International Journal of Research
Available at https://edupediapublications.org/journals

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 13
October 2017

By Using Acf&Companding Transform for Reduction of Paper In Ofdm Signal

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ABSTARCT:

High top-to-average strength ratio of the transmit sign is a main disadvantage of multicarrier transmission which includes OFDM or DMT. This article describes a number of the crucial PAPR bargain strategies for multicarrier transmission which include amplitude clipping and filtering, coding, partial transmit collection, decided on mapping, interleaving, tone reservation, tone injection, and energetic constellation extension. Among the several PAPR cut price strategies, companding rework seems appealing for its simplicity and effectiveness. This paper proposes a brand new companding set of policies. Compared with the others, the proposed set of rules gives an improved bit mistakes charge and minimized out-of-band interference at the same time as lowering PAPR successfully. Theoretical evaluation and numerical simulation are offered Also, we make some comments on the criteria for PAPR reduction technique choice and in brief cope with the hassle of PAPR bargain in OFDMA and MIMO-OFDM.

INTRODUCTION

ORTHOGONAL frequency division multiplexing (OFDM) has been attracting substantial attention due to its excellent performance under severe channel condition [1]. The rapidly growing application of OFDM includes WiMAX, DVB/DAB and 4G wireless systems. However, OFDM is not without drawbacks. One critical problem is its high peak-to-average power ratio (PAPR) [1]. High PAPR increases the complexity of analog-to-digital (A/D) and digital-to-analog (D/A) converters, and lowers the efficiency of power amplifiers. Over the past decade various PAPR reduction techniques have been proposed, such as block coding, selective mapping (SLM) and tone reservation, just to name a few [2]. Among all these techniques the simplest solution is to clip the transmitted signal when its amplitude exceeds a desired threshold. Clipping is a highly nonlinear process, however. It produces significant out-of-band interference

(OBI). A good remedy for the OBI is the so-called companding. The technique 'soft' compresses, rather than 'hard' clips, the signal peak and causes far less OBI. The method was first proposed in [3], which employed the classical μ-law transform and showed to be rather effective. Since then many different companding transforms with better performances have been published [4]-[7]. This paper proposes and evaluates a new companding algorithm. The algorithm uses the special airy function and is able to offer an improved bit error rate (BER) and minimized OBI while reducing PAPR effectively. ORTHOGONAL frequency division multiplexing (OFDM) is commonly adopted in wireless communication systems due to its key advantages such as flexibility in resource allocation and high spectrum utilization [1]. As OFDM signal is essentially a sum of multiple signals aligned in frequency domain, its probability density function (pdf) in time domain resembles Gaussian distribution, and thus its amplitude has high peak-to-average power ratio (PAPR) [2]. This poses strict demands on the dynamic range of data converters and especially limits efficient operation of power amplifiers (PAs). Due to the nonlinear nature of many analog devices, the actual analog front-end that should operate with a large linear range entails significant cost and power loss. Therefore, extensive research has been conducted focusing on achieving low PAPR in the digital front-end. The digital front-end is an intermediate between the physical layer and analog devices, and it primarily serves for frequency shifting, resampling, filtering, and impairment compensation for the analog front-end [3]. The PAPR reduction carried out in the digital front-end gives no change to the physical layer and thus is commonly applied in practice. Provided that the resulting error vector magnitude (EVM) is tolerable, PAPR can be reduced to a certain level by introducing some degree of distortion. Meanwhile, the signal after PAPR reduction should conform to the spectral mask. More specifically, the adjacentchannel leakage ratio (ACLR) should meet the system requirement [4]. Among many PAPR reduction techniques, most of the socalled distortion-less approaches (such as selective mapping [5]) are not applicable to the standardized OFDM systems as they call for major modifications in the physical layer architecture. This paper thus focuses on the techniques that are standard-compliant, and such approaches include clipping and filtering (CAF) [6], [7] and peak cancellation (PC) [8]. In principle, CAF induces peak regrowth due to the existence of the post-clipping filter to meet the spectral constraint, resulting in intractable PAPR regrowth. On the other hand, PC does not cause any PAPR regrowth but does exhibit out-of-band radiation caused by the cancelling pulse. By judicious design of peak cancelling pulses, however, the PAPR can be reduced while the out-of-band radiation is kept negligible. Moreover, since there is no need to invoke an additional filter (which contains a number of multipliers) for the out-of-band suppression,PC has lower complexity than CAF when implemented by hardware [8], [9].

