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PAPR REDUCTION USING ITERATIVE COMPANDING TRANSFORMS TECHNIQUE ON TURBO CODE BASED MIMO OFDM SYSTEM FOR BETTER PERFORMANCE

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Abstract— Peak to Average Power Ratio (PAPR) significant reduction and Bit Error Rate (BER) performance along with no change in average output and power level of Orthogonal Frequency Division Multiplexing (OFDM) signal introduces by a novel approach using iterative companding transform. By adaptively manipulating transform parameter in this iterative process design flexibility of companding increase. The propose scheme had less computational complexity and functional form. The Theoretical and practical simulation result regarding transform gain are derived and offer overall performance in the reduction of PAPR, BER performance and bandwidth efficiency.
Keyword—Orthogonal Frequency Division Multiplexing (OFDM), Peak to Average Power Ratio (PAPR), Frequency Division Multiplexing (FDM), Multiple Input Multiple Output (MIMO), Companding transform; parameter optimization, Complementary Cumulative Distribution Function (CCDF), etc.

I. INTRODUCTION

4^{th} generation of wireless communication mainly introduce by a technology known as OFDM technique. The FDM is the main principle of OFDM with a systematic controlled order with improved efficiency of spectral and multipath delay. OFDM is a type of multi carrier transmission method in which a single data signal is divided into multiple data signal, after that these data signal is modulated with subcarrier orthogonal signal and makes a great reeducation in its symbol rate. Its orthagonality between the signals are maintained using time-dispersive channel, therefore whenever increase consistent OFDM signal its resultant signal get larger peak and rest time it remain low. Therefore OFDM experience a higher PAPR problem.
The reduce the peak to average power ratio several method have been proposed such as clipping coding, tone reservation, peak windowing. But most of these technique are unable to achieve simultaneous a large reduction in PAPR (peak to average power ratio) with low complexity. Among all these techniques the simplest solution is to clip transmitted signal when its amplitude exceed a preferred threshold. Clipping highly non-linear process, it produces significant out of band interference. A good remedy for out of band interference is called companding. The scheme ‘soft’ compress, rather than ‘hard’ clips, in the signal peaks causes far less out of band

interference. In proposed method in which employed in classical companding transform and showed effective. Since then many different companding algorithm with better performance have been published. This paper organized as follows: section 2, presents companding algorithms such as μ law campanding, the exponential, and companding using airy function. In section three these algorithms compared with non-companded. We use bit error rate and peak to average power ratio as a comparison parameter for companding algorithm. In section four we conclude.

II. RELATED WORK

Krishna Kumar [1] proposes effective performance of three different algorithms (Selective Mapping (SLM), Partial Transmit Sequence (PTS), Clipping and Filtering) for PAPR reduction of OFDM Signal. According to different comparison curve of the SLM and PTS techniques, SLM algorithm is most suitable when the system can tolerate more redundant information otherwise PTS algorithm is more acceptable for such situation when complexity becomes first considering factor and after the analyzed a clipping and filtering method to reduce PAPR in OFDM system. Propose method observed that Amplitude Clipping and Filtering reduce complexity as compared to SLM and PTS also analyzed a iterative clipping and filtering method to reduce PAPR and its performance is much better as compared.

Xiaodong Li [2] define techniques for PAPR reduction in OFDM signal. Propose method apply the clipping and filtering method to input the signal with parameter of power spectral density, crest factor and bit error rate (BER). Simulation result of techniques define the varying crest factor with reduction in PAPR compare to conventional OFDM system.

Sung-EunPark[3] propose a method for PAPR reduction in 802.16 Physical Layer. Propose the Tone Reservation (TR) techniques in the terms of performance and complexity. Other PAPR reduction scheme needs the signaling overhead information like SLM and PTS methods needed some side information to indicate the used pattern; similarly other PAPR reduction scheme has a same case with TR method. As performance feature, The TR has a good performance. Moreover, TR method doesn't need any operation in receiver end.

Jung-Chieh Chen [4] define a technique for PAPR reduction based on Tone injection (TI) without loss in the data rate and without any extra signal information. They propose a cross entropy method for solving such problem and its simulation result shows that propose entropy method reduces the PAPR in OFDM signal with less complexity.

