Performance Analysis of the Partial Transmit Sequence using modified Clipping Algorithm for PAPR reduction in OFDM

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Abstract — Orthogonal frequency division multiplexing (OFDM) is a promising multicarrier modulation technique for high data rate communication. Unless, OFDM faces the peak-to average-power ratio (PAPR) problem that is a major drawback of multicarrier transmission system which leads to power inefficiency of high power amplifier (HPA) and also demands the large dynamic range of digital to analog converter (DAC) at the transmitter. A number of schemes have been proposed to reduce the PAPR problem. The clipping technique is one of the scheme to reduce the PAPR problem in OFDM system. This paper presents the performance analysis of partial transmit sequence using modified clipping technique to reduce the PAPR problem. The PAPR reduction capability of this technique is demonstrated by presenting simulation results of PAPR.

Keyword - OFDM, performance optimization, Broadband Wireless Access (BWA), PAPR, PTS, interleaved partitioning, cooperative PTS.

1. INTRODUCTION

OFDM is a new modulation theme that has brought important attention from the previous few years, OFDM divides high data rate signals into the variety of low data rate signals that are transmitted at the same time over a variety of orthogonal subcarriers. OFDM provides new modulation scheme which proposed many facility for broadband wireless transport and uphold high data rate. The structure of OFDM reduces multipath interference, also it can utilize multipath to give better signal quality by processing the reflected packets to increase gain.

These techniques also rectify non line of sight delivery. It endorses both TDD and FDD. OFDM supports sub channelization which is a technique that splits channels into sub channels even into several thousand sub channels. OFDM system is based on principle of orthogonality. It has been also characterized as a physical layer of wireless networking standard HIPERLAN-2 in Europe and IEEE 802.11a and IEEE 802.11g standard in the United States. Single carrier systems upload their data by decreasing the symbolic time, so bandwidth utilization is also becomes more, at the same time wideband channels are precise to fading which needs composite equalizer at the receiver side to get back the real signal. OFDM has overcome from this problem by splitting wideband channel into narrow band channels, with experiencing of flat fading, thus signal tab equalizer is required at the receiver side, which reduces intricacy. Within the past several years OFDM has been applied to long haul communication network, despite of this it has some drawbacks as OFDM system, which are not durable in estimating carrier frequency errors, even a small carrier frequency offset demolish the orthogonality between the subcarrier which causes extreme increase in bit error rate.

Practical communication systems are peak power limited, but they suffer from large envelope variation which is also a drawback of OFDM system. It is one of the major practical complications of uncoded OFDM signal. PAPR is directly related with number of subcarriers that are summed up sequentially this problem termed as PAPR. Over the last decade a lot of research has been carried out in reducing the two major limitations of OFDM for improving the

performance of the system. The large variation in the envelope of OFDM signal, which creates high PAPR, is the main key limit of this research. Already various schemes are provided nowadays for PAPR reduction. Overall it is recorded that these techniques have big computational overhead. Clipping causes reductions in

bandwidth efficiency. Therefore it's necessary to introduce a new technique which can overthrow those drawbacks of existing ones and also gives a performance improvement from the possible implementation point of view.

OFDM is a multi-carrier modulation technique which started in 1960's. Chang proposed the carrier transmission in 1966.Weinstein and Ebert in 1971 projected finite time multicarrier transmission known as OFDM [1] [2] [3]. The rebound of OFDM provides the freedom to use enhance techniques, such as adaptive loading, transmit diversity and receiver diversity to improve efficiency of transmission. Shannon expressed that the highest data rate obtain from frequency selective channels by using a multi carrier system with set of narrow band channels, transmission powers and data rates [4].

Presently, OFDM has been executed in wide band data transmission (IEEE 802.11 a, HIPERLAN-2), ADSL, VHDSL, DAB, HDTV, IEEE 802.16 Wimax standard and its application [5]. PAPR reduction schemes are basically divided into two categories,

I. Distortion based schemes.
II. Non-distortion based schemes.

Clipping is most basic technique to compensate the PAPR, it comes with a drawback of out of band radiation to reduce the impacts, filtering scheme can apply but it creates peak re-growth [6]. Similarly, tone reservation, tone injection creates peak re-growth. Selective level mapping (SLM) is applied by constructing a set of proper different signals from the real data signals then transmitter will select the signal that has lowest power.

