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PAPR Reduction in OFDM System using Partial Transmit Sequence and Precoding Techniques

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A B S T R A C T

In recent time, the demand for multimedia data services has grown up rapidly. One of the most promising multi-carrier systems, Orthogonal Frequency Division Multiplexing (OFDM) forms basis for all 4G wireless communication systems due to its large capacity to allow the number of subcarriers, high data rate and ubiquitous coverage with high mobility. OFDM is significantly affected by peak–to–average–power–ratio (PAPR). Unfortunately, the high PAPR inherent to OFDM signal envelopes will occasionally drive high power amplifiers (HPAs) to operate in the nonlinear region of their characteristic curve. The nonlinearity of the HPA exhibits amplitude and phase distortions, which cause loss of orthogonality among the subcarriers. Not only that, high PAPR also leads to in-band distortion and out-of-band radiation. This project emphasis mainly on the PAPR reduction of OFDM system using Partial Transmits Sequence (PTS) and Pre-coding techniques. Some other techniques such as amplitude clipping have low-complexity and suffer from various problems such as in-band distortion and out-of-band expansion. Signal companding methods have low-complexity, good distortion and spectral properties but they have limited PAPR reduction capabilities. Other techniques such as coding, partial transmit sequences (PTS) and selected mapping (SLM), have also been considered for PAPR reduction. Such techniques are efficient and distortion less, nevertheless, their computational complexity is high.

Keywords: PAPR, OSDM, PTS, QAM, DHT

1. Introduction

One of the promising multicarrier communication systems, OFDM, has been adopted by many wireless communication standards due to its several advantageous features in multipath environments. PTS and Pre-coding are efficient techniques because it utilizes frequency domain and they are distortion-less techniques. In spite of good performance than other techniques, complexity is challenging issue of these techniques. In an OFDM system, a large number of subcarriers are used to transmit the modulated symbols and consequently, the OFDM signals have a high peak-to-average power ratio (PAPR). To reduce the high PAPR, we propose a project on "PAPR reduction in OFDM system using Partial Transmit Sequence (PTS) and Pre-coding techniques", low PAPR is obtained. To propose a method to obtain the considerable reduction in PAPR using precoding method as comparison to the PAPR obtained by using PTS scheme. A new technique is proposed to reduce the PAPR, which uses the Discrete Hartley transform (DHT) – Precoding and it is less complex than PTS method. The aim of the project is to propose a new hybrid technique to reduce the PAPR. This proposed technique uses the Discrete Hartley transform (DHT) – Precoding and it is less complex than PTS method. Furthermore, it reduces the PAPR considerably with only few numbers of subblocks as compare to PTS technique. This chapter describes in detail the OFDM system model and PAPR. Simulation results are done to evaluate the PAPR performance. At last, simulation results as well as conclusion is discussed. One of the challenging issues of OFDM system is high peak to average power ratio (PAPR). High PAPR force the high-power amplifier (HPA) to operate in non-linear region.

This operation in non–linear region degrades the power efficiency of the amplifier simultaneously requires large back-off power. Numerous techniques have been proposed during for reducing the PAPR. The main problems regarding these techniques are computational complexity, HPA efficiency and BER performance. The main purpose of this project is to study and analyse the PAPR reduction techniques of the OFDM system and then to propose new scheme with low computational complexity as well as less influence on HPA efficiency.