Abdul Wahab [5] propose a method for reducing of PAPR in OFDM signal .Propose method separate the frequency of sub-carrier to halved as compared to the conventional OFDM such that its resultant simulation result shows that this techniques reduces the PAPR in significantly for high data rate system and also improve the performance of system .

III. **ORTHOGONAL FREQUENCY DIVISION MULTIPLEXINGTECHNIQUE**

OFDM make possible the higher and fast wireless data communication for various compatible application because of its main feature of high data rate and mobility. Only OFDM can work as modulator as well as multiplexer and from some past times the MIMO (Multiple – Input Multiple – Output) wireless communication system has enhance its data rate and channel

capacity feature in tremendous way. The compatible usage of OFDM in wireless standard like DVB, WIMAX, IEEE802.11a and LTE are gained very large benefits.
OFDM is a special type of multi carrier data transmission method in which a single data signal is divided into multiple data signal, and after that these data signal is modulated with subcarrier orthogonal signal and makes a great reeducation in its symbol rate. Its orthogonally between the signals are maintained using time-dispersive channel, therefore whenever increase consistent OFDM signal its resultant signal get larger peak and rest time it remain low. Therefore OFDM experience a higher PAPR problem.

$$\left\{\frac{1}{\sqrt{T_s}}\exp^{jw_k t} \text{ for } t \in [0, T_s]\right\} \quad (1)$$

With $w_k = w_0 + k w_s; \quad k = 0,1,\ldots,N_c - 1$
w_0 Is the lowest frequency used and w_k is the subcarrier frequency.
As a substitute of bank of matched filters & baseband modulator, Inverse Fast Fourier Transform and Fast Fourier Transform is active method of OFDM system implementation.

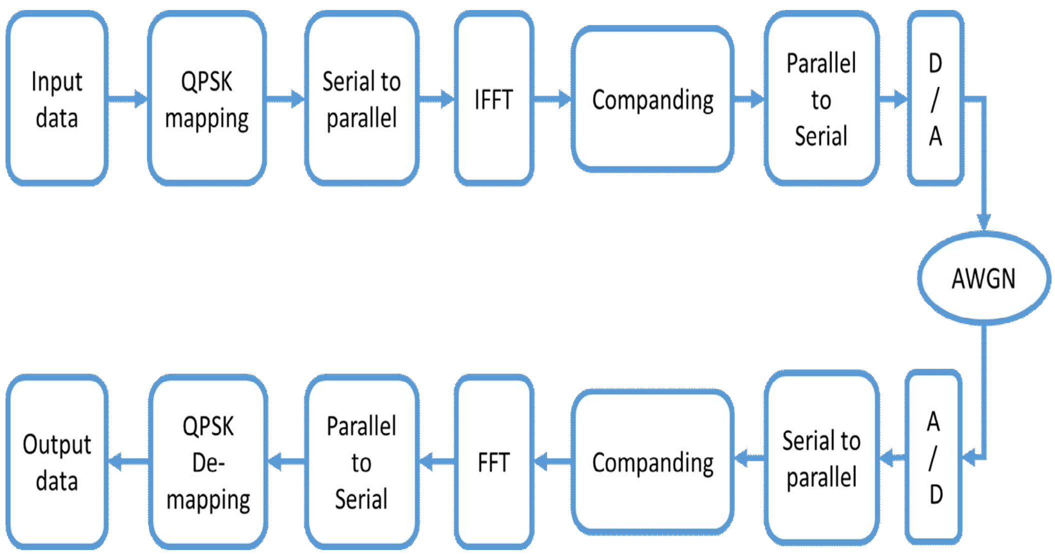

Figure.1 Block diagram OFDM system with companding algorithm

IV. PEAK TO AVERAGE POWER RATIO

High Peak-to-Average Power Ratio has been recognized as one of the major practical problem involving OFDM modulation technique. Generally, the PAPR of OFDM signals *x* (*t*) isdefined as the ratio period among the maximum instantaneous power and its average power during an OFDM symbol [1].