Our companion paper [10] demonstrates a low-complexity real-time implementation of PC techniques using FPGA. Applications of the PC concept to other PAPR reduction techniques such as active constallation extension and tone reservation, and their design issues have been addressed in, e.g., [11] and [12]. Performance analysis of deliberately clipped OFDM signals can be found in, e.g., [6], [13], [14] and similarly the OFDM system after nonlinear power amplification is theoretically analyzed in, e.g., [15], [16]. Nevertheless, attempts for theoretical analysis of the OFDM system with PC are rather scarce. A bit error rate analysis of PC is found in [17], but it fails to address the resulting power spectrum, an important factor upon designing peak cancelling pulses under a given ACLR constraint. The difficulty in rigorous spectral analysis of PC stems from the fact that the PC event is a point process and thus it cannot be explicitly modeled by a stationary process.

PAPR IN OFDM

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Published. This paper proposes and evaluates a new companding algorithm. The algorithm uses the special airy function and is able to offer an improved bit error rate (BER) and minimized OBI while reducing PAPR effectively. The paper is organized as follows. In the next section the PAPR problem in OFDM is briefly reviewed.

OFDM is a powerful modulation technique being used in many new and emerging broadband communication systems.

Advantages

- Robustness against frequency selective fading and time dispersion.
- Transmission rates close to capacity can be achieved.
- Low computational complexity implementation (FFT).

Drawbacks

- Sensitivity to frequency offset.
- Sensitivity to nonlinear amplification.
- Compensation techniques for nonlinear effects.
- Linearization (digital predistortion).
- Peak-to-average power ratio (PAPR) reduction.
- Post-processing.

PAPR-reduction techniques

- Varying PAPR-reduction capabilities, power, bandwidth and complexity requirements.
- The performance of a system employing these techniques has not been fully analyzed
- PAPR is a very well known measure of the envelope fluctuations of a MC signal
- Used as figure of merit.
- The problem of reducing the envelope fluctuations has turned to reducing PAPR.
- In this paper we present a quantitative study of PAPR and NL distortion

- simulate an OFDM-system employing some of these techniques

COMPANDING BASICS

A companding system compresses the signal at input and expands the signal at outputin order to keep the signal level above the noise level during processing. In otherWords, companding amplifies small inputs so that the signal level is well above theNoise floor during processing. At the output, the original input signal is then restoredby a simple attenuation. Companding increases the SNR when the input signal is lowand therefore reduces the effect of a system's noise source.

