in offset Quadrature amplitude modulation based OFDM systems. So, Segmental Partial Transmit Sequence (S-PTS) technique is proposed which deal with the high PAPR problem. In this technique, the input signals are divided into a number of segments. Each segment has a number of data blocks. At each segment, the high PAPR is reduced. But, it is also having the drawback of decrease in the data rate due to smaller segment length (T_s). The decrease in the data rate can be controlled by providing appropriate segment length using Segmental Partial Transmit Sequence technique along with better PAPR reduction.

Keywords: OFDM, QAM, PAPR, S-PTS.

1.INTRODUCTION

Orthogonal Frequency Division Multiplexing is a digital communication method in which the signal is to split a high-rate datastream into a number of lower rate streams transmitted at different frequencies mainly used for digital broadcasting systems. Due to insertion of cyclic prefix, the data rate is reduced.

Currently, the offset quadrature amplitude modulation based orthogonal frequency division multiplexing has been introduced which provide high spectral efficiency. In addition to that, Inter Symbol Interference is avoided without using cyclic prefix.

But high peak to average power ratio (PAPR) is the major drawback of both OFDM and OQAM based OFDM systems. PAPR is defined as the relation of peak power to the average power. The peak power is definite as the power of sine wave with amplitude equal to the maximum envelope value.

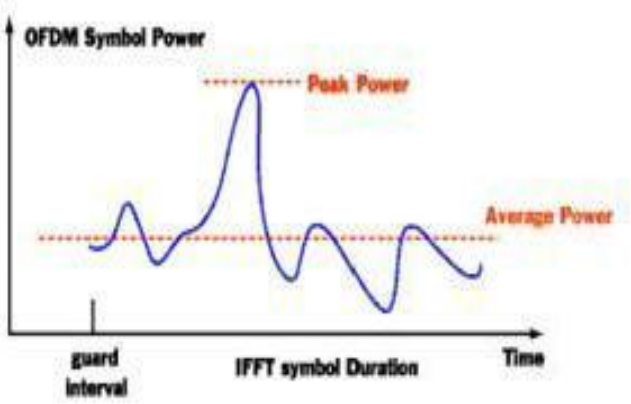

Fig.1.PAPR estimation

It is expressed as dB and it can be written as,

$$PAPR(X[N]) = \frac{\max |x[n]|^2}{E[|x[n]|]} \quad (1)$$

where E[.] is the expectation operator.

Many PAPR reduction techniques such as Clipping and filtering, Peak cancellation, SLM, PTS and so on are introduced as the solution for this problem. But it is not very effective for OQAM based OFDM system. In recent times, many techniques have been planned to decrease the high PAPR in OQAM-OFDM systems such as Overlapped SLM, Sliding window Tone Reservation and so on.

Segmental Partial Transmit Sequence technique is proposed to reduce the high PAPR with simplicity. Here, the signals are divided into several number of segments, in which it contains several number of data blocks. But it also has drawback of decreased data rate due to 4-QAM as modulation. In this paper, using the same S-PTS technique, data rate is improved by providing 16-QAM as modulation along with better PAPR reduction.

2. PREVIOUS WORK

Y.Wang et al., [5] proposed an efficient nonlinear

companding scheme to reduce the peak-to-average power ratio of orthogonal frequency division multiplexing signals. By transforming the data of original signals into a specified distribution form along with remaining an unaffected average output power level, this scheme can achieve noteworthy reduction in PAPR as well as an improved BER performance concurrently.

E. Al-Dalakta et al., [6] proposed an efficient technique for reducing the bit error rate of OFDM signals transmitted over nonlinear solid state power amplifiers. It was based on predicting the distortion power that an SSPA would produce due to the nonlinear characteristics of such devices. Simulation outcome confirmed that the signal to noise ratio that is required to get a BER of 10^-4 using the proposed technique was less by about 8 dB when it was compared to the standard PTS utilizing 16 partitions. Furthermore, complexity analysis demonstrated that this system offers a significant complexity drop of about 60% compared to state-of-the- art methods.

