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A Novel Enhanced Technique for PAPR reduction Using Weighted OFDM signal

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Abstract: Simultaneously multiple carriers are using a transmission technique known as orthogonal frequency-division multiplexing (OFDM) for modulation. The OFDM based systems has spectral efficiency high and for inter symbol interference it is robust against, frequency selective fading channels. The signal get distortion due to the transmission of signal have high peak to average ratio is the main disadvantage of the system. At the receiver, to overcome drawback by removing weight with no distortion PAPR reducing scheme which is depends on OFDM signal which has weight is proposed. By forcing a weight on each OFDM signal which is discrete through a signal of certain kind which is band limited. Before a high power amplifier (HPA) consider an OFDM signal which is formed with data of discrete weights, at the end of receiver the original signal can be collected completely, Meanwhile the time duration required to transmit the OFDM signal have weights is same as the original OFDM signal's time duration .Now we propose the effectiveness of the scheme through the evaluation of computer simulation results. By proposing new approach for the bit error rate (BER) analysis as well as propose a novel technique to mitigate PAPR and thereby increasing the performance of the multiple-input and multiple-output OFDM (MIMO-OFDM) system. It is observed that BER performance of the MIMO OFDM signal have weight is improved compared to clipping and filtering method this can be specified from the numerical results. This method has less PAPR value than the clipping and filtering method. Here the proposed method is simpler than that of the C and F method.

Keywords: Bit error rate, Convolution, Orthogonal Frequency Division Multiplexing (OFDM), peak-to-average-power-ratio (PAPR), weighted data.

1. INTRODUCTION

A Transmission technique which simultaneously modulates the multiple carriers which are transmitted is OFDM Technique. The multiple carriers which are transmitted have overlapped spectrum. Using correct technique of time windowing at the receiver these can be orthogonally demodulated. A special case of frequency division multiplexing (FDM) is OFDM.

In FDM, several user signals that are of lower rates is modulated and transmitted in parallel with a separate carrier. Multi carrier modulation technique is OFDM technique that involves splitting in to parallel N lower rate bit streams from the high bit rate steam. Each of these bit streams is modulated by orthogonal N sub carriers. This is the main idea of OFDM is several orthogonal sub channels are divided from the available spectrum so that every sub channels of narrowband that is almost flat fading experienced. This is a system have capability to provide data rates in higher form with sufficient resistivity to radio channel characteristics.

2. PEAK -TO- AVERAGE POWER RATIO

The signal which we want to transmit has PAPR in higher rates this is a main problem in this OFDM based system. The signal should be distorted at the HPA of a transmitter which is nonlinear. Thus, we limit the power efficiency of HPF to avoid nonlinear distortion, Otherwise PAPR will be observed due to this the performance will be degraded.

In this method average value of the total system is less due to use of modulated sub carriers independently which are in large number , the system has peak value which is very high. This peak power to average power ratio is defined peak to average power ratio.

PAPR

High peaks in OFDM system can be denoted as PAPR. In some literatures, it is also treated as PAR. It is usually defined as:

$$\text{PAPR}=\frac{\text{P}_{peak}}{\text{P}_{average}}=10\log_{10}\frac{\max\left[\left|x_n\right|^2\right]}{E\left[\left[\left|x_n\right|^2\right]\right]}$$

Where P_{peak} represents peak output power, and $\text{P}_{average}$ is the average output power. E [·] denotes the prospective value, x_n represents the OFDM signals which are symbols of X_k. Mathematically, x_n is expressed as:

$$x_n=\frac{1}{\sqrt{n}}\sum_{k=0}^{N-1}X_k W_N^{nk}$$

power amplifiers are employed to access the required power level for transmission in MIMO OFDM systems. To achieve the peak power efficiency, high power amplifiers (HPAs) are functioned at or near the saturation

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region which causes to distortion and experience inter-modulation products between different subcarriers. The basic structure of PAPR reduction system model is shown in Fig.1. At the transmitting end, An input bit stream is appended into space time coding then modulated by OFDM and placed to antennas for radiation.