HISTORY AND APPLICATIONS

The concept of companding was first patented by A.B. Clark at AT&T in 1928. The purpose of the patent was to adaptively transmit images through a noisy medium such that the received image has tone values similar to the image transmitted. Since then, companding has been developed for numerous other applications such as audio transmission and recording, communication systems, and signal processing. The μ-Law, for example, applies a logarithmic formula to audio or speech signals such that the transmit signals has a smaller number of bits. The logarithmic formula compresses the signal by allocating more bits or quantization levels to smaller values to reduce the signal to quantization noise ratio, which in general increased as the amplitude of the signal decreased. New variations of companding for transmission and communications have been proposed using the hyperbolic tangent function [2]. used for ofdm signals, the hyperbolic tangent can reduce the magnitude of the signal peaks to increase the efficiency in transmission. in all the examples cited above, only a simple compression algorithm is required because the transmission channel is modeled as additive noise.if convolutions occurred within the channel, as in companding for signal processing, then compensation methods would be required to reduce the effects of transients, Recent applications of companding have been developing in the fields of analog and digital signal processing. Tsividis first proposed using companding in analog signal processors in. Unlike previous companding techniques where the transmitter and the receiver are geographically different locations, the compressor and expander for a signal processor can be placed on the same chip, introducing the concept of syllabic companding: the compression level is known to both the compressor and the expander and can be determined by the average value of the input rather than the instantaneous value of the input. The concept is demonstrated in [14] for a second order high Q band pass filter. It was found that transients occur within companding signal processors and various compensation. Using companding on signal processors has the additional benefit of lower power dissipation for a required signal to noise ratio. it is shown that to increase the SNR requirements of an analog system by 3 dB requires twice the capacitance area and double the power dissipation. If companding is employed, then the necessary SNR can be met without such a large increase in chip size and power consumption.

NEW COMPANDING ALGORITHM

OBI is the spectral leakage into alien channels. Quantificationof the OBI caused by companding requires the knowledgeof the power spectral density (PSD) of the companded signal.Unfortunately analytical expression of the PSD is in generalmathematically intractable, because of the nonlinear compandingtransform involved. Here we take an alternative approachto estimate the OBI. Let (x) be a nonlinear compandingfunction, and (t) = $\sin(\omega t)$ be the input to the compander.The companded signal (t) is:(t) = $[(t)]$ = $f[\sin(\omega t)]$ .Since (t) is a periodic function with the same period as (t),(t) can then be expanded into the following Fourier series:

$$y(t) = \sum_{k=-\infty}^{+\infty} c(k)e^{jk\omega t},$$

where the coefficients $c(k)$ is calculated as:

$$c(k) = c(-k) = \frac{1}{T}\int_0^T y(t)e^{-jk\omega t}dt \qquad T = \frac{2\pi}{\omega}.$$

Notice that the input x in this case is a pure sinusoidal signal,any $(k) \neq 0$ for $|k|>1$ is the OBI produced by the nonlinearcompanding process. Therefore, to minimize the OBI, (k)must approach to zero fast enough as $k$increases. It hasbeen shown that $(k) \cdot k-(m+1)$ tends to zero if $y(t)$ andits derivative up to the m-th order are continuous, or inother words, $c(k)$ converges at the rate of $k-(m+1)$. Given anarbitrary number n, the n-th order derivative of $y(t)$, dny/dtn,is a function of $dif(x)/dxi$, (i= 1, 2, ⋯ , n), as well assin(ωt) and cos(ωt), i.e.:

$$\frac{d^n y}{dt^n} = g\left(\frac{d^n f(x)}{dx^n}, \frac{d^{n-1} f(x)}{dx^{n-1}}, \cdots, \frac{df(x)}{dx}, \sin(\omega t), \cos(\omega t)\right)$$

sin(ωt) and and cos(ωt) are continuous functions, $dny/dtn$is continuous if and only if $dif(x)/dxi$(i= 1, 2, ⋯ , n) are continuous. Based on this observation we can conclude:

Companding introduces minimum amount of OBI if the companding function (x) is infinitely differentiable.The functions that meet the above condition are the smooth functions. We now propose a new companding algorithm using asmooth function, namely the airy special function. The companding function is as follows:

$$f(x) = \beta \cdot \mathrm{sign}(x) \cdot [\mathrm{airy}(0) - \mathrm{airy}(\alpha \cdot |x|)]\,,$$

where airy(⋅) is the airy function of the first kind. α is the parameter that controls the degree of companding (and ultimately PAPR). $\beta$is the factor adjusting the average output power of the compander to the same level as the average input power:

$$\beta = \sqrt{\frac{E\left[|x|^2\right]}{E\left[|\mathrm{airy}(0) - \mathrm{airy}(\alpha \cdot |x|)|^2\right]}},$$

where $E[\cdot]$ denotes the expectation. The decompanding function is the inverse of (x):

$$f^{-1}(x) = \frac{1}{\alpha} \cdot \mathrm{sign}(x) \cdot \mathrm{airy}^{-1}\left[\mathrm{airy}(0) - \frac{|x|}{\beta}\right],$$

