PAPR REDUCTION TECHNIQUES IN OFDM SYSTEMS

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Abstract: Communication is one of the important aspects of life. With the advancement in age and its growing demands, there has been rapid growth in the field of communications. Signals, which were initially sent in the analog domain, are being sent more and more in the digital domain these days. For better transmission, even single – carrier waves are being replaced by multi – carriers. Multi – carrier systems like CDMA and OFDM are now – a – days being implemented commonly. Orthogonal frequency-division multiplexing (OFDM) is a method of digital modulation in which a signal is split into several narrowband channels at different frequencies. Priority is given to minimizing the interference, or crosstalk, among the channels and symbols comprising the data stream. Less importance is placed on perfecting individual channels. The primary advantage of OFDM over single-carrier schemes is its ability to cope with severe channel conditions without complex equalization filters. But the large Peak – to – Average Power Ratio of these signal have some undesirable effects on the system. In this thesis we have focused on learning the basics of an OFDM System and have undertaken various methods to reduce the PAPR in the system so that this system can be used more commonly and effectively. The basic Techniques here we used in order to reduce the PAPR are Amplitude clipping , Selective Mapping , Partial Transmit Sequence. The CDF Of above techniques and their comparison of CDF of the techniques are shown in this paper.
Keywords: CDMA, OFDM, BER, CCDF, CDF, Multicarrier, IFTT.

I. INTRODUCTION

OFDM is essentially identical to coded OFDM (COFDM) and discrete multi-tone modulation (DMT), and is a frequency-division multiplexing (FDM) scheme used as a digital multi-carrier modulation method. The word "coded" comes from the use of forward error correction (FEC). A large number of closely spaced orthogonal sub-carrier signals are used to carry data on several parallel data streams or channels. Each sub-carrier is modulated with a conventional modulation scheme (such as quadrature amplitude modulation or phase-shift keying) at a low symbol rate, maintaining total data rates similar to conventional single-carrier modulation schemes in the same bandwidth. we have some of the disadvantages in this model like Sensitive to Doppler shift, sensitive to frequency synchronization problems, High peak-to-average-power ratio (PAPR), requiring linear transmitter circuitry, which suffers from poor power efficiency, Loss of efficiency caused by cyclic prefix/guard interval. In this paper we mainly concentrate on PAPR problem.

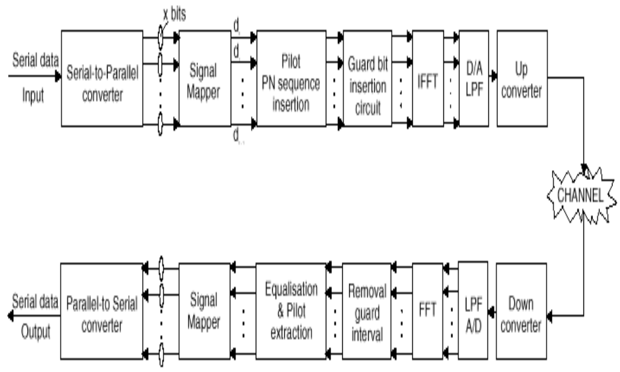

FIG: (1) Block diagram of OFDM Conventional model

Development of OFAM:
The development of OFDM systems can be divided into three parts. This comprises of Frequency Division Multiplexing, Multicarrier Communication and Orthogonal Frequency Division Multiplexing. Multicarrier Communication OFDM THEORY Orthogonal Frequency Division Multiplexing is a special form of multicarrier modulation which is particularly suited for transmission over a dispersive channel. Here the different carriers are orthogonal to each other, that is, they are totally independent of one another. This is achieved by placing the carrier exactly at the nulls in the modulation spectra of each other.
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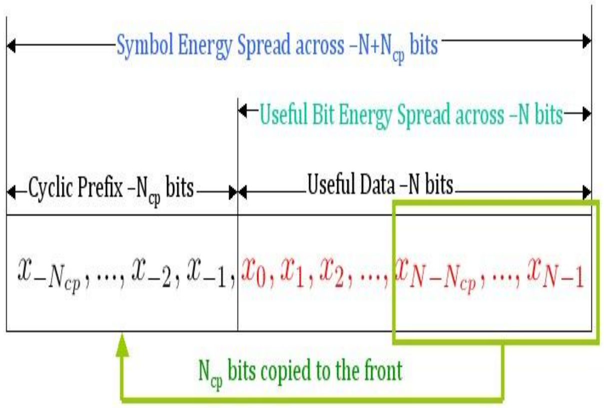
A. Serial to parallel conversion:

In an OFDM system, each channel can be broken into various sub-carriers. The use of sub-carriers makes optimal use out of the frequency spectrum but also requires additional processing by the transmitter and receiver. This additional processing is necessary to convert a serial bit stream into several parallel bit streams to be divided among the individual carriers. Once the bit stream has been divided among the individual sub-carriers, each sub-carrier is modulated as if it was an individual channel before all channels are combined back together and transmitted as a whole. The receiver performs the reverse process to divide the incoming signal into appropriate sub-carriers and then demodulating these individually before reconstructing the original bit stream.

