A Brief Survey on PAPR Reduction Techniques with Different Approaches

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Abstract- The growing demand for high speed and reliable communication system has led to the integration of multicarrier techniques. The principle of multi-carrier transmission is to divide the entire bandwidth into smaller bandwidths each with a different sub-carrier frequency, such that each of these narrow-band signals is immune to frequency selective fading and the data-rates are improved in comparison to single-carrier system as the total bandwidth can be increased significantly. Theserious drawback associated with multicarrier techniques is high Peak-to-Average Power Ratio (PAPR). This high PAPR acts as a bottleneck for multicarrier techniques and limits its applications. So PAPR must be reduced at any cost. The objective of this work is to study different multicarrier techniques such as OFDM. Then integration of both the techniques to enhance the speed, range and reliability of the wireless communication link is studied. The main disadvantage associated with the multicarrier techniques is Peak-to-Average Power Ratio (PAPR).

Keywords- Peak-to-Average Power Ratio (PAPR), OFDM, Data rate, Multi carrier, PAPR reduction.

I. INTRODUCTION

The demand of high data rate services has been increasing very rapidly and there is no slowdown in sight. It is well known that the data transmission includes both wired and wireless medium. Often, these services require very reliable data transmission over very harsh environment. Most of these transmission systems experience much degradation such as large attenuation, noise, multipath, interference, time variance, nonlinearities and must meet the finite constraints like power limitation and cost factor. One physical layer technique that has gained a lot of popularities due to its robustness in dealing with these impairments is multi-carrier modulation technique. In multi-carrier modulation, the most commonly used technique is Orthogonal Frequency Division Multiplexing (OFDM); it has recently become very popular in wireless communication.

Unfortunately the major drawback of OFDM transmission is its large envelope fluctuation which is quantified as Peak to Average Power Ratio (PAPR). Since power amplifier is used at the transmitter, so as to operate in a perfectly linear region the operating power must lies below the available power. For reduction of this PAPR lotof algorithms have been developed. All of the techniques have some sort of advantages and disadvantages [1]. Clipping and Filtering is one of the basic technique in which some part of transmitted signal undergoes into distortion. Also the Coding scheme reduces the data rate which is undesirable. If considering Tone Reservation (TR) technique it also allows the data rate loss with more probable of increasing power. Again the techniques like Tone Injection (TI) and the Active Constellation Extension (ACE) having criteria of increasing power will be undesirable in case of power constraint environment. If go for the Partial Transmit Sequence (PTS) and Selected Mapping (SLM) technique, the PTS technique has more complexity than that of SLM technique.

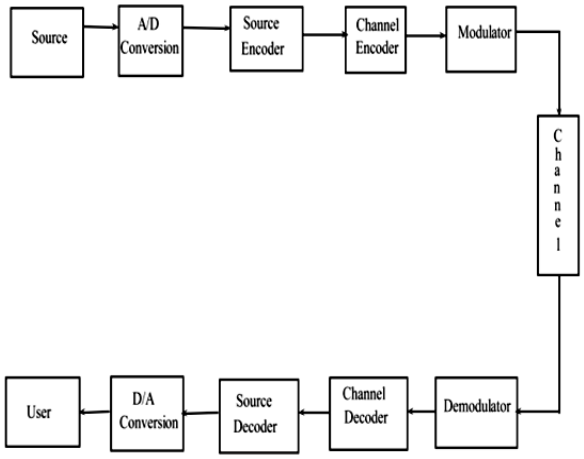

Figure 1.1 Block Diagram a General Digital Communication System.

The figure 1.1 describes about a general digital communication system blocks. The A/D converter being used to convert the analog source to the digital i.e. in the form of binary sequences. The source encoding takes place to compress the transmitted digital data up to an extent such that it can be received withoutany loss. There aresome basic source coding techniques are available like the Hoffman coding and Shannon-Fano coding. The objective of source encoding is to remove redundancy from the source. The sequence of binary digits from the source encoder also knownas information sequence is

passed to the channel encoder. The channel encoder addsredundant bits to the information sequence from the received signal for the reliable communication. The channel encoder maps k information bits into a unique n bit sequence called codeword. The ratio n/k is a measure of the redundancy introduced bythe channel encoder and the reciprocal of this ratio is called code rate. The output of the channel encoder is passed to the digital modulator.

a. Partial Transmit Sequence

The demerits of high PAPR incurred in OFDM system is generally addressed to by a number of PAPR reduction techniques which reduce the PAPR value to a certain threshold such that the derogatory effects are eliminated [4]. Some of the techniques have moderate PAPR reduction capability but have lower complexity while some have very good PAPR reduction capability at the cost of very high complexity. Partial Transmit Sequence technique complies with the second type of techniques with high computational complexity and good PAPR reduction performance.