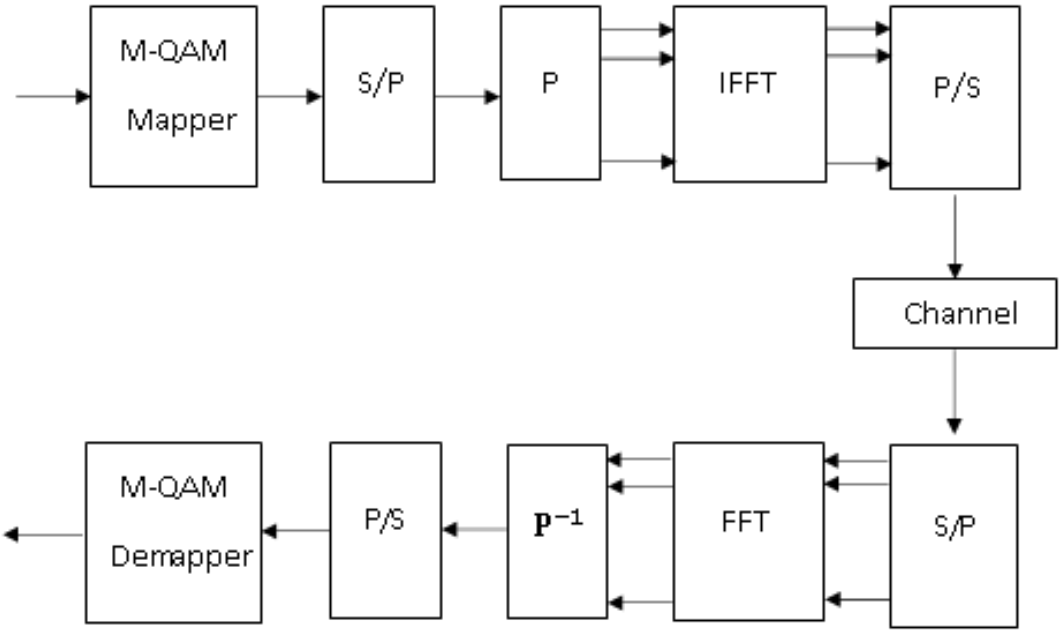
2. Literature Survey

In wireless and mobile communications, due to the ever-increasing technology, the information rate of the signal rises. In Orthogonal Frequency Division Multiplexing (OFDM), the vast data is split into low rate and this low data rate signal is moderated with N orthogonal subcarriers. OFDM is extensively expended in Digital Audio Broadcasting (DAB), Digital Video Broadcasting (DVB), Wireless LANs, Digital Subscriber Lines (DSL) as it has elevated power and spectral efficiency. OFDM is a multicarrier system, aches with high PAPR, degrades the proficiency of high-power amplifiers (HPA). Voluminous PAPR reduction techniques have been implemented like distortion based techniques: clipping trail to in-band and out-band distortion and Companding the out-band distortion and BER which are not power efficient and probabilistic techniques like selected mapping (SLM), partial transmit

sequence (PTS) were implemented. The subcarriers of OFDM signal are used by generated correlated signals. In PTS the multiplication and additional complexity can be lowered by using less IFFTs. To get considerable PAPR of OFDM signal the subcarrier waveforms are biased with different shapes. The pre-coding methods are distortion-less, amplifies the diversity gain and degrades PAPR. In this proposed technique the Precoding methods like Discrete Fourier Transform (DFT), Discrete Hartley Transform (DHT), and Walsh Hadamard Transform (WHT) is spread over the PTS OFDM system. From the original data block ,several candidate data blocks are generated and the one with lowest PAPR is transmitted. Advantage is it is independent of the number of subcarriers(N) and no distortion is introduced. Disadvantage is that it incurs data loss and degrade BER performance. The adaptive Huffman encoding algorithm is applied in the OFDM transmitter section, so that the high peak powers are eliminated before the transmission starts. The idea behind the coding scheme is to reduce the PAPR of OFDM signal with constant modulus constellation points combined with modulation scheme. The coded OFDM signal not only reduces the peak power but also it reduces the data rate of the system when compared to other schemes. In companding we enlarge the small signals while compress the large signals so that the immunity of small signals from noise will increase. This way high peaks are reduced, thereby reducing PAPR. Advantage is less distortion is introduced. Disadvantage is that there is loss in data rate. In this technique ,some code words are used to minimize the PAPR of the signal. Instead of dedicating some bits of the codeword to enhance BER performance the bits are now dedicated to reduce PAPR. Advantages are it has less distortion and high PAPR reduction. Disadvantage is the complexity is high and there is data rate loss.