B. Inverse Discrete Fourier Transform :

The modulation of data into a complex waveform occurs at the Inverse Fast Fourier Transform (IFFT) stage of the transmitter. Here, the modulation scheme can be chosen completely independently of the specific channel being used and can be chosen based on the channel requirements. In fact, it is possible for each individual sub-carrier to use a different modulation scheme. The role of the IFFT is to modulate each sub-channel onto the appropriate carrier. Lets say, without cyclic prefix we transmit the following N values (N=Nfft=length of FFT/IFFT) for a single OFDM symbol. X0,X1,X2,X3……….Xn-1 .Lets consider a cyclic prefix of length Ncp, (where Ncp<N), is formed by copying the last Ncp values from the above vector of X and adding those Ncp values to the front part of the same X vector.With a cyclic prefix length Ncp, (where Ncp<N), the following values constitute a single OFDM symbol



If T is the duration of the an OFDM symbol in secs, due to the addition of cyclic prefix of length Ncp, the total duration of an OFDM symbol becomes T+Tcp, where Tcp=Ncp*T/N. Therefore, the number of samples allocated for cyclic prefix can be calculated as Ncp=Tcp*N/T, where N is the FFT/IFFT length, T is the IFFT/FFT period and Tcp is the duration of cyclic prefix.

C. Parallel to Serial Conversion

Once the cyclic prefix has been added to the sub-carrier channels, they must be transmitted as one signal. Thus, the parallel to serial conversion stage is the process of summing all sub-carriers and combining them into one signal. As a result, all sub-carriers are generated perfectly simultaneously. However, OFDM also has its shortcoming. The major drawback of OFDM signal is its large peak-to-average power ratio (PAPR), which causes poor power efficiency or serious performance degradation to transmit power amplifier.

II. EFFECT OF PAPR IN OFDM MODEL

The peak-to-average power ratio (PAPR) is a related measure that is defined as the peak amplitude squared (giving the peak power) divided by the RMS value squared (giving the average power)

$$\text{PAPR}=\frac{max\,|x(t)^2|}{E[|X(t)|2]}$$

Cognitive Radio can be defined as an intelligent wireless system that is always alert about its surrounding environment through sensing and should have ability to dynamically adjust its radio operation parameters. The CR demands that the physical layer (PHY) needs to be adaptable and flexible. It is also for Effective Transmission as such of OFDM. For flexibility and adaptability, the OFDM is an attractive candidate for CR systems. This dissertation proposes a novel non-contiguous OFDM (NC-OFDM) technique, where the implementation achieves high data rates of non-contiguous subcarriers while simultaneously avoiding any interference to the transmissions. In this dissertation we apply different modulation techniques to reduce high PAPR for non-contiguous bands spectrum of OFDM based CR. The simulation results for PAPR reduction shows that higher modulation techniques are better compared to lower modulation techniques.

A. Selected mapping (SLM):

In particular SLM technique whole set of signal represent the same signal but form it most favorable signal is chosen related to PAPR transmitted. The side information must be transmitted with the chosen signal. This technique is probabilistic based will not remove the peaks but prevent it from frequently generation. This scheme is very reliable but main drawback that is side information must be transmitted along with chosen signal. SLM is also a non-distortion PAPR reduction scheme suffer from the problem of SI. The PAPR reduction capability of SLM based OFDM system mainly depends on the number of alternative sequences and the generation of phase sequence set used to produce the alternative sequences. We have proposed a novel M-ary chaotic sequence to generate the phase sequence set for achieving better PAPR reduction capability in SLM-OFDM system. We have also utilized the CCM mapping scheme to avoid the requirement of SI. The proposed scheme can effectively reduce PAPR of the OFDM signal. The PAPR reduction capability of the proposed scheme is compared with existing Riemann matrix based phase sequence set generation and it has been found that the PAPR reduction capability of proposed scheme with eight alternative sequences is very close to SLM-OFDM system utilizing Riemann matrix phase sequence. The SER performance of SLM-OFDM system utilizing Riemann matrix phase sequence is mathematically analyzed and it has been found that as the number of alternative sequences increases the PAPR reduction capability of SLM-OFDM system increases at the cost of SER performance degradation, whereas in the proposed scheme the SER performance remains unchanged by increasing the number of alternative sequences. The SER performance of the proposed scheme has also been evaluated over fading channel and is found to be better than SLM-OFDM system with Riemann matrix based phase sequence for same number of alternative sequences.

