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An Efficient PAPR Reduction with Transmitted Power using Gaussian Distribution in OFDM

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ABSTRACT

This paper works on the reduction of PAPR with reduced transmitted power of OFDM using Gaussian distribution. Peak power to average power ratio in case of OFDM is quiet large due to adding of subcarrier coherently.The proposed technique extract the basic features of Gaussian distribution in companding for efficient transmission of OFDM with orthogonal subcarrier by improving peak signal power simultaneously with average power .

IndexTerms—Complementary cumulative distribution function (CCDF),high power amplifier (HPA), Orthogonal Frequency Division Multiplexing (OFDM), Peak-to-Average Power Ratio (PAPR), inter-symbol interference (ISI),bit error rate(BER).

I. INTRODUCTION

This paper not only works in PAPR reduction ofOFDM systems by using companding using Gaussian distribution, it also improved the transmitted power.It transforms the original distribution function of OFDM signal magnitude into a Gaussian distribution function[1]. This function has better design flexibility and more degrees of freedom than the other schemes[2], therefore performance of this Gaussian companding function is quiet improve in terms of SNR and BER[3]. In the orthogonal frequency division multiplexing (OFDM) the peak power might be much larger than the average power, due to adding up subcarriers coherently which resulting in large peak-to-average power ratio (PAPR)[2].High PAPR has the following consequences (1) The signal peaks move into the non-linear region of the RF power amplifier which reduces the overall efficiency of the RF power amplifier.(2) It requires a high-resolution digital- to- analog converter (DAC) at the transmitter and high-resolution analog -to -digital converter (ADC) at the receiver[4].(3) Intercarrier interference(ICI)[4] and Inter symbol interference occurred due to the non-linearity of signal.In the present work utilization of the OFDM capabilities are not fully explored[5]. There are still several aspects which can beexplored to reduce the peak-to-power ratio (PAPR)[6] and intercarrier interference (ICI) of OFDM signal[7]. Therefore, the basic requirement to reduce the PAPR of standard OFDM signal is a prime motivating factor for this work with simultaneously reduced transmitted power using Gaussian distribution function as a compander with the specific value of SNR[8].

II. PEAK TO AVERAGE POWER RATIO

In orthogonal frequency division multiplexing,the peak power due to the adding of subcarrier is large as compared to average power.Thepeak to average power ratio (PAPR) of a discrete time signal x(n) is given as

$$\text{PAPR}=log_{10}\frac{Max\{|S_n|^2\}}{E\{|S_n|^2\}} \quad (1)$$

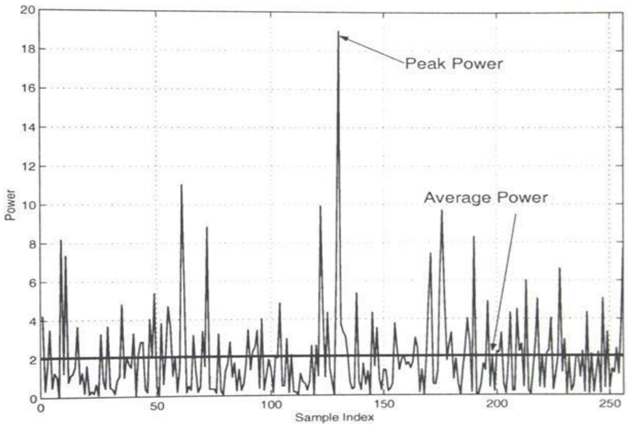

Fig.1.Power samples of one symbol OFDM signal

In the OFDM system, the input to the amplifier of the system is the analog signal converted in the discrete time domain by using inverse FFT is given in eq(2)

$$x(n)=1/\sqrt{}\text{N}\sum_{i=0}^{N-1} X(i)e^{j2\pi in/N};0\leq n \leq N-1 \qquad (2)$$

When number of subcarrier increase then PAPR will increase[8]. Assume N number of Gaussian independent and identically distribute(i.i.d) random variables x_n, $0 \leq n \leq N-1$ with zero mean and unit power. The average value of the signal and its power $E_n= (x[n])^2$ is then given in eq(3).

$$\text{E}\left[\frac{1}{\sqrt{N}}\left(\left|x_0+x_1+\cdots+x_{N_1}\right|\right)^2\right] = \frac{1}{N}E\left(\left|x_0+x_1+\cdots+x_{N_1}\right|\right)^2$$

$$=\frac{\text{E}|x_0^2|}{N}+\frac{\text{E}|x_1^2|}{N}+\frac{\text{E}|x_2^2|}{N}+\ldots\ldots.+\frac{\text{E}|x_{N-1}^2|}{N} = 1 \qquad (3)$$

