A REVIEW ON PAPER PROBLEM IN OFDM SCHEME

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Abstract – *OFDM has become the efficient multiplexing scheme in modern wireless communication system. It has been used for 802.11a, LTE applications. The OFDM system has several advantages in wireless communication over other technologies. In advantages with it has faces a major drawback like Peak to average Power Ratio. The high peak-to-average ratio is the main obstacle which causes non-linearity at the receiving end. PAPR occurs due to IFFT operations. In this review paper, we discuss about the OFDM importance and PAPR effect on OFDM scheme. In the given paper, PAPR reduction technique i.e. Companding has been also discussed.*

KeyWords: *OFDM, LTE, PAPR,*

1. INTRODUCTION TO OFDM SYSTEMS

As communication systems increase their information transfer speed, the time for each transmission necessarily becomes shorter. OFDM plays important role in 4G communication leading to various applications in wireless communication. FFT and IFFT are the hearts of OFDM system. OFDM is implemented by using different modulation techniques like BPSK, QPSK, QAM etc. This Orthogonally can be completely maintained with a minute increase in SNR, even though the signal passes through a time dispersive fading channel, by introducing a cyclic prefix. We need to take care that the length of the cyclic prefix is at least equal to the length of the multipath channel. The size of cyclic prefix is usually taken as one fourth the symbol size. OFDM have several attractive features which make it more advantageous for high speed data transmission over other data transmission techniques. These features includes

(i) High Spectral Efficiency
(ii) Robustness to channel fading
(iii) Immunity to impulse interferences
(iv)Flexibility
(v) Easy equalization

But inspite of these benefits there are some obstacles in using OFDM:

(i) OFDM signal exhibits very high Peak to Average Power Ratio (PAPR)

(ii) Very sensitive to frequency errors

(iii) Intercarrier Interference (ICI) between the subcarriers In this paper, we will discuss the problem of high PAPR associated in OFDM.

2. PAPR IN OFDM

The OFDM technique divides the total bandwidth into many narrow sub-channels and sends data in parallel. It has various advantages, such as high spectral efficiency, immunity to impulse interference and, frequency selective fading without having power channel equalizer. But one of the major drawbacks of the OFDM system is high PAPR. OFDM signal consists of lot of independent modulated subcarriers, which are created the problem of PAPR. . It is impossible to send this high peak amplitude signals to the transmitter without reducing peaks. So we have to reduce high peak amplitude of the signals before transmitting. The PAPR is the relation between the maximum power of a sample in a given OFDM transmit symbol divided by the average power of that OFDM symbol. PAPR occurs when in a multicarrier system the different sub-carriers are out of phase with each other. At each instant they are different with respect to each other at different phase values. In LTE system, OFDM signal PAPR is approx. 12dB.

2.1 PAPR Mathematical model

The high PAPR in an OFDM system arises due to IFFT operation

Information symbols like X(0), X(1), X(2) loaded onto the subcarriers. Hence transmitted samples are x(0), x(1), x(2), x(N-1) which are IFFT samples in information symbols.

$X(k)= \frac{1}{N}\sum_{l=0}^{N-1} X(l)e^{j2\pi kl/N}$

Average power
$= E\{|x(k).x(k)|\}$

$\frac{1}{N}E\{|x(k)|^2\}E\{\left|e^{\frac{j2\pi kl}{N}}\right|\}$

$E\{|x(k)|^2\} = \frac{1}{N^2}\sum_{l=0}^{N-1} E\{|x(l)|^2\}$

Consider, Expected magnitude i.e. $E\{|x(l)|^2\}= a^2$

$= \frac{1}{N^2} a^2$

$= \frac{a^2}{N}$

Hence the average power of transmission is $\frac{a^2}{N}$.
Where, a^2 is a peak power.
Hence PAPR= $\frac{a^2}{\frac{a^2}{N}} = N$
Hence PAPR in an OFDM scheme can be significantly higher. Further the PAPR rises with N i.e. the number of subcarriers

$$PAPR(x) = \frac{\max |x(k)|^2}{E\{|x(k)|^2\}}$$

PAPR is randomly sinusoidal leads occurred during transmission of the OFDM to reduction of PAPR is important point in the OFDM system. Because of when we are talking about the high speed data communication in real life like high speed internet access, video calling and Digital audio broadcasting (DAB), Microwave terrestrial television, digital video broadcasting (DVB), 4G system, hyper LAN. Therefore as if we see most of the communication systems needed high data rate. But high PAPR in OFDM system prevent these types of facilities in the real life. So it is necessary to reduce PAPR in OFDM system.

3. PAPR REDUCTION TECHNIQUE

COMPANDING TECHNIQUE

The term "companding" is composed of the words "compressing" and "expanding" Companding is used in digital telephony systems, compressing before input to an analog-to-digital converter, and then expanding after a digital-to-analog converter.