Seung Hee Han et al., [10] proposed a modified selective mapping technique to reduce the high PAPR of the transmitted signal which is a major drawback of OFDM. In this technique, they embed the phase sequence, which was used to lower the PAPR of the data block, within the check symbols of the coded OFDM data block. It was shown that it achieved both PAPR reduction from the SLM technique in addition to error performance upgrade from the channel coding with no loss in data rate from the transmission of side information.

Jianping Wang et al., [14] proposed the Segmental Clipping for the PAPR diminish of the Orthogonal frequency division multiplexing by offset quadrature amplitude modulation technique which has drawn noteworthy interests in recent years. Still, most of the existing OFDM peak-to-average ratio reduction methods cannot be used in the OFDM-OQAM system directly. Here, a modified scheme called overlapped segmental clipping (OS-Clipping) was proposed to deal with the high PAPR difficulty specifically in the OFDM-OQAM system. For the projected OS-clipping scheme, the input signals were separated into a number of overlapped segments & then the clipping operation was processed on each segment. Simulation results shows that the modified scheme used in the OFDM-OQAM system provided better performance than conventional clipping scheme.

Alexandre Skrzypczak et al., [9] proposed the selective mapping technique to reduce the large Peak to Average Power ratio in OFDM/OQAM system. OFDM/OQAM is now a recognized other to conventional OFDM for the transmission of signals over multi-path fading channels. Indeed with OFDM/OQAM an suitable pulse-shaping can be introduced to fight against time & frequency dispersion. In order to reduce the rate of large peak-to-power ratios (PAPR) that are natural to multi-carrier modulations, a PAPR reduction method was proposed. This technique was an adaptation to OFDM/OQAM of the selective mapping technique already used for OFDM. It was shown that, as with OFDM, the result increases with the number of SLM codes, but was also dependent upon the length of the OFDM/OQAM pulse shape.

Kumar.C et al.,[15] focused with multipath channel estimation in multi carrier systems. In less complex per-path random walk kalman filter (RW-KF) solution is proposed to overcome the multipath fading effect is based on independent processing of the path. A single channel is designed and by using the least square estimator, error signal for single path is estimated. An error signal for each channel path is calculated with the least square criterion. Based on the error signal, kalman filter is applied to each path independently. This per path kalman filter solution explores the time- domain correlation of the channel, while the least square step exploits the frequency-domain correlation of the channel. The proposed per-path KF is shown to be efficient as the exact kalman filter (i.e. joint multipath kalman filter).

3.PROPOSED METHOD

The proposed method is improving the data rate by using Segmental Partial Transmit Sequence along with enhanced PAPR reduction & the work flow is shown below.

Fig.2 project the work flow for the proposed system. There are several steps to implement the proposed methodology to improve data rate with PAPR reduction. Data rate is defined as the ratio of the number of bits that are conveyed or processed for each unit time which is represented in the unit of bps.

First step is to design the general OFDM signal by using 16-Quadrature Amplitude Modulation. The OFDM signal is designed and the graph is plotted between Bit Error Rate & Signal to Noise Ratio. BER is expressed as a percentage. SNR is stated as the ratio of signal power to the noise power that is expressed as decibels (dB).

Then, that signal is filtered by using a raised cosine filter which is regularly used for pulse shaping in digital modulation due to its capability to minimize the inter

symbol interference (ISI). Pulse shaping is nothing but the process of changing the waveform of transmitting pulses.

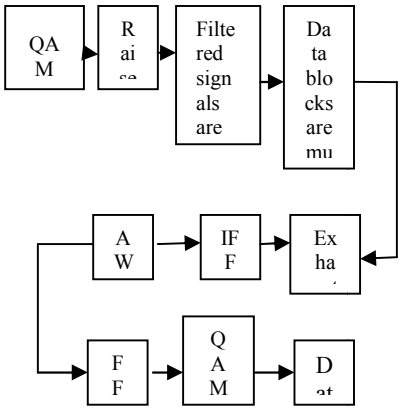

Fig.2. Flow of Work

Then the filtered signal is divided into several segments, each segment having several numbers of data blocks by using S-PTS technique. In the existing system, by using this technique, they reduced the large PAPR. The date rate is reduced due to lower 'L' value in the segment length (i.e., T_s=LT, L=2). In proposed work, improving the data rate with reduction of huge PAPR by providing L=4, 6 and so on in the segment length. Some disjoint blocks are there, which are multiplied with phase rotation sequence.