B. Partial transmit sequence (PTS):

Partial transmit sequence is also one of the Probabilistic based. Main idea of this scheme is data block divide into non overlapping sub block with independent rotation factor. This rotation factor generates time domain data with lowest amplitude. This is modified technique of SLM scheme. And gives better performance than SLM. Because of differential modulation no needs to transmit the side information. PTS is one of the most promising PAPR reduction schemes to reduce the PAPR of the OFDM signal but it suffers from the problem of SI. In order to completely eliminate the requirement of side information, a novel quaternary to concentric circle constellation mapping for PTS based PAPR reduction scheme is proposed. In this scheme first we have proposed a novel concentric circle constellation having 13 constellation points. The constellation points lie at origin and on circles of radius 2 and 4. We have used a quaternary to concentric circle constellation mapping (CCM). In this mapping scheme the quaternary data points (0, 1, 2 & 3) are initially mapped to four different points of concentric circle constellation and these after multiplication with the phase factors (1, j, -1, -j) cover all13 points of the constellation in such a way that SI is not required at the receiver to recover the original OFDM signal. For CCM, a new decoding scheme called as circular boundary is also proposed besides the conventional minimum distance decoding. A complete SER analysis of CCM with both the decoding schemes and MPSM-PTS [18] with minimum distance decoding over additive white Gaussian noise (AWGN) channel is done. We have also proposed the method for coupling the CCM with PTS based PAPR reduction scheme.

C. AMPLITUDE CLIPPING:

Clipping & Filtering techniques is mostly effective techniques to reduce the high PAPR in OFDM system. Here clipping is the nonlinear process which increase the band noise distortion, also increase in the bit error rate also decrease the spectral efficiency here using with filtering this techniques will give better performance. Filtering after clipping will reduce out of band radiation. This technique will reduce the PAPR with out spectrum expansion. here if the OFDM signal is over sampled then the scheme of correction is suitable with the clipping so that each subcarrier generated with the interference. So for proposed this scheme each signal must be oversampled by factor of four. This scheme is more compatible with the PSK modulation scheme. The problem in this case is that due to amplitude clipping distortion is observed in the system which can be viewed as another source of noise. This distortion falls in both in – band and out – of – band. Filtering cannot be implemented to reduce the in – band distortion and an error performance degradation is observed here. On the other hand spectral efficiency is hampered by out – of – band radiation. Out – of – band radiation can be reduced by filtering after clipping but this may result in some peak re – growth. A repeated filtering and clipping operation can be implemented to solve this problem. The desired amplitude level is only achieved after several iteration of this process.

III. SIMULATION RESULTS

In this section, we provide the simulation results of the cumulative distribution functions for the proposed OFDM versus conventional OFDM. The cumulative distributive functions of various reduction techniques are shown below and respective graphs are also plotted. Finally the comparison between all the CDFs are also shown. The respective simulation results are also presented here.

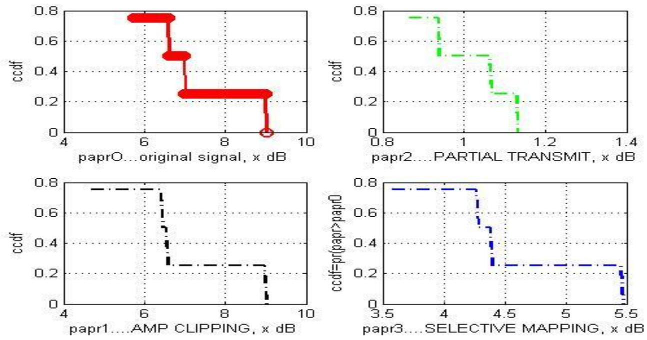


Fig: 2 Cumulative distributive functions of different PAPR reduction techniques

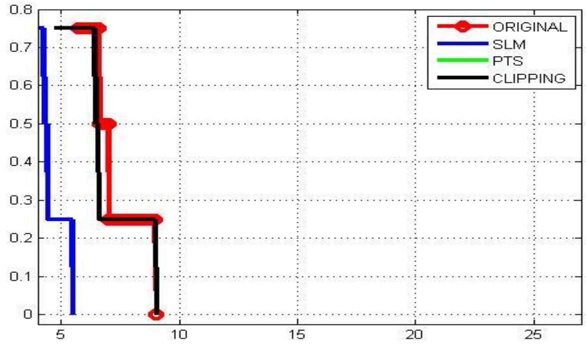


Fig: 3 Comparison of Cumulative distribution function of PAPR reduction in OFDM

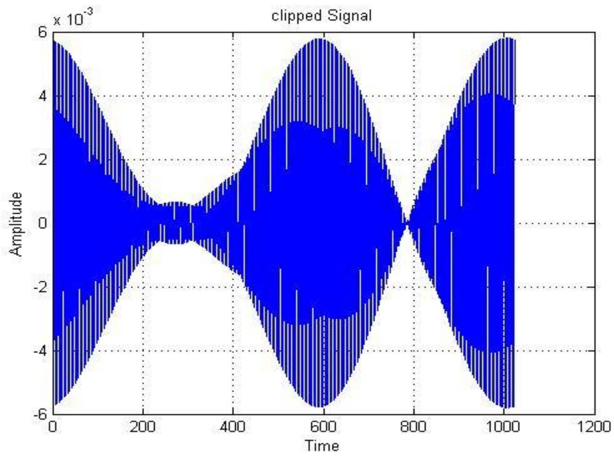


Fig: 4 PAPR reduction in OFDM Amplitude Clipping

IV. CONCLUSION

In this paper, technique for PAPR of OFDM signals has been proposed. These are very efficient and simple technique, when compared to previous techniques. Cumulative distributive functions of various reduction techniques and the respective graphs are plotted. The simulation results are shown.

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