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Callenges Facing In Ofdm System And Its Solutions

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Abstract

Mobile communication is one of the fastest growing features in communication system. In next generation wireless communication orthogonal frequency division multiplexing (OFDM) is one of the most commonly used radio access scheme because of it low symbol rate and affinity to different transmission bandwidth arrangements. This system we are currently using as radio access technique in latest cellular communication system like long term evaluation (LTE)in the 3 GPP (3rd Generation Partnership Project) wireless communication. Nevertheless, peak-to-average power ratio of OFDM signal is a significant drawback as it restricts the efficiency of the transmitter. high peak-to-average power ratio (PAPR) is the major drawback in the OFDM systems it causes a nonlinear distortion in transmitted OFDM signal when it travels through a nonlinear amplifier.

In this paper we are discussing about problem in OFDM system i.e. Peak to Average Power Ratio also called as PAPR and Bit Error Rate Called (BER). It affects the performance and efficiency of power amplifier, Different algorithm have been developed to overcome PAPR viz. clipping, SLM (Selective Mapping), PTS (Partial Transmit Sequence) and the overall analysis of different techniques.

Keywords: BER(Bit Error Rate) ,OFDM(orthogonal frequency division multiplexing), PAPR(peak-to-average power ratio) , PTS (Partial Transmit Sequence)

I. Introduction

With the continuous growth of digital communication in recent years, the need for high speed data transmission is increased. Moreover, future wireless systems are expected to support a wide range of services which includes video, data and voice. Orthogonal Frequency Division Multiplexing (OFDM) is a one of the promising candidates for achieving high data rates in mobile environment because of its multicarrier modulation technique [1]. Because of high capacity of transmission, and multi carrier modulation technique it is chosen as digital audio broadcasting (DAB), terrestrial digital video broadcasting TV (DVB-T), asymmetric digital Subscriber Lines (ADSL), ultra-wideband system. The IEEE 802.11a standard for wireless local area networks (WLAN) and IEEE 802.16 standard is also based on OFDM.

The basic principle of OFDM is to split a high rate data-stream into multiple lower rate data streams that are transmitted simultaneously over a number of sub carriers. OFDM sends high-speed signals concurrently on orthogonal carrier frequencies. This results much more efficient use of bandwidth as well as robust communications during noise and other interferences [2]. OFDM is combination of modulation and multiplexing. It transforms signals from frequency domain to time domain. The time domain OFDM signal is constituted by the sum of complex exponential functions, whose amplitudes and phases are determined by the data symbols transmitted over the different carriers. OFDM is a multicarrier system which uses Discrete
Fourier Transform (DFT) or Fast Fourier Transform (FFT). The basic principle behind OFDM technique is that high rate data stream is splitting into a number of lower rate data stream and transmit them simultaneously over multiple number of carriers. In OFDM the cyclic prefix is used for lower multi-path distortion. [1]

II. OFDM SYSTEM

With the rapid growth of digital communication in recent years, the need for high speed data transmission is increased. Moreover, future wireless systems are expected to support a wide range of services which includes video, data and voice. Orthogonal Frequency Division Multiplexing (OFDM) is a promising candidate for achieving high data rates in mobile environment because of its multicarrier modulation technique [1]. Due to its high capacity transmission, and multi carrier modulation technique it was chosen for digital audio broadcasting (DAB), terrestrial digital video broadcasting TV (DVB-T), asymmetric digital Subscriber Lines (ADSL), ultra-wideband system. The IEEE 802.11a standard for wireless local area networks (WLAN) and IEEE 802.16 standard is also based on OFDM [2]. The basic principle of OFDM is to split a high rate data-stream into multiple lower rate data streams that are transmitted simultaneously over a number of sub carriers. OFDM sends multiple high-speed signals concurrently on orthogonal carrier frequencies. This results much more efficient use of bandwidth as well as robust communications during noise and other interferences. With OFDM, it is possible to have overlapping sub channels in the frequency domain, thus increasing the transmission rate. In order to avoid a large number of modulators and filters at the transmitter and complementary filters and demodulators at the receiver, it is desirable to be able to use modern digital signal processing techniques, such as fast Fourier transform (FFT). After more than forty years of research and development carried out in different places, OFDM is now being widely implemented in high-speed digital communications. In a basic communication system, the data are modulated onto a single carrier frequency. The available bandwidth is then totally occupied by each symbol. This kind of system can lead to inter-symbol-interference (ISI) in case of frequency selective channel. The basic idea of OFDM is to divide the available spectrum into several orthogonal sub channels so that each narrowband sub channels experiences almost flat fading. The major advantages of OFDM are its ability to convert a frequency selective fading channel into several nearly flat fading channels and high spectral efficiency. [4]