II. MUTICARRIER TRANSMISSION SCHEMES

Multipath channel propagation is devised in such a manner that there will be a minimized effect of the echoes in the system in an indoor environment. Measures are needed to be taken in order to minimize echo in order to avoid ISI (Inter Symbol Interference). The figure 2.1 shows the scenario for multipath propagation.

In a single carrier system, a single fade causes the whole data stream to undergo into the distortion i.e known as the frequency selective fading. To overcome the frequency selectivity of the wideband channel experienced by single-carrier transmission, multiple carriers can be used for high rate data transmission. In multicarrier transmission [4], a single data stream is transmitted over a number of lower rate subcarriers. The figure 2.2 shows the basic structure and concept of a multicarrier transmission system.

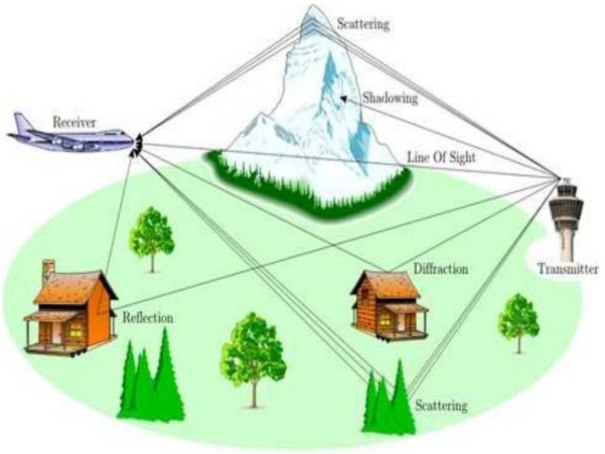

Figure 2.1 Multipath Propagation

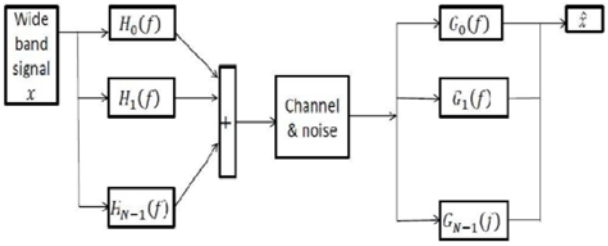

Figure 2.2 Multicarrier Transmissions.

Using this multicarrier transmission the frequency-selective wideband channel can be approximated by multiple frequency-flat narrowband channels. Let the wideband be divided into N narrowband subchannels, which have the subcarrier frequency of f_k, k = 0, 1, ..., N − 1. Orthogonality among the subchannels should be maintained to suppress the ICI (Inter Carrier Interference) which leads to the distortionless transmission. So in this transmission scheme the different symbols are transmitted with orthogonal subchannels in parallel form. If the oscillators are being used to generate the subcarriers for each subchannel, the implementation of this transmission scheme becomes complex. To avoid this complexity one important transmission scheme comes into picture that is the OFDM (Orthogonal Frequency Division Multiplexing).

III. LITERATURE REVIEW

SR. NO.	TITLE	AUTHORS	YEAR	APPROACH
1	PAPR reduction scheme: wavelet packet-based PTS with embedded side information data scheme	J. Zakaria and M. F. Mohd Salleh	2017	A wavelet packet (WP)-based PTS (WP-PTS) scheme is selected as the MCM transmission method
2	A hybrid PAPR reduction approach for the IM/DD optical OFDM communications,	P. Miao, D. Jiang, L. Wu and P. Chen	2017	A novel hybrid peak-to-average power ratio (PAPR) reduction approach combining multi-band Jacket matrix spreading (MB-JS)
3	Comparision between SLM-companding and precoding-companding techniques in OFDM systems	A. Kangappaden, A. R. Daniel, V. P. Peeyusha, M. P. Raja, P. Sneha and A. M. V. Das	2016	main three reduction techniques, precoding and SLM in combination with nonlinear companding
4	Overlapped Smart Gradient	S. K. Vangala and S.	2015	Reported overlapped Smart Gradient