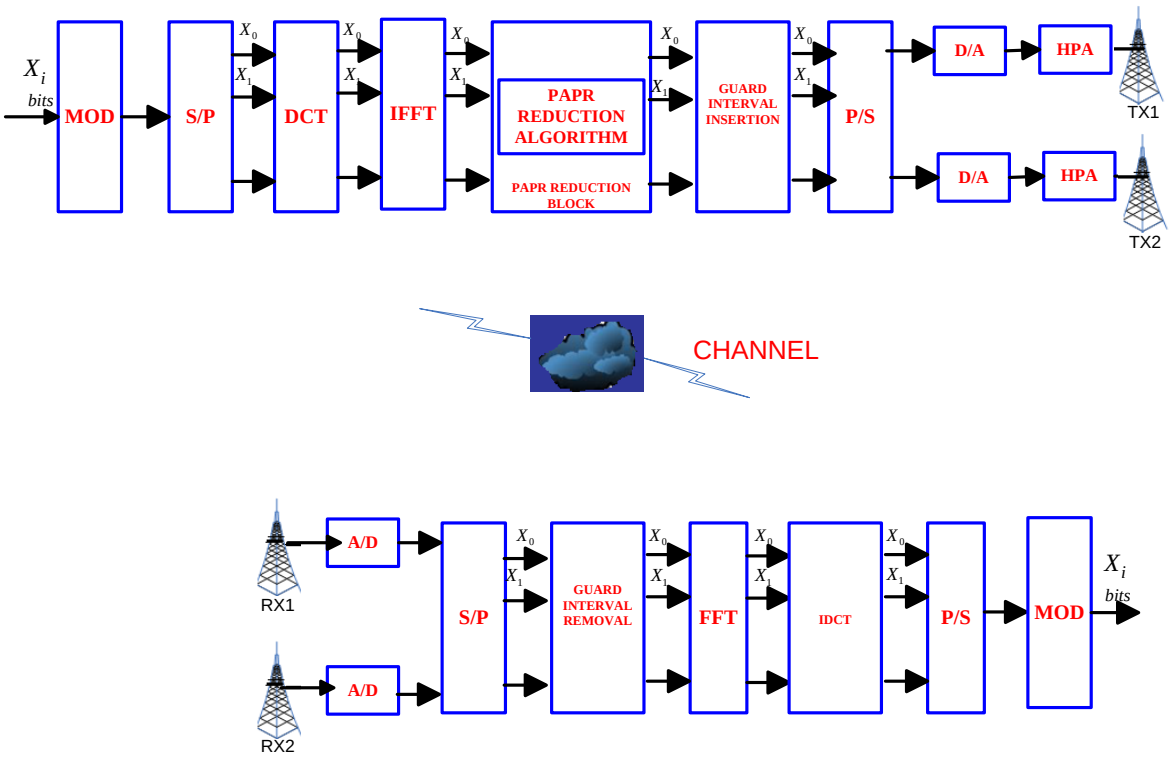

Fig.1. PAPR reduction system model in MIMO-OFDM SYSTEMS

Therefore in time domain, a multi-carrier signal is the sum of many narrow band signals results to the high PAPR and hence reduces the performance of the system. When CCDF, $PAPR_0$ threshold is exceed, PAPR value of OFDM sign can be expressed as:

$$PAPR(X(\mathrm{n}) = p_r(PAPR(X(\mathrm{n})) > \mathrm{PAPR}_0)$$

Depending on the independent data block N, SISO OFDM PAPR-CCDF represented as:

$$p = p_r(PAPR(X(\mathrm{n})) > \mathrm{PAPR}_0) = 1-(1-e^{-\mathrm{PAPR}_0})^N$$

If this equation is composed of MIMO-OFDM system, PAPR value on the i[th] transmitted antenna is, PAPR_i

$$p_r(PAPR_{MIMO-OFDM} > \mathrm{PAPR}_0) = 1-(1-e^{-\mathrm{PAPR}_0})^{M_t N}$$

Based on above it can be infer that MIMO-OFDM system has better PAPR performance.

When N signal that have same phase undergo coherent addition, the peak produced which is N times compared to the signal which we have average value.

$$PAPR(X_N) = \frac{\max_{0\le t\le NT}|x_N(t)|^2}{E(|x_N(t)^2|)}$$

For reducing the high PAPR as this problem has practical importance different types of schemes have been developed they are

- Clipping and Filtering
- selected mapping,
- Partial Transmit Sequence (PTS) and
- interleaving tone reservation/injection
- Active signal constellation extension and others.

3. EXISTING METHOD

Clipping is one of the simplest methods for reducing PAPR. This is also an effective method. A threshold value that is there in this method. The threshold value which is exceeded the peak value when it is large that occurs infrequently are clipping deliberately. The threshold value is selected such that with less BER it should provide good reduction in PAPR. Clipping is a nonlinear process.

This the performance of BER get weakens caused by large enough to have an effect of in -band distortion; due to the presence of out band distortion lost the efficiency of the spectrum. A clipper can do this process.

Depends on predetermined level known as clipping level (CL) the clipper limits the signal. If the CL is crossed by the signal envelope it must limits the signal otherwise without any change clipper passes signal.

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$$y[n] = \begin{cases} -CL, & \text{if } x[n] < -CL \\ x[n], & \text{if } -CL \le x[n] \le CL \\ CL, & \text{if } x[n] > CL \end{cases}$$

Where CL is the clipping level, x[n] is the OFDM signal. The BER performance is lost by the in –band distortion. The filtering process cannot reduce this distortion. However, on oversampling the signal at the outside of the noise is reshaped by taking longer IFFT. Later a process called as filtering can be used to remove this. Thus by oversampling we reduce the effect of in-band distortion can be used to reduce

The spreading of spectrum will happen when the out of band distortion is present that can be refrain from by filtering the clipped OFDM signal. This can also preserve the efficiency of the spectrum thus in turn improve the BER performance but it can also results in some regrowth of the peak power.