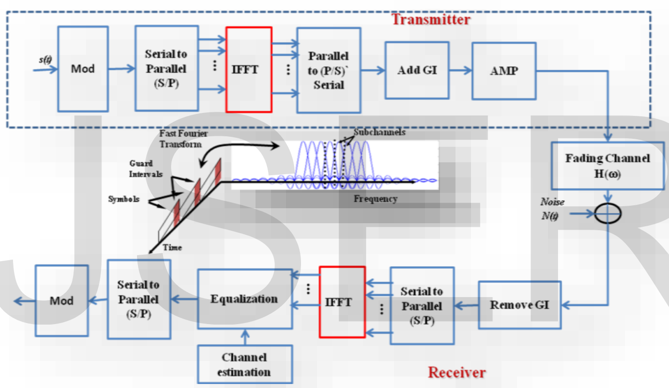

Fig 1: OFDM Transmitter and receiver Blok diagram

III. PROBLEM IN OFDM AND ITS SOLUTIONS

A. Problem In OFDM

OFDM faces several challenges. The key challenges are ISI due to multipath-use guard interval, large peak to average ratio due to non-linearity's of amplifier; phase noise problems of oscillator, need frequency offset correction in the receiver.

One of the major problems is high Peak-to-Average Power Ratio (PAPR) of transmitted OFDM signals. Therefore, the OFDM receiver's detection efficiency is very sensitive to the nonlinear devices used in its signal processing loop, such as Digital-to-Analog Converter (DAC)and High Power Amplifier (HPA), which may severely impair system performance due to induced spectral regrowth and detection efficiency degradation. For example, most radio systems employ the HPA in the transmitter to obtain sufficient transmits power and the HPA is usually operated at or near the saturation region to achieve the maximum output power efficiency ,and thus the memory-less nonlinear distortion due to high PAPR of the input signals will be introduced into the communication channels. If the HPA is not operated in linear region with large power back-off, it is impossible to keep the out-of-band power below the specified limits. This situation leads to very inefficient amplification and expensive transmitters. That's why it is important and necessary to research on the characteristics of the PAPR including its distribution and reduction in OFDM systems, in order to utilize the technical features of the OFDM.

As one of characteristics of the PAPR, the distribution of PAPR, which bears stochastic characteristics in OFDM systems, often can be expressed in terms of Complementary Cumulative Distribution Function (CCDF). Recently, some researchers have reported on determination of the PAPR distribution based on different theoretic and hypotheses.

B. Peak to average power reduction techniques

Peak-to-Average Power Ratio can be defined as the ratio of peak to average power value of the system. PAPR gets increased due to the occurrence of huge amount of sub-carriers that are modulated independently in OFDM system and of the signals which undergoes coherent addition resulting in same phase. As a result of high PAPR it leads to the following demerits which include complexity of converters and reduction in efficiency of amplifiers.[1]

C. Clipping

The simplest and most widely used technique of PAPR reduction is to basically clip the parts of the signals that are outside the allowed region. For example, using HPA with saturation level below the signal span will automatically cause the signal to be clipped. For amplitude clipping, that is

$$B(x) = \begin{cases} x, |x| \leq A \\ Ae^{j\emptyset(x)}, |x| > A \end{cases}$$

Wherever,

B(x) = Amplitude rate subsequent to clipping.

x = Preliminary indicator rate.

A = Boundary rest by the consumer in order to clip signal.

A is present clipping level and it is a positive real number. Generally, clipping is performed at the transmitter. However, the receiver needs to estimate the clipping that has occurred and to compensate the received OFDM symbol accordingly.