The PAPR can be defined as
$$\text{PAPR} = 10\log_{10}\frac{P_{peak}}{P_{av}} \quad (2)$$
Where P_{peak} and P_{av} can be compute as:
$$P_{peak} = \max|x(t)|^2 \quad (3)$$

$$P_{av} = \frac{1}{T}\int_0^T |x(t)|^2 dt$$
Hence, the PAPR is expressed as:

$$\text{PAPR}=10\log_{10}\frac{\max|x(t)|^2}{\frac{1}{T}\int_0^T|x(t)|^2dt} \qquad (4)$$

When N sinusoids add, the peak magnitude would have a value of N, where the average may be quite low because of the destructive interference between the sinusoids. High PAPR signals are usually outcast for it and usually force the analog circuitry. For power amplifier has High PAPR, signals may require a large range of dynamic linearity from the analog circuits which commonly results in expensive devices and high power consumption with lower efficiency (operate with larger back-off to maintain linearity) [1].

V. COMPANDING ALGORITHM

μ-Law Companding

μ−Law is a simple but effective companding technique to reduce the peak-to-average power ratio of orthogonal frequency-division multiplexing signal. The idea comes from the use of companding in speech processing. Since orthogonal frequency-division multiplexing signal is similar to speech signal in the sense that large signals only occur very infrequently, the same companding technique might be used to improve OFDM transmission performance.

A QAM-OFDM system diagram is shown in Figure .1. The incoming bit stream is packed into x bits per symbol to form a complex number $S_k$where x is determined by the QAM signal constellation. For a real sequence output at the

IDFT, the complex input to the IDFT has Hermitian symmetry and is constrained as follows

$$S_{N-K} = S_k \qquad (5)$$

Where k=0, 1, 2……… (N/2)-1, and S(0)=0.

Suppose N is even and $S_k = a_k - jb_k$

$$S(n) = \frac{1}{\sqrt{N}}\sum_{k=1}^{\frac{N}{2}-1}\left(a_k\cos\frac{2\pi kn}{N} + b_k\sin\frac{2\pi kn}{N}\right) \qquad (6)$$

$$n = 0, 1, 2 \ldots\ldots\ldots\ldots\ldots\ldots, N-1$$

The μ law companding technique can be then introduced. The samples of OFDM signal s(n) are companded before it is converted into analog waveform. The signal after companding is given by

$$S_c(n) = \frac{A sgn(s(n))\ln[1+\mu\left|\frac{s(n)}{A}\right|}{\ln(1+\mu)} \qquad (7)$$

'A' is normalization constant, after D/A conversion the signal transmitted through channel. At the receiver end, received signal first converted into digital form, the sampling result is

$$s(n) = S_c(n) + q(n) + w(n) \qquad (8)$$

Where q is analog to digital conversion error and w is AWGN channel factor. The expanded signal can be approximated as:

$$S'(n) \approx s(n) + \frac{[q(n)+w(n)]AB}{\mu} + S(n)[q(n) + w(n)]B \qquad (9)$$

VI. TURBO CODES

Turbo codes were first presented at the International Conference on Communications in 1993 by C. Berrou. Until then, it was widely believed that to achieve near Shannon's bound performance, one would need to implement a decoder with infinite complexity or close.

In a typical turbo decoding system, two decoders operate iteratively and pass their decisions to each other after each iteration. These decoders should produce soft-outputs to improve the decoding performance. Such a decoder is called a Soft-Input Soft- Output (SISO) decoder. Each decoder operates not only its own input but also on the other decoder's incompletely decoded output which resembles the operation principle of turbo engines. This analogy between the operation of the turbo decoder and the turbo engine gives this coding technique its name, “turbo codes”. The decoding process of turbo code is shown in figure 2.

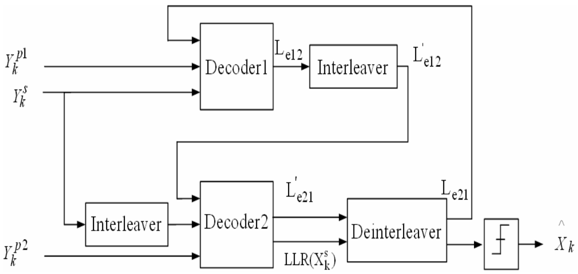

Figure.2 Block diagram of turbo decoder

Turbo decoding process can be explained as follows: Encoded information sequence Xk is transmitted over an Additive White Gaussian Noise (AWGN) channel, and a noisy received sequence Yk is obtained. Each decoder calculates the Log-Likelihood Ratio (LLR) for the kth data bit dk, as

L(dk)=log⌊(P(d_k=1|Y)))/(P(d_k=0|Y))⌋ (10)

LLR can be decomposed into 3 independent terms, as

L(dk)=Lapri(dk)+Lc(dk)+Le(dk) (11)

Where Lapri(dk) is the a-priori information of dk , Lc(xk) is the channel measurement, and Le(dk) is the extrinsic information exchanged between the constituent decoders. Extrinsic information from one decoder becomes the a-priori information for the other decoder at the next decoding stage.