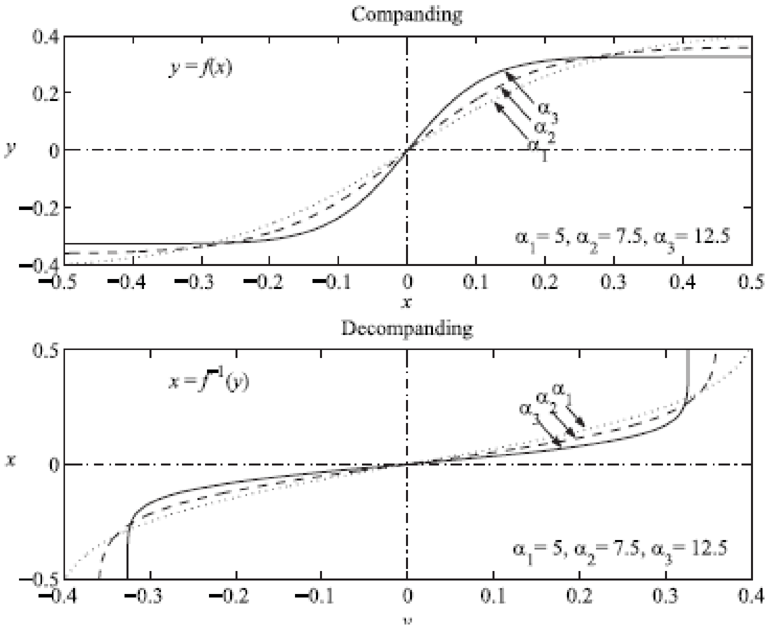
where the superscript-1 represents the inverse operation. Notice that the input to the decompander is a quantized signal with finite set of values. We can therefore numerically pre-compute $f-1(x)$ and use table look-up to perform the decompanding in practice. Next we examine the BER performance of the algorithm. Let (t) denote the output signal of the compander, (t) the white Gaussian noise. The received signal can be expressed as:

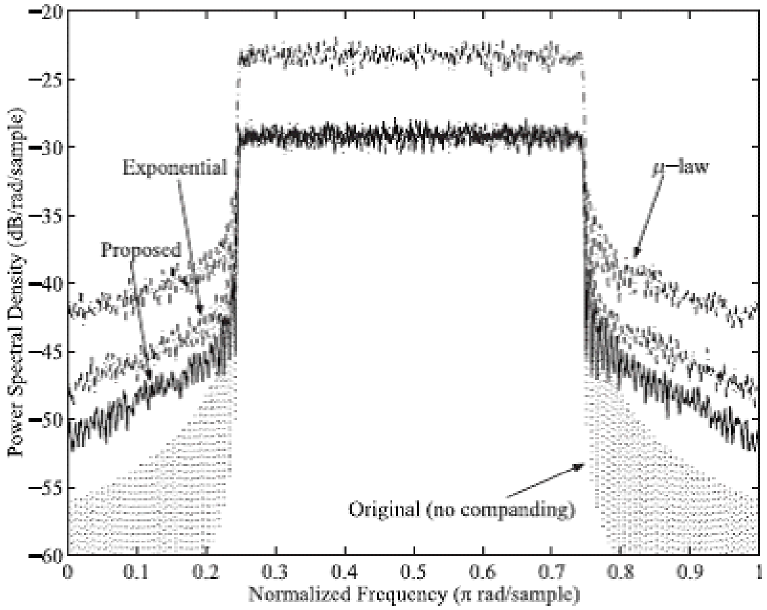
$$z(t) = y(t) + w(t).$$

The decompanded signal ˜(t) simply is:

$$\tilde{x}(t) = f^{-1}[z(t)] = f^{-1}[y(t) + w(t)].$$

Notice that the signal-to-noise ratio (SNR) in a typical additive white Gaussian noise (AWGN)