D. Selected Mapping (SLM)

In a typical OFDM system with PTS approach to reduce the PAPR, the input data block in X is partitioned into M disjoint sub blocks, which are represented by the vectors

$\{X^{(m)}, m = 0,1, \dots, M-1\}$ Therefore, we can get $X = \sum_{m=0}^{M-1} X^{(m)}$ Where,

$X^{(m)} = [X_0^{(m)} X_1^{(m)} \dots X_{N-1}^{(m)}]$ with $X_k^{(m)} = X_k$ or 0 $(0 \leq m \leq M-1)$

In general, for PTS scheme, the known subblock partitioning methods can be classified into three categories adjacent partition, interleaved partition and pseudo-random partition. Then, the sub blocks $X^{(m)}$ are transformed into M time-domain partial transmit sequences

$$x^{(m)} = \left[x_0^{(m)} x_1^{(m)} \dots . x_{LN-1}^{(m)}\right] = IFFT_{LN \times N}[x^m]$$

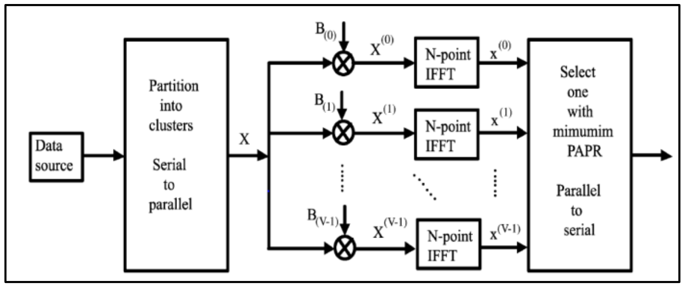

Fig 2: Block diagram of SLM technique

These partial sequences are independently rotated by phase factors b = $\{b_m = e^{j\theta_m}$, m=0,1,…,M-1$\}$ The objective is to optimally combine the M sub blocks to obtain the time domain OFDM signals with the lowest PAPR

$$\tilde{x} = \sum_{m=0}^{M-1} b_m \, x^{(m)}$$

E. Partial Transmit Sequence(PTS)

High computational complexity for searching the optimal phase factors and the overhead of the optimal phase factors as side information needed to be transmitted to receiver for the correct decoding of the transmitted bit sequence

In general, PTS needs M IFFT operations for each data block, and the number of the required side information bits is $\lfloor M \ \log_2 W \rfloor$ where $\lfloor x \rfloor$ denotes the smallest integer that does not exceed x

Similarly, in SLM, the input data sequences are multiplied by each of the phase sequences to generate alternative input symbol sequences. Each of these alternative input data sequences is made the IFFT operation, and then the one with the lowest PAPR is selected for transmission [2]. A block diagram of the SLM technique is depicted in Fig. 4. Each data block is multiplied by V different phase factors, each of length N.

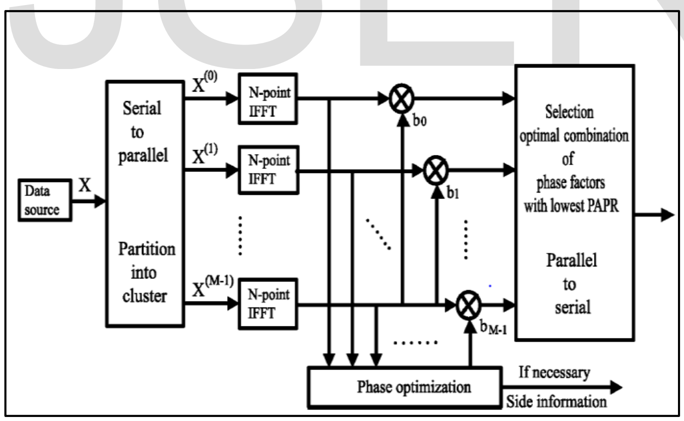

Fig. 3: Block diagram of PTS technique

IV. RESULTS AND ANALYSIS

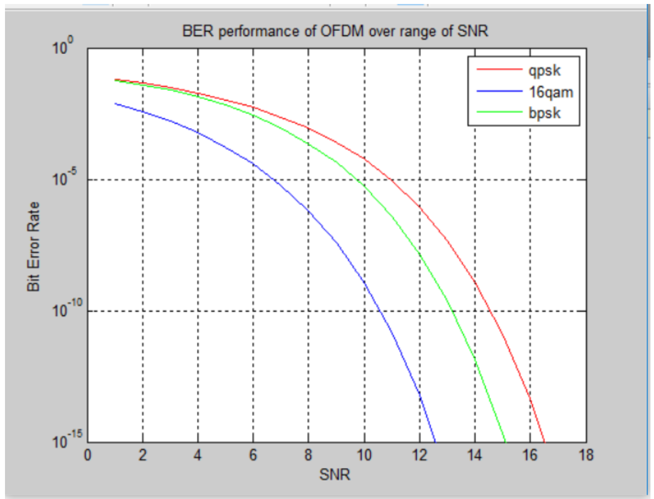

Fig 4 : BER performance over range of SNR for 64 bit.