The maximum value of the sum occurs when all the random variable x_i add coherently according to the central limit theorem,which is given in eq(4).

$$\text{Max}\left[\frac{1}{\sqrt{N}}\left(\left|x_0+x_1+\cdots+x_{N_1}\right|\right)\right]^2=\left[\left|\frac{N}{\sqrt{N}}\right|\right]^2=\text{N} \qquad (4)$$

Thus the maximum value of PAPR is N for N subcarrier.

III. COMPANDING

Companding with Gaussian distribution using Gaussian Gaussian function as a compander.It is a continuous curve whose power spectral density is independent to frequency and it is a symmetric curve which depend on two parameter:mean and the standard deviation.The mean defines the position of the center and the standard deviation definesthe height and width of the curve.

$$\text{P(y)} = \frac{1}{\sigma\sqrt{2\pi}}e^{\frac{-(y-\boxed{?})^2}{2\sigma^2}} \qquad (5)$$

The center contains the greatest number of a value and probability of occurrence is maximum around it.Fig[2] shows the Gaussian function as a compander with maximum probability around its centre and minimum at the extreme position from the centre.

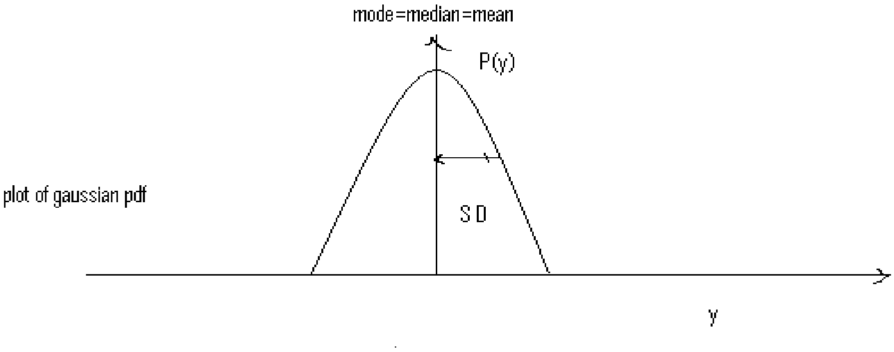

Fig2.Gaussian distribution function

The sum of random variable shows its behavior as Gaussian function as the number of terms in a random variable tends to infinity.

IV. PERFORMANCE AND RESULT

This is the bit error probability and received subcarrier power before simulation of companding function with the help of GUI model of matlab.

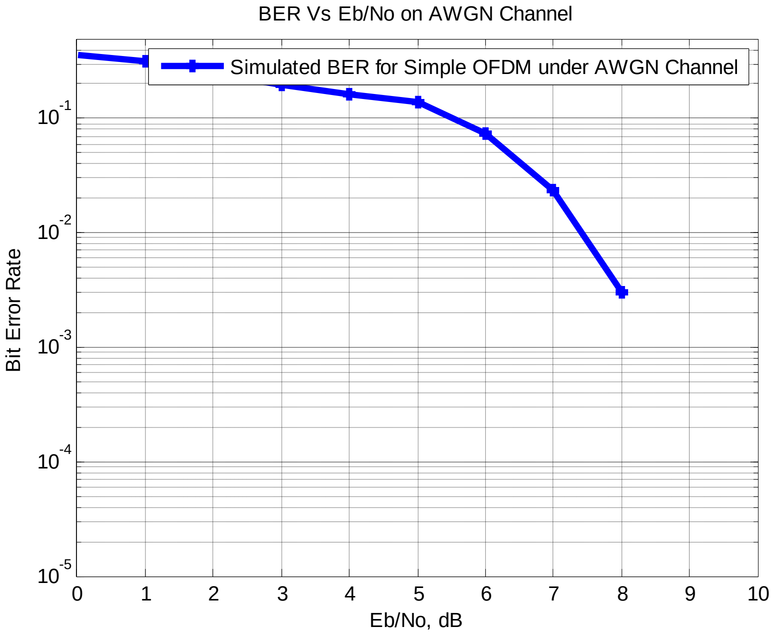

Fig3.BER v/s E_b/N_o for AWGN channel

Without using companding the received carrier power can be represented as shown in fig4 with maximum received power.