	Projection Tone Reservation PAPR reduction for FBMC/OQAM signals	Anuradha		Projection Tone Reservation (OSGP-TR) method to reduce the PAPR of the FBMC/OQAM signals
5	Comparisons of low complexity transforms for multi carrier schemes	T. Deepa, R. Kumar and S. Sohale	2014	Reported the comparisons of different low complexity transforms which includes direct computation of discrete Fourier transform (DFT)
6	A combined weighting and PTS technique for PAPR reduction in OFDM signals	L. S. Hameed		Initially a weight is imposed on each discrete OFDM signal via a certain kind of a band limited signal
7	A genetic algorithm based PAPR reduction in WPM system,	N. Dixit, N. Singh, S. Mandake, M. H. Naikwadi and K. P. Patil	2013	Reported Genetic Algorithm (GA) based approach for the reduction of PAPR.

J. Zakaria and M. F. Mohd Salleh, [1] Partial transmit sequence (PTS) is an effective scheme to reduce high peak-to-average power ratio (PAPR) for multicarrier modulation (MCM) signal transmission systems. This approach produces side information (SI) data as a result of the MCM signal optimisation process. The generated SI data are required to be transmitted with the original data over the channel for successful data recovery at the receiver. An effective method for SI data transmission has not yet been identified and research is still ongoing. Hence, the authors introduce a technique that embeds SI data into the original data frame. In this study, a wavelet packet (WP)-based PTS (WP-PTS) scheme is selected as the MCM transmission method. The proposed scheme is called WP-PTS with embedded SI data. In addition, a suitable scheme for reconstructing the original data is developed. Simulation result shows that the PAPR performance of the proposed scheme improves by up to 2.5 dB at a complementary cumulative distribution function level of 10-4 compared with the original WP-orthogonal frequency-division multiplexing system without the PAPR reduction scheme when the number of selected disjoint subblocks is 16.

P. Miao, D. Jiang, L. Wu and P. Chen,[2]a novel hybrid peak-to-average power ratio (PAPR) reduction approach combining multi-band Jacket matrix spreading (MB-JS) with the clipping and filtering for the orthogonal frequency division multiplexing (OFDM)-based optical communication systems has been reported. The PAPR performance of the proposed scheme is theoretical analyzed and the received signal-to-noise ratio (SNR) for each split sub-band are calculated. The 50 m step-index (SI) polymer optical fiber (POF) transmission based on offline processing is adopted as a special case to evaluate the system performance and then make comparisons with some other well known PAPR reduction techniques. With the help of this methodology, at least 2.57 dB PAPR reduction is obtained and 4 dBm power savings is achieved when compared to the original OFDM transmission. It is demonstrated that the proposed scheme can offer better system performance and make a favorable trade-off among the PAPR reduction, bit error rate and computational complexity.

A. Kangappaden, A. R. Daniel, V. P. Peeyusha, M. P. Raja, P. Sneha and A. M. V. Das,[3]OFDM is a multicarrier modulation technique which is used in communication systems like Wireless Personal Area Network (WPAN), Wireless Local Area Network (WLAN), Wireless Metropolitan Area Network (WMAN), Wi-Max, DVB-T etc for the high rate transmission over wireless radio channels. It is commonly known as a transmission technique of high spectral efficiency and robustness against frequency selective fading. The advantages of OFDM include simple digital realization, compatibility with multipath fading channel, less complex receivers and improve the bandwidth efficiency. At the same time, it also increases system capacity providing reliable transmission. But the main problem of OFDM systems is Peak to average power ratio due to its envelope fluctuation. The objective of this project this to provide a broader understanding in peak-to-average power ratio (PAPR) problem in orthogonal frequency division multiplexing (OFDM) systems. This workshowcases main three reduction techniques, precoding and SLM in combination with nonlinear companding in detail considering advantages and disadvantages of each technique.

S. K. Vangala and S. Anuradha, [4] The Filter Bank Multicarrier based on Offset Quadrature Amplitude Modulation (FBMC-OQAM) system is now a recognized alternative to the conventional OFDM system. However, the FBMC/OQAM system also suffers from the high peak-to-average power ratio (PAPR) problem that is inherent to the multicarrier modulations (MCM). a overlapped Smart Gradient Projection Tone Reservation (OSGP-TR) method to reduce the PAPR of the FBMC/OQAM signals has reported in this work. Since adjacent data blocks in the time domain overlap with each other due to the introduction of the filter bank, the OSGP-TR method scales the filtered clipping noise to generate the peak-canceling signal, and all the influences of the associated

overlaps are taken into account when computing the scaling factors. The proposed FBMC OSGP-TR method outperforms a conventional SW-TR (Sliding Window Tone Reservation) method by 2.6dB in PAPR reduction at a clip probability of 10-3 on the 1st iteration.