Sr No	No of Sub carrier	PAPR of normal OFDM	PAPR of SLM modified OFDM	PAPR of clipped OFDM	Efficiency of SLM technique in %age	Efficiency of Clipping+Filtering technique in %age
1	32	17.578	12.1982	10.4526	30.6054	40.5358
2	64	22.5058	16.0078	10.8218	28.8727	51.9155
3	128	19.8372	15.7333	10.8918	20.6881	45.0938
4	256	22.3547	17.198	10.7899	23.0674	51.7331
5	512	24.1285	19.5882	10.3349	18.8173	57.1671

Fig 5 : Simulation result for different sub carrier.

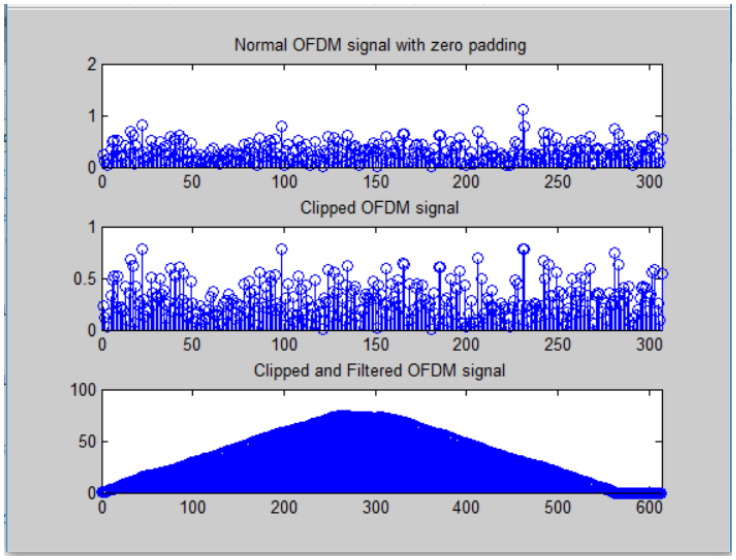

Fig 6 : Clipping and filtering of OFDM signal for 256 subcarrier.

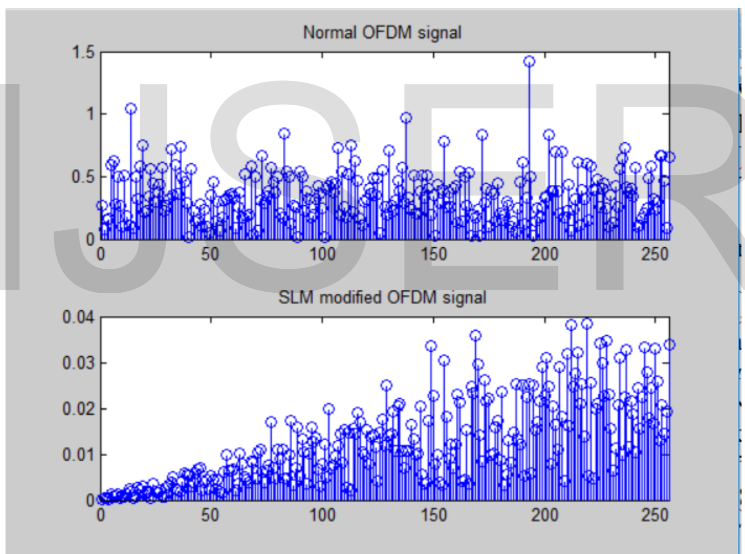

Fig : SLM of OFDM signal for 256 subcarrier.

V. CONCLUSION

It is conclude that the Amplitude Clipping and filtering outcome with defeat in information while Selected Mapping (SLM) doesn't have an effect on the records Include a note with your final paper indicating that you request color printing.

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