Using the first order Taylor series expansion,

$$\tilde{x}(t) \approx x(t) + \frac{df^{-1}(u)}{du}|_{u=y(t)} \cdot w(t).$$

From the given Equation shows that if (t) falls into the range of the decompanding function $f-1(u)$ where $df-1(u)/du|u=y(t)$ <1,the noise $w(t)$ is suppressed, and if $y(t)$ is out of the range,$df-1(u)/du|u=y(t)$ >1 and the noise is enhanced. Therefore,if the parameter αin (8) is properly chosen such that more(t) is within the noise-suppression range of $f-1(u)$, it ispossible to achieve better overall BER performance. It is worth to mention though that BER and PAPR affect each other adversely and therefore there is a tradeoff to make.

RESULTS:

The OFDM system used in the simulation consists of 64QPSK-modulated data points. The size of the FFT/IFFT is256, meaning a 4× oversampling. Given the compander input

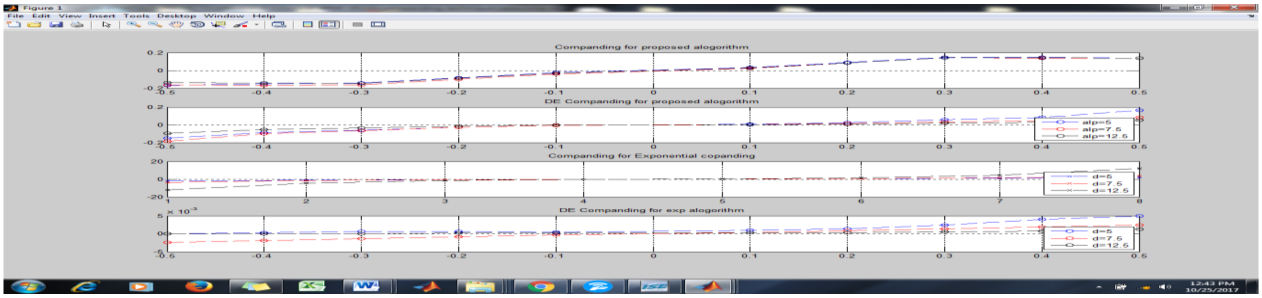


Fig 6.1: Results For Companding Algorithm

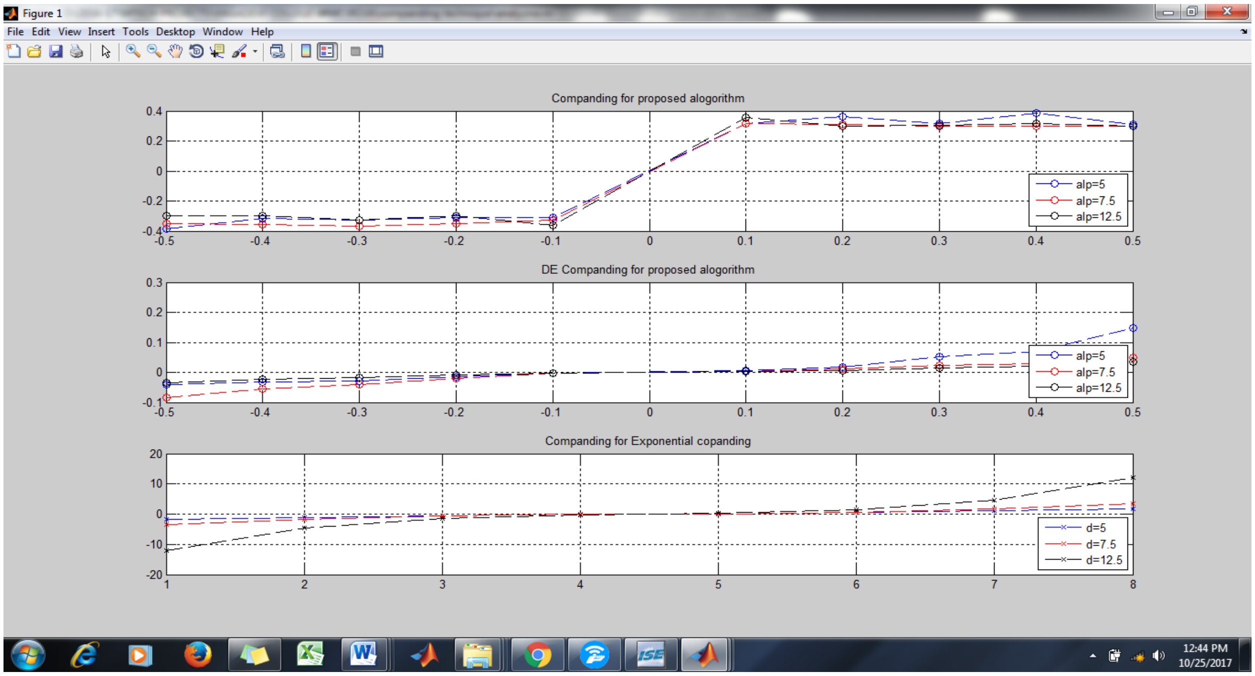
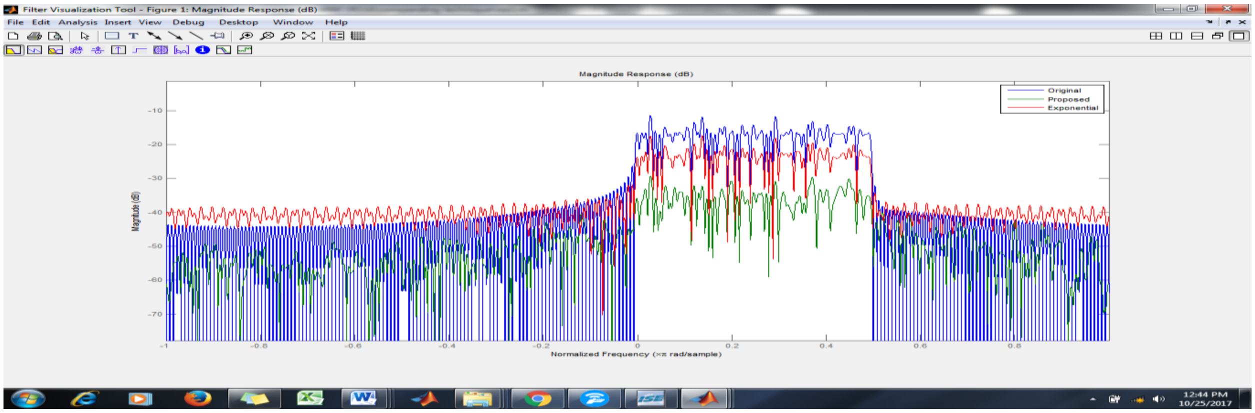