3. Proposed System

Recently, the demand for multimedia data services has grown drastically which drive us in the age of 4th generation wireless communication system. This requirement of multimedia data service where user is in large numbers and with bounded spectrum, modern digital wireless communication system adopted technologies which are bandwidth efficient and robust to multipath channel environment known as multi-carrier communication system. The modern digital multicarrier wireless communication system provides high speed data rate at minimum cost for many users as well as with high reliability. In single carrier system, single carrier occupies the entire communication bandwidth but in multicarrier system the available communication bandwidth is divided by many sub-carriers. So that each sub-carrier has smaller bandwidth as compare to the bandwidth of the single carrier system. These tremendous features of multicarrier technique attract us to study Orthogonal Frequency Division Multiplexing (OFDM). OFDM is a multi-carrier modulation (MCM) technique in which complex data symbols (i.e., BPSK, QPSK, QAM, MPSK etc.) are transmitted in parallel after modulating them over orthogonal sub-carrier. In single carrier (SC) system, one complex data is transmitted using one carrier and in this parallel transmission, complex data is transmitted over sub-carrier. Here the effective data rate of the system is same as of SC system. In OFDM system, the orthogonality among sub-carriers is maintained by using inverse Fast Fourier Transform (IFFT). A guard band is inserted between successive OFDM symbols. By adding guard band in OFDM symbols, OFDM convert wideband frequency selective channel into collection of parallel narrowband flat fading channel, one channel across each subcarrier. Thus, it removes Inter-Symbol Interference (ISI). Due to features like high immune to multipath fading, high data transmission rate and requirement of less complex equalizer, OFDM has been exploited by many high data rate broadband wireless communication systems of present generation.



PAPR occurs due to large dynamic range of OFDM symbol waveforms. High PAPR in OFDM essentially arises because of IFFT pre-processing (i.e., OFDM signal consists of a number of independently modulated sub-carriers which can give a large peak when added up with same phases). Here, data symbols across sub-carriers add up to produce high Peak value signals. As long as signal swing is limited to dynamic or linear range, input and output is linearly related. (i.e., around this mean, if the deviation of the voltage is small, then signal will still be confined to linear amplification range). But in

OFDM system, swing of instantaneous power is very high compare to mean. So, it will cross over into the non-linear range where amplification is non-linear. As amplification is non-linear all the property of OFDM is lost (i.e., orthogonality is lost), then there will be extreme intercarrier interference. So, high PAPR in OFDM results in amplifier saturation, thus leading to ISI. A *Discrete Hartley Transform* (DHT) is a Fourier-related transform of discrete, periodic data similar to the discrete Fourier transform (DFT), with analogous applications in signal processing and related fields. Its main distinction from the DFT is that it transforms real inputs to real outputs, with no intrinsic involvement of complex numbers. Just as the DFT is the discrete analogue of the continuous Fourier transform, the DHT is the discrete analogue of the continuous Hartley transform, introduced by R. V. L. Hartley in 1942. Because there are fast algorithms for the DHT analogous to the fast Fourier transform (FFT), the DHT was originally proposed by R. N. Bracewell in 1983 as a more efficient computational tool in the common case where the data are purely real. It was subsequently argued, however, that specialized FFT algorithms for real inputs or outputs can ordinarily be found with slightly fewer operations than any corresponding algorithm for the DHT.

4. CONCLUSION AND FUTURE SCOPE

The proposed technique analyzed the PAPR of DHT – Pre-coded OFDM system for M-QAM (where M = 16). MATLAB simulation shows that DHT – Pre-coded OFDM System shows better PAPR gain as compared to OFDM – Original system. The main concept of the proposed method is to multiply encoded data with DHT precoding matrix and the lowest PAPR is obtained. From the result of the simulations, the proposed technique has low PAPR as compare to PTS and Precoding method. Using a few numbers of sub blocks, a remarkable reduction in PAPR is achieved that can't be achieved in PTS by large number of subblocks. Therefore, complexity of more IFFT operations for PTS method has been omitted because the proposed scheme achieves low PAPR by using few numbers of subblocks. Additionally, the DHT – Pre-coded OFDM system does not require any power increase, complex optimization and side information to be sent for the receiver. In the present scenario, the PAPR problem is still challenging issue mostly for the devices where the minimization of linear range of power amplifier is importance. In this project a DHT – precoding technique to reduce the PAPR of OFDM system is presented. This proposed system can be made more reliable by implementing a technique to recover the original signal in multipath environment without transmitting side information. Further enhancement in improving the pre-coded methods can be done. Different reduction technique algorithm as presented in the literature survey chapter can be applied. Furthermore, window functions like Discrete Fourier Transform (DCT), Modified Bartlett Hanning (MBH), Discrete Hartley Transform (DHT), Zadoff-Chu Transform (ZCT) etc can be applied to generate the precoding matrix. The proposed PAPR reduction technique can be applied with multiple input multiple output (MIMO) OFDM system.

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