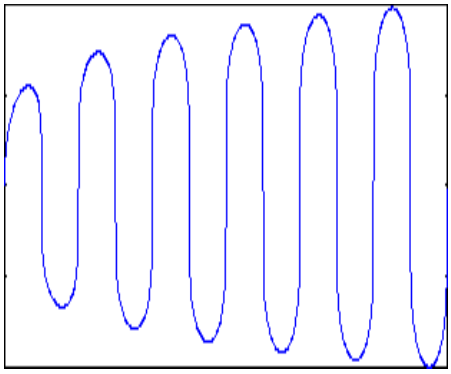

Fig.1 After compressing before expanding signal

Companding is a signal processing technique used in the digital systems primary in audio such as microphones (more effectively in wireless) to minimize the noise levels in the sound quality mainly owing to low-level radio frequency interference in the frequency channel. The main aim of the companding process is to preserve the signal-to-noise ratio of the original audio. In the digital scheme companding is also used by compressing the signals before input to an analog-to-digital converter, and then expanding after a digital-to-analog converter.

This technique is also used in the digital file formats for better signal-to-noise ratio (SNR) at very low bit rates. Two international standards for encoding signal data to 8-bit codes are A-law and μ-law. The μ- law and A-law companding standard employ logarithm-based functions to encode audio samples for ISDN digital telephony service by means of non linear quantization.

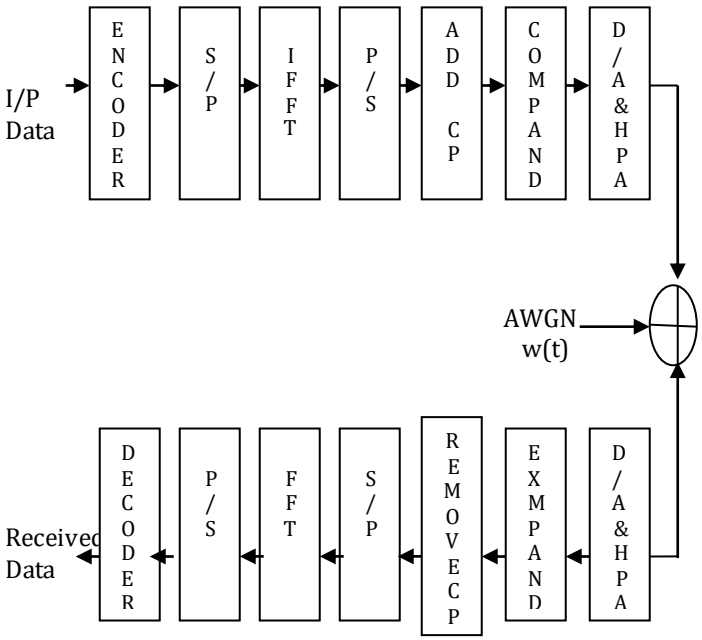

Fig.2 An OFDM system with Companding Technique

Figure 1 depicts the block diagram of an OFDM system which utilizes the conventional companding scheme. Additive White Gaussian Noise (AWGN) channel is used as the noise channel. The μ-law companding transform mainly concentrates on enlarging small amplitude signals while keeping peak signals unchanged, and thus it increase the average power of the transmitted signals and possibly results in exceeding the saturation region of HPA to make the system performance worse.

μ- law Companding

The μ-law compander employs the logarithmic function at the transmitting side. In general a μ law compression characteristic:

$$y = \frac{\log(1+\frac{\mu|x|}{V})}{\log(1+\mu)}\text{sgn}(x)$$

where, μ is the μ-law parameter of the compander, where x: input signal, V : is the maximum value of the signal x. μ: parameter controls the amount of compression. The maximum value of output y is the same maximum of input x is equal V.

A-law Compander

The chararcteristic of this compander is given by:

$$y = \frac{1+\log A|x|}{1+\log A}$$

The quantization error is more than μ-law compander.
So, the large is the value μ of, effective is the reduction in PAPR. For reduction of large amount of PAPR, large value of μ is to be taken.

4. CRITERIA OF PAPR REDUCTION

A. Excellent ability of PAPR diminishment:

While selecting the PAPR diminishment method, the factor should be kept in mind that it have minimum destructive issues. For example interior band and exterior band distortion.

B. Minimum normal power:

PAPR is reduced but normal power of system is enhanced, which results in reduction of the bit error rate performance of system.

C. Minimum difficulty in implementation:

Usually, complex schemes provide better PAPR lessening. But time and hardware requirements should be minimum.

D. No BER performance degradation:

We should consider those methods for which there is enhancement in BER on the receiver end.

5. CONCLUSION

In this review paper, OFDM and problem created in OFDM i.e. PAPR effect has been discussed. In this Literature paper, the PAPR reduction technique like companding technique has been used. The companding technique has been introduced i.e. μ- law compander plays vital role in OFDM implementation.

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