Le12 and Le21 in Figure 1 represent the extrinsic information from decoder1to decoder2 and decoder2 to decoder1 respectively.

VII. RESULT

The parameter of simulation are given as follows

Discussion with Companding

- Modulation scheme : BPSK ,QPSK,QAM-8
- MIMO encoding scheme : Alamouti
- No. of transmitter antenna :2
- No. of receiver antenna :2
- Channel coding : Turbo code
- Channel : Rayleigh fading channel
- Equalizer : Zero forcing
- Performance parameter: BER, CCDF with SNR and PAPR respectively.

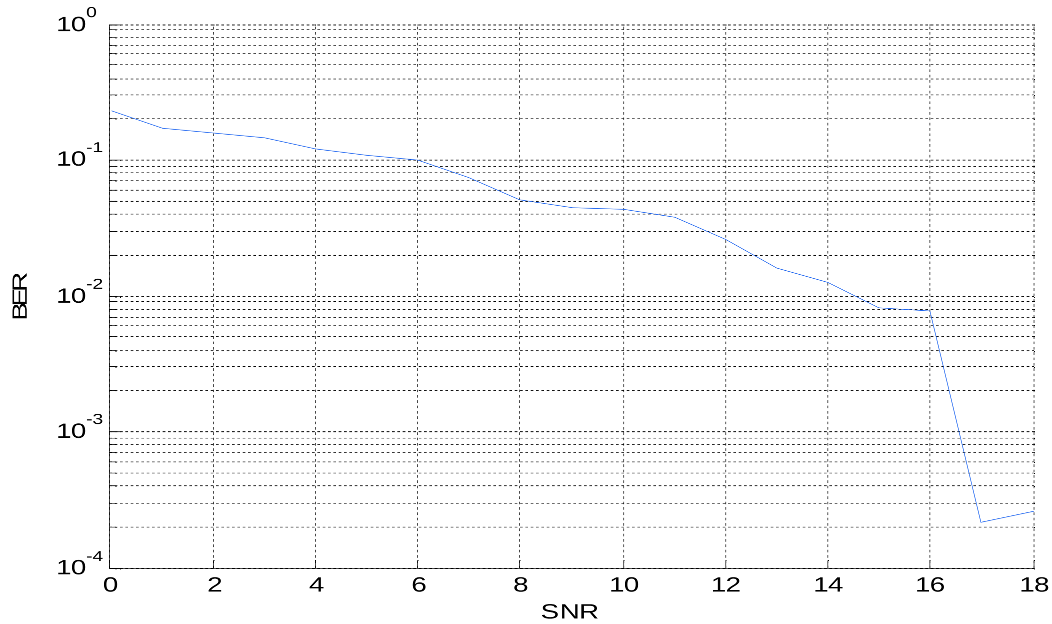

Figure. 3 BER curve for Adaptive modulation scheme for MIMO WiMAX for 2x2 antenna scheme