T. Deepa, R. Kumar and S. Sohale,[5]Multi carrier modulation (MCM) transmits the data by dividing the data streams into several bit streams, and these sub streams are used to modulate several carriers. MCM is highly useful in high data rate wireless communication system. Orthogonal frequency division multiplexing is the widely implemented MCM technique for current wireless systems. All system faces the complexity reduction issues, as the number of sub carrier increases and also in high peak to average power ratio (PAPR) & bit error rate (BER) performance. The comparisons of different low complexity transforms which includes direct computation of discrete Fourier transform (DFT), radix 2 Fast Fourier transform (FFT), divide and conquer algorithm, WHT-DFT transform and combined T-transform has presented in this work. This comparison includes the multiplication and addition complexity values for given transforms with their methodologies and comparing it with the simulation results.

L. S. Hameed,[6]At present for high data rate transmission, Orthogonal Frequency Division Multiplexing (OFDM) is the best and efficient modulation and multiplexing scheme adapted for 4G wireless communication applications. As an attractive technology for wireless communications, OFDM which is one of multi-carrier modulation (MCM) techniques offers a considerable high spectral efficiency, multipath delay spread tolerance, immunity to the frequency selective fading channels and power efficiency. As a result, OFDM has been chosen for high data rate communications. One of the challenging issues for Orthogonal Frequency Division Multiplexing (OFDM) system is its high Peak-to-Average Power Ratio (PAPR). Methods for reduction of PAPR in multi-carrier OFDM through the joint use of weighting, and Partial Transmit Sequence (PTS) has presented in this work. In the proposed scheme, initially a weight is imposed on each discrete OFDM signal via a certain kind of a band limited signal, and PTS is done on weighted discrete data and is then considered before a high power amplifier (HPA). All the simulations are conducted in MATLAB over AWGN channel using Quadrature Phase Shift Keying (QPSK) modulation scheme. The simulation results show that the proposed scheme significantly provides better PAPR reduction and high performance on Bit Error Rate (BER) compared to weighting and PTS technique.

N. Dixit, N. Singh, S. Mandake, M. H. Naikwadi and K. P. Patil,[7]The major drawback of multicarrier transmission such as Orthogonal Frequency Division Multiplexing (OFDM) and Wavelet Packet Modulation (WPM) is their high Peak-to-Average Power Ratio (PAPR). A Genetic Algorithm (GA) based approach for the reduction of PAPR has proposed in this work. The GA approach has proved to be an efficient optimization tool for the reduction of PAPR as well as the computational load. The results show that the P APR of the original WPM signal is 12.5 dB and that obtained after applying GA is 9.5 dB, thereby reducing the PAPR by about 3dB. Further, it is observed that GA performs better than Partial Transmit Sequence (PTS) and Selective Mapping Technique (SLM) if number of generations is increased.

IV. PROBLEM IDENTIFICATION

In the telecommunications field, the terms of discrete multi-tone (DMT), multichannel modulation and multicarrier modulation (MCM) are widely used and sometimes they are interchangeable with OFDM. In OFDM, each carrier is orthogonal to all other carriers. However, this condition is not always maintained in MCM. OFDM is an optimal version of multicarrier transmission schemes.In a classical parallel data system, the total signal frequency band is divided into N nonoverlapping frequency subchannels. Each subchannel is modulated with a separate symbol and then the N sub channels are frequency-multiplexed. It seems good to avoid spectral overlap of channels to eliminate inter-channel interference. However, this leads to inefficient use of the available spectrum.The main problems with OFDM signal is very sensitive to carrier frequency offset, and its high Peak to Average Power Ratio (PAPR).

V. CONCLUSION

This review work investigates the impact of PAPR inmulticarrier signal and its reduction schemes.Multicarrier signal and multiple access techniques are employed side by side in cellular systems. The need for multiple access techniques arises from the necessity to share a limited resource of radio spectrum amongst many users. Multiple access schemes are used to allow many mobile users to share simultaneously a finite amount of radio spectrum. The sharing of spectrum is required to achieve high capacity by simultaneously allocating the available bandwidth (or the available amount of channels) to multiple users.High PAPR causes intermodulation products, increases the cost of the transmitter, and increases the complexity of the ADC. So PAPR must be reduced at any cost. To reduce PAPR many methods have been discussed in this work.

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