In general, an M-array QAM scheme enables the transmission of $M = L^2$ independent symbols over the same channel bandwidth. From that, the data rate will be improved using,

$$L=\sqrt{M} \quad (2)$$

The exhaustive search method is used to achieve the optimal phase combination. Then the signal is transformed by using Inverse Fast Fourier Transform (IFFT) for efficient implementation.

Then the signal is transferred to the receiver side through Additive white Gaussian noise channel which is a good model for many satellites and deep space communication. The reverse operation is done to get the original information.

4.PARAMETERS

Here, the system performance is evaluated based on following parameters:

CCDF:

It is called Complementary Cumulative Distributive Function which is the most important parameter used to provides the PAPR & It gives the probability of the OFDM signals envelope exceeding a specified PAPR threshold within the OFDM symbol.

$$CCDF[\text{PAPR}(x_n(t))] = \text{prob}\,[\text{PAPR}\,(x_n(t) > \delta)] \quad (3)$$

where $\text{PAPR}(x_n(t))$ is the PAPR of the n^{th} OFDM symbol and δ is some threshold.

BER:

It is called Bit Error Rate which is the ratio of number of bit errors to the total number of transmitted bits. The specific BER is achieved in terms of signal to noise ratio (SNR) based on performance of a modulation technique. The relation between BER and SNR is written as

$$BER=(1/SNR)^k \quad (4)$$

where k is represented as subcarrier.

Data rate:

It is nothing but speed at which the data transmitted per unit time. The unit of data rate is bps. It is expressed as,

$$\text{Date rate} = 2*BW*\log 2L \quad (5)$$

Where BW is represented as Bandwidth.

The relation between data rate and signal to noise ratio is written as,

$$\text{Data rate} = BW \log 2\,(SNR) \quad (6)$$

5. RESULT

Here, high PAPR is reduced using S-PTS technique in OFDM with 16-QAM and the output is shown below.

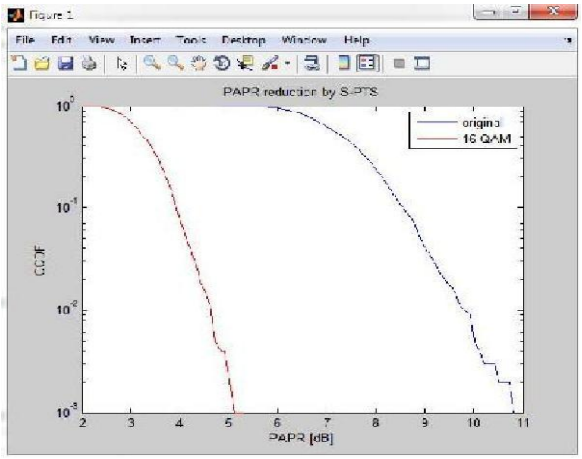

Fig.3. Plot between CCDF and PAPR

Fig.3 shows the output between CCDF and PAPR. Generally, we know that OFDM signal is modulated by using Phase Shift Keying or Quadrature Amplitude Modulation. Here, QAM is used as a modulation. PAPR value for 4-QAM and 16-QAM is compared below

Table-1 Comparison between 4-QAM and 16-QAM

PARAMETERS	ORIGINAL	4-QAM	16-QAM
CCDF	10^-3	10^-3	10^-3
PAPR	10.8 dB	6.6 dB	5.1 dB

6.CONCLUSION AND FUTURE WORK

In this paper, high PAPR is reduced for OFDM with 16-QAM using S-PTS technique. Even though the high PAPR is reduced, it has another drawback which is reduction in data rate. In future, data rate is increased using same technique which can be calculated based on the graph between SNR and BER.

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