Fig 6.2.propsoed Companding Algorithm



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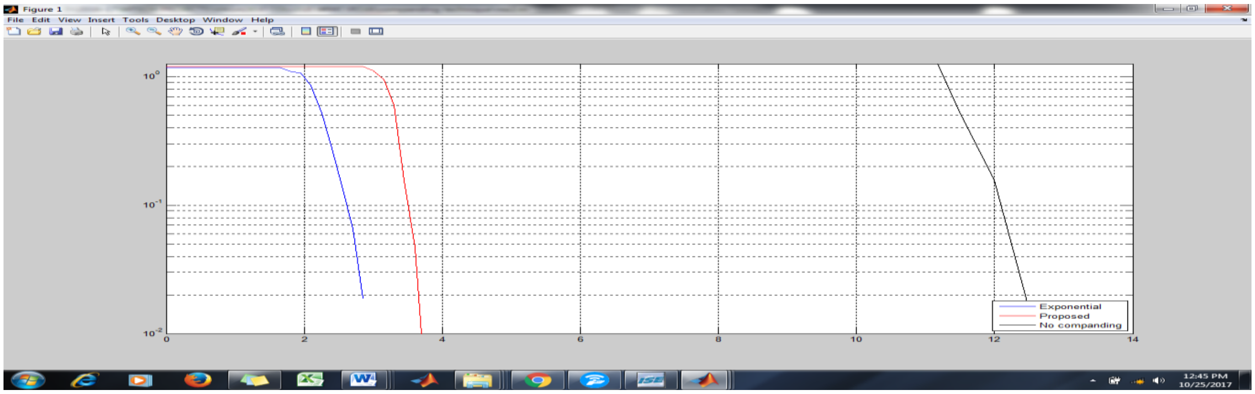

Complementary cumulative distribution function of original andcompanded signals (compander input power = 3dBm, α= 30). original and companded signals in AWGN channel (compander input power = 3dBm, α= 30).power of 3dBm, the parameter αin the companding functionis chosen to be 30. Consequently about 19.6 percent of $(t)$is within the noise-suppression range of the decompanding function. Two other popular companding algorithms, namelythe μ-law companding [3] and the exponential companding[5], are also included in the simulation for the purpose of performance comparison.The simulated PSD of the companded signals is illustrated in Fig. 2. The proposed algorithm produces OBI almost 3dBlower than the exponential algorithm, 10dB lower than theμ-law. The result is in line with our expectation. The μ-law function has a singularity in its second order derivative at x =0 and therefore is expected to have the strongest OBI. Fig. 3 depicts the CCDF of the three companding schemes.The new algorithm is roughly 1.5dB inferior to the exponential, but surpasses the μ-law by 2dB.The BER vs. SNR is plotted in Fig. 4. Our algorithm out performs the other two. To reach a BER of 10−3, for example, the required SNR are 8.9dB, 10.4dB and 11.7dB respectively for the proposed, the exponential and the μ-law companding schemes, implying a 1.5dB and 2.8dB improvement with the new algorithm. The amount of improvement increases as SNR becomes higher. One more observation from the simulation is unlike the exponential companding whose performance is found almost unchanged under different degrees of companding, the new algorithm is flexible in adjusting its specifications simply by changing the value of αin the companding function.

Orthogonal Frequency Division Multiplexing (OFDM) is an attractive multicarrier technique for mitigatingthe effects of multipath delay spread of radio channel, and hence accepted for

APPLICATION

- Several wirelessstandards as well as number of mobile multimedia applications.
- WiMAX
- 4G wireless systems
- DVB/DAB
- Wireless networkin downlink and SC-FDMA in the uplink.
- High speed wireless multiple access communication systems.

Among all these techniques the simplest solution is perhaps to clip the transmitted signal when its` amplitude exceeds a desired threshold. But clipping corresponds to a highly nonlinear process which produces significant out-of-band interference (OBI). Improved versions of the clipping technique have been proposed (i.e. clipping and filtering) that remove the out-of-band radiation but they may causes some peak regrowth letting the signal samples to exceed the clipping level at some points.

ADVANTAGES

Another attractive solution is the “companding” technique which was originally designed for speech process singusing the classical μ-law transformation and showed to be rather effective . It is the most attractive PAPR reduction technique for multicarrier transmission due to its good performance and low complexity. This technique ‘soft’ compresses, rather than ‘hard’ clips, the signal peak and causes far less OBI. However, companding techniques may introduce undesired effects because of the requisite expansion of the compressed signal at the receiver end, a process which amplifies receiver noise.

CONCLUSION:

In this paper, we have proposed a new companding algorithm. Both theoretical analysis and computer simulation show that the algorithm offers improved performance in terms of BER and OBI while reducing PAPR effectively

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