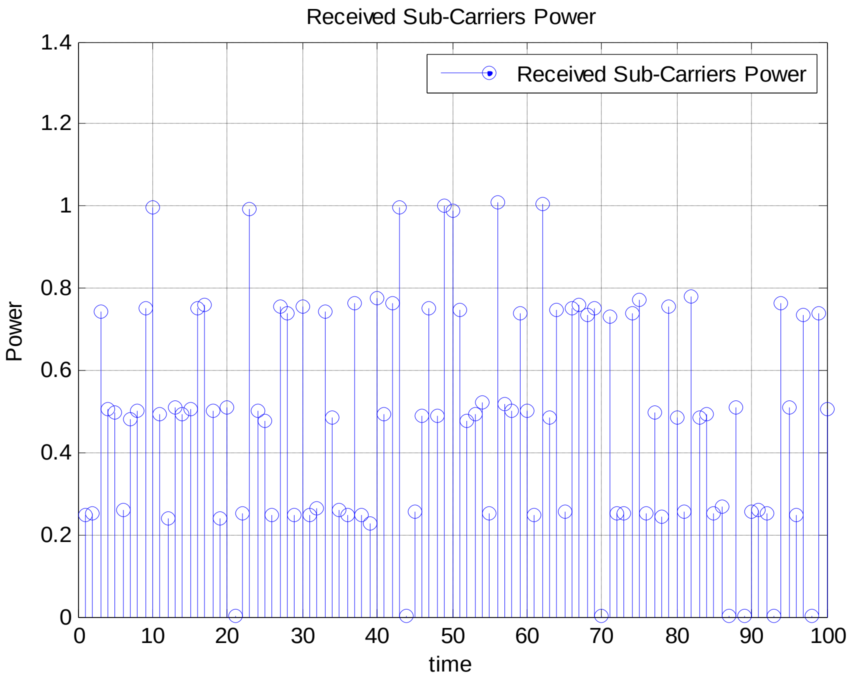

Fig4. Received carrier power without companding

After applying Gaussian function as mentioned in eq (5) can be represented in fig5 with reduced received carrier power as

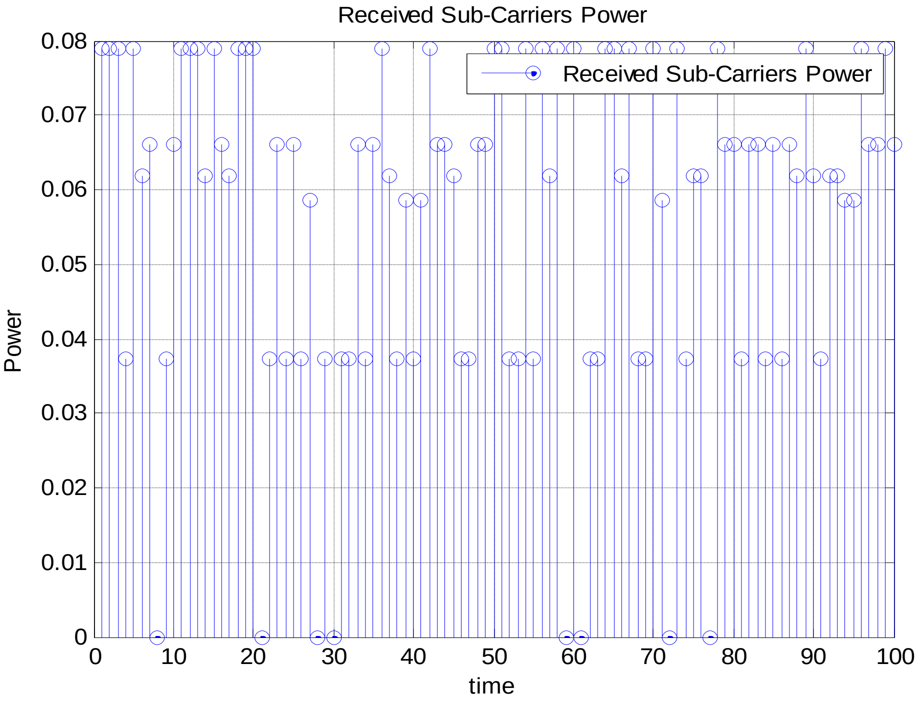

Fig5.Received carrier power with companding

V.COMPARISON

Comparison of proposed technique with companding using Gaussian function and without companding in the context of peak to average power ratio as shown in fig6.The simulated curve indicate that PAPR reduced 33% from the simple OFDM.