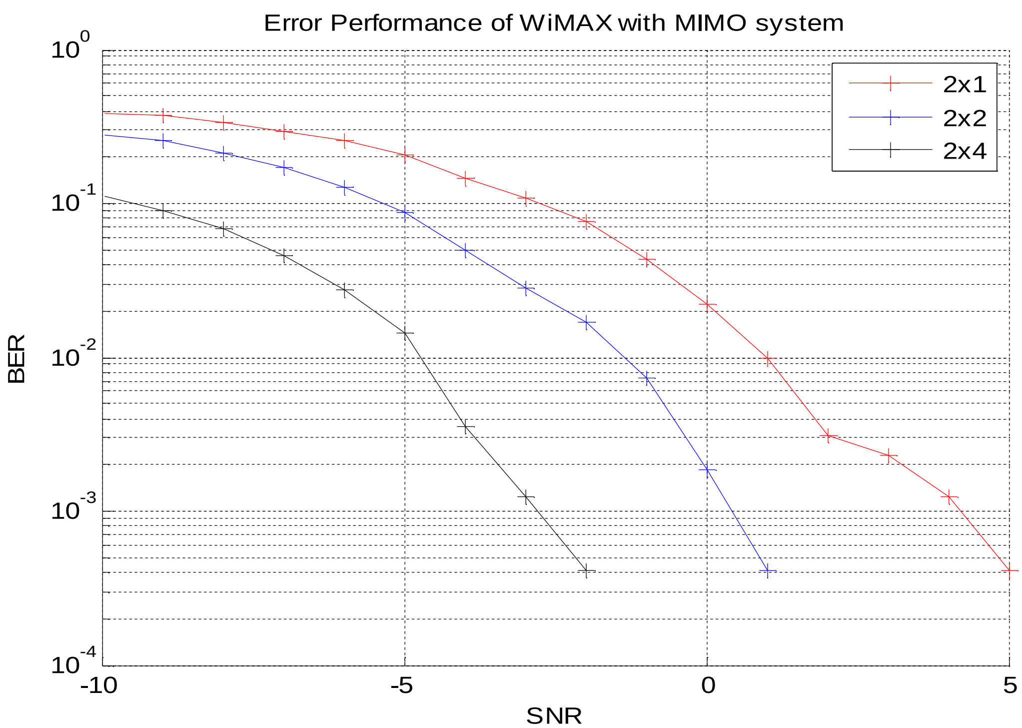

Figure. 4 BER for different modulation scheme for MIMO WiMAX for 2x2 antenna scheme

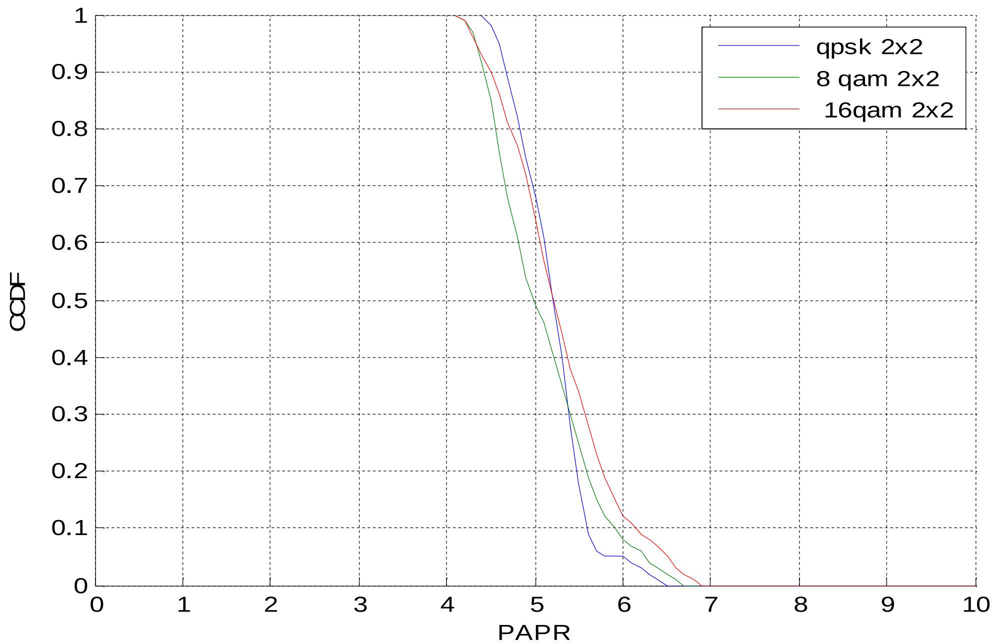

Figure. 5 CCDF vs PAPR for different modulation scheme for WiMAX

VIII. **CONCLUSION**

In this paper, performance enhancement ofOFDM system is done with PAPR. Exponential companding scheme offers better improvement in PAPR among all these techniques as it adjusts both large and small peaks. Thus by using airy companding scheme we can offer improved BER while reducing PAPR effectively.

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