Partial transmit sequence (PTS) is also the same scheme in which sub-blocks of real signals are best combined at the transmitter side to construct a transmitted signal with lowest power. Although PTS and SLM are dominant to reduce PAPR. They needed the side data in order to decode the signal at receiver end [7].S.Abouty, ***et.al***, show that the clipping noise obtained after several clipping and filtering iterations is approximately proportion to that created in the first iteration. Therefore, we scale the clipping noise produced in the first iteration to get a new clipping and filtering technique with three fast Fourier transforms or inverse fast Fourier transform (FFT/IFFT) operations, to obtained the same PAPR reduction as that of the existing iterative technique with 2K+1 FFT/IFFT operations, where K represents the number of iterations [8].J. Armstrong illustrated that replicate clipping and frequency domain filtering of an OFDM signal can be expressively reduce the

PAPR of transmitted signal. This scheme causes no out of band radiation. Valuable power reduction can be achieved with finite levels of clipping [9].

Y.C. Wang, proposed upgraded optimization scheme dynamically convert the filter response in an ICF procedure [10]. The PAPR of OFDM signal can be reduced by using resulting optimized ICF scheme. The three fundamental advantage of proposed method are:

I. The number of iteration is reduced to reach the given PAPR level.
II. Good out-of-band radiation.
III. Low distortion by filtered OFDM symbols.

P. Sharma, ***et.al***, proposed the new scheme that combines selective level mapping and composite technique to reduce PAPR [11]. However, a compatible technique is distortion technique, using a convolution code with compounding also improves performance of bit error rate in OFDM system. It also removes disadvantages from SLM technique of extra side information that is this technique does not require any side information unlike convention SLM.T.Jiang analyzed various PAPR reduction scheme on the basis of complexity out of band radiation, bandwidth expansion, performance of spectrum spillage. Some methods of PAPR reduction for multi user OFDM are also discussed [12].

Z. M. Husain addresses an efficient peak power reduction scheme for OFDM system [13]. This method is based on clipping and iterative processing. Iterative processing is performed to limit PAPR in the time domain but the subtraction process performs in frequency domain. The results of such methods are capable for reducing PAPR significantly with minimum degradation in bit error rate.

Md.Lodro manifested the utilization of convolution codes which endow error correction capability and also achieve PAPR reduction when applied in OFDM system. Due to the

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preamble of resistors for the generation of polynomials approval of convolution codes produced. Behind schedule several top configurations are hindered for this purpose. Thus, the performance of bit error rate is analyzed for the entire three tap in AWGN channel using BPSK modulation scheme [14].

2. OFDM WITH SYSTEM MODEL

In the OFDM transmitter, the signal is defined in the frequency domain. It is a sampled signal, and it is defined such that the discrete Fourier spectrum exists only at distinct frequencies. Each OFDM carriers corresponds to one element of this discrete Fourier spectrum.

The amplitudes and phases of the carriers depend on the data to be transmitted. The data transitions are synchronized at the carriers, and can be processed together, symbol by symbol as shown in diagram be figure 1.

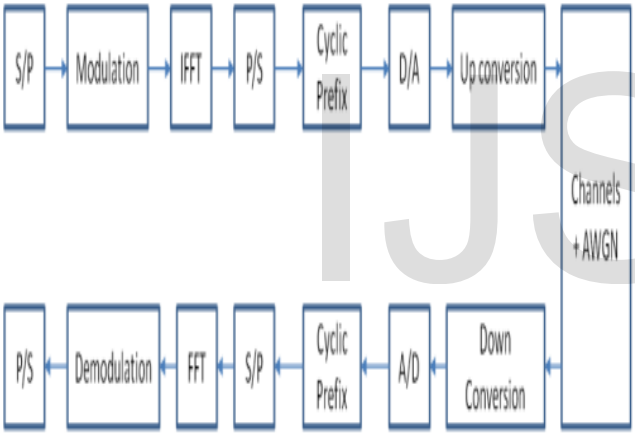

Figure 1.: OFDM system model

In these model data coming from the input are arranged into vectors with number of components equal to the number $\widetilde{N}$ of carriers. Each component is composed by a number of bits depending on the alphabet of the modulation scheme used on the next stage. For example, if we use a 1536 carriers system with BPSK, we'll have vectors of 1536 component each one composed by 1 bit (BPSK is 2-ary).Each component (group of bits) is mapped into a complex symbol depending on the alphabet of the modulation scheme used. For example, with BPSK the alphabet is{ -1 ; +1 }.In order to obtain real samples after IFFT, a 2*Number of carrier points IFFT is done with :