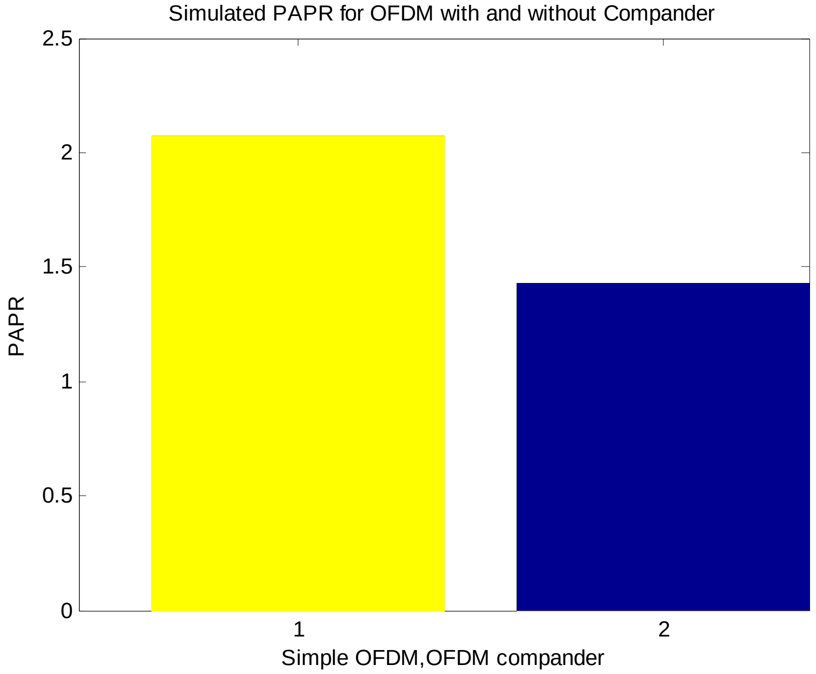

Fig 6.Comparison curve with and without companding for PAPR

VI. ERROR PERFORMANCE

Error performance of proposed technique in AWGN channel shows better result can be represented in fig7.

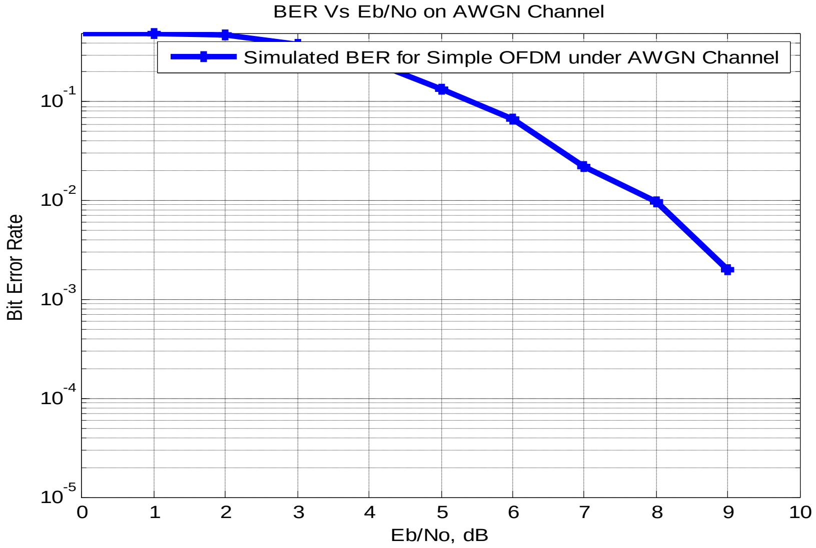

Fig7.Error performance in AWGN channel for companding

Comparison of error performance of simple OFDM with and without companding shown in fig8 as.

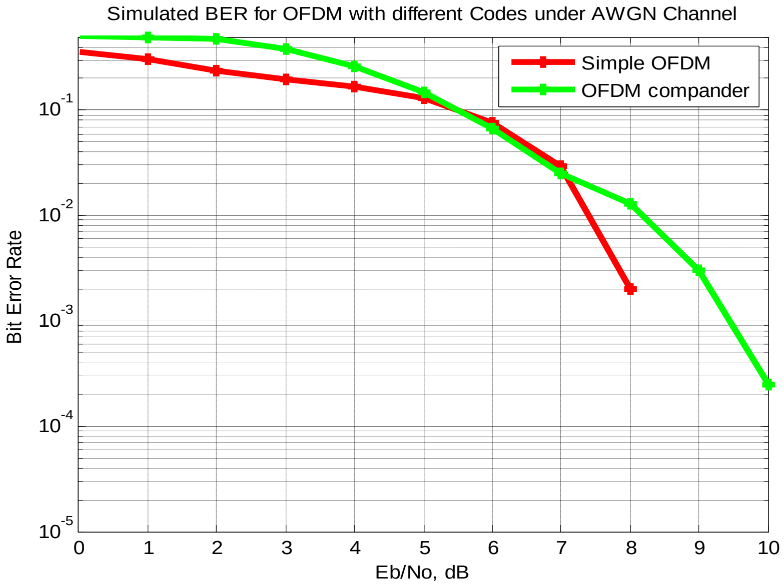

Fig8.Comparison of bit error rate with and without companding

VII. RESULTS

It is based on the value of signal to noise ratio(SNR) in dB, number of channels(N) and orthogonal subcarrier are selected for min value of PAPR with minimum transmitted and received carrier power in table I and II.

TableIDifferent parameter with using compandingfunction

N	ORTHOGONAL CARRIER	SNR(dB)	Sigma	μ	PAPR	AVERAGE POWER
1000	4	0-10	1	0	1.3919	0.05679
10000	4	0-10	1	0	1.38	0.057
100000	4	0-10	1	0	1.38	0.057
1000	4	0-10	1	0	1.2406	0.06419

Table. II Different parameter withoutcompandingfunction

N	ORTHOGONAL CARRIER	SNR(dB)	Sigma	μ	PAPR	AVERAGE POWER
1000	4	0-10	1	0	2.09	0.4955
10000	4	0-10	1	0	2.05	0.50246
100000	4	0-10	1	0	2.1095	0.49941
1000	4	0-10	1	0	2.02	0.49425

VIII. CONCLUSION

Non-linear companding for PAPR reduction using Gaussian distribution technique was the main focus of this paper. It isthe most promising reduction technique.It was also mentioned that transmitted average power with PAPR reduction quiet reduced as compared to other technique. This paper also showed the simulation results of OFDM symbol with and withoutcompanding in case additive white Gaussian noise channel. The simulation results indicated that large PAPR reduction is possible with non-linear companding of the Gaussian distribution because in case of Gaussian distribution data has less of a tendency to produce unsually extreme values,called outliers,as compared to other distribution technique of PAPR reduction.

REFERENCES

[1]. A.Zolghadrasliand M. H. Ghamat,"AnOverview ofPAPRReduction Techniques for MulticarrierTransmission and Propose of new technique for PAPR reduction,"Iranian Journal of Electrical and Computer Engineering,Vol 7,No-2,2008.

[2]. Davis,J.A and J,Peak to mean power control in OFDM , Golay Complementary sequences, Reed-Muller codes,''IEEE trans. Inform. Theory,Vol-45,2397-2417,Nov-1999.

[3]. Jayalath, A. D. S. and C. Tellambura,"Use of data permutation to reduce Peak to average Power.

[4] Xiaodong Li and Leonard J. Cimini,"Effect of clip-ping and Filtering on the performance of OFDM.," IEEE communication letter,Vol-2,May-1998.

[5] J. Hou, J. H. Ge, and J. Li, "Trapezoidal companding scheme for peak-to-average power ratio reduction of OFDM signals," Electron. Lett., vol. 45, no. 25, pp. 1349–1351, Dec. 2009.

[6]. J. Hou, J. Ge, D. Zhai, and J. Li, "Peak-to-average power ratio reduction of OFDM signals with nonlinear companding scheme," IEEE Trans. Broadcast., vol. 56, no. 2, pp. 258–262, Jun. 2010.

[7]. Jiang, W. Yao, P. Guo, Y. Song, and D. Qu, "Two novel nonlinear companding schemes with iterative receiver to reduce PAPR in multicarrier modulation systems," IEEE Trans. Broadcast., vol. 51, no. 2, pp. 268–273, Jun. 2006.

[8]. Cho, Yong Soo; Kim, Jaekwon; Yang, Won Young; Kang,Chung G." MIMO-OFDM Wireless Communications with MATLAB "Wiley, Hoboken, 2010,ISBN: 9780470825624.