The Inverse Fast Fourier Transform algorithm (IFFT) is applied to the vector giving a real samples vector. The guard interval is added at the beginning of the vector by repeating the components of the end. Vectors are concatenated to form a time signal (parallel/serial conversion) Windowing the signal is necessary to limit the bandwidth. Most used window is the raised cosine. The signal is then passed through the channel. Channel is modelled by a linear system with frequency response c(t) together with a source of additive Gaussian noise. At the reception, signal is rearranged again into vectors (serial/parallel conversion) and guard interval is dropped.

Fast Fourier Transform (FFT) is computed in order to get back the complex vector of symbols. Mapping of digital signal is performed by the DFT in OFDM in to complex signal and reverse mapping is performed by IDFT.

3. PTS TECHNIQUE

The OFDM technique has numerous assets, like immense spectral efficiency, resistance to impulse interference and, frequency selective fading while not having a powerful channel equalizer.

Nevertheless, OFDM technique has certain drawbacks. One of the drawback is, carrier frequency offset, tiny frequency offset fails to perform the principle of Orthogonality between the subcarriers and the error rate increases. Another drawback is that the OFDM signals affected by huge envelope variations. Such variations become problematic as peak to average power increases in the peak power limited communication system.

Thus, this envelope peak needs a system with immediate signal power which has large power efficiency or power amplifier. Such drawback is known as Peak to Average Power Ratio. OFDM signal consist of independent modulated subcarriers that generate the matter of Peak to Average Power Ratio. This is adverse impact on the time period.

Number of techniques used to minimize PAPR, such as clipping technique, clipping and filtering technique, Partial Transmit Sequence (PTS) etc. Similar techniques accomplish PAPR reduction but at the cost of bit error rate boost, power boost, procedure complexness improvement and so on.

Muller and Hubber projected the partial transmit sequence

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in 1977. This technique generates input data which first goes through the serial to parallel block and then input data is converted into the sub-blocks. These sub-blocks passes through the IFFT block and the signals multiplied with the random phases. This technique is adjustable for OFDM system.

The most important point in this technique is that the input data is broken into the non-overlapping sub-blocks. Partial transmit sequence works higher than the selective level mapping technique. Once the differential modulation is applied to all the sub-blocks, then it's not necessary to send all the side information at the receiver end to get the real data.

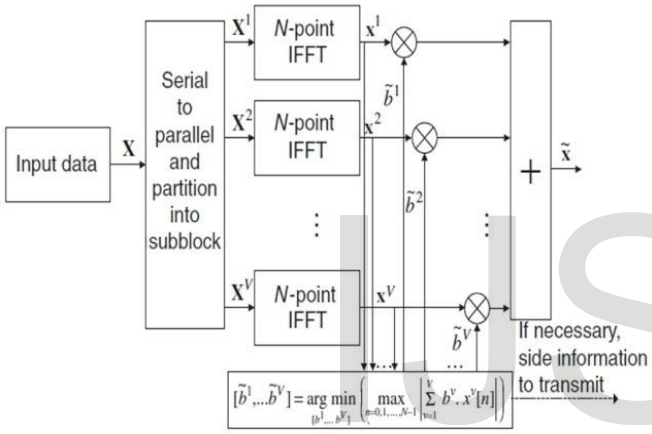

Figure.2. Partial Transmit Sequence Technique

4. CONCLUSION

In the signal scrambling technology, we have study the method of selected mapping and partial transmit sequence. The paper presents an overview of OFDM and PAPR. Basically the reduction of PAPR includes affinity with various modulation techniques, high spectral efficiency and system complexity must be low. Numbers of factors are taken into the account, before selecting any of the reduction technique for PAPR. These factors comprise of range for reduction, power in transmit signal, expansion of BER, decrease in data rate and increase in complexity of system. Multicarrier transmission any of the PAPR reduction scheme is absolute solution, the selection of reduction technique must be precise and follow according to the requirement of system.

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