The CR related to the level which is clipped given by the expression

$$CR = 20\log_{10}\left(\frac{CL}{E[x[n]]}\right)$$

Where E[x[n]] is the average of OFDM signal x[n]

To a predefined level an OFDM signal in time domain is deliberately clipped know as CL and subsequently filters the out-of-band radiation by the CF method. And yet, this filtering operation leads to the peak regrowth.

Therefore, we have been available an algorithm called iterative clipping and filtering (ICF) algorithm that can be used to suppress the regrowth of the peak and out of band radiation. Although an in- band clipping noise is get rid of by filtering due to this influence increase in bit error rate (BER). Due to some drawbacks in the previous methods we go for better method that is scheme for PAPR reduction by weighted OFDM.

4. WEIGHTED ORTHOGONAL FREQUENCY-DIVISION MULTIPLEXING SYSTEM

In this scheme, via signal of band limited of certain kind we form a signal in weighted discrete OFDM form. By using the circular convolution process this method is motivated, in between the modulated OFDM signal and a signal of certain kind circular convolution is taken place due to this smoothen the peak of the OFDM signal before the HPA. From the weight which we can provide an OFDM signal have weight that should be derived from a signal of band limited have no zero on the real line . The convoluted signal of PAPR can be degraded by doing circular convolution in between the signal xN which is modulated by multiple carriers and a suitable signal of band having no zero on the real line. The convolution scheme for an OFDM system and the proposed weighted scheme are given as simplified block diagram in simplified form shown in Fig. 2. As described in Fig. 2(a), we use IFFT to carrier the data streams of modulated on the multi carriers. The signal of PAPR can be reduced by this convolution block which is corresponding to the weight block of the scheme which is proposed, as shown in Fig. 2(b). A prefix which is added before the HPA in cyclic form this is shown in the following block.

Reducing the PAPR of the convoluted signal by taking the circular convolution between x_N is a modulated signal with multiple carriers and a suitable signal Φ having compact support. For collecting the OFDM signal with weighted form by considering the corresponding convolution method

4.1 Convolution method:

F[f] is the Fourier transform of f

$$F[f](\xi) := \int_R f(x) e^{-j\xi x} dx$$

F−1[F] is the inverse Fourier transform of F is defined by

$$F^{-1}[F](x) := \frac{1}{2\pi}\int_R F(\xi) e^{j\xi x} d\xi$$

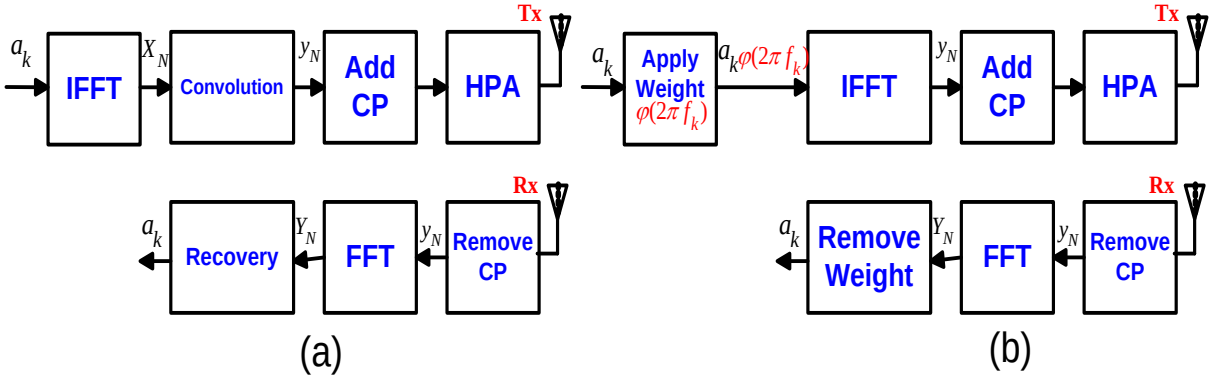

Fig. \2. Simplified block diagrams for an OFDM system with (a) convolution scheme and (b) proposed weighting scheme.

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Sine function, Gaussian function, and some different type of functions were used as weighted functions
We consider signal φ as

$$\varphi(x)=\frac{1-\mathrm{sinc}(x)}{\pi^2 x^2}$$

A signal ϕ is a band limited with bandwidth π, on the real line has no zero. Consider the circular convoluted signal as

$$y_N(t):=\frac{1}{2\pi}x_N * \Phi(t)=\frac{1}{2\pi}\int_{-\pi}^{\pi}x_N(t-\xi)\phi(\xi)d\xi$$

4.2 Weighted OFDM system:
The signal y_N is the simple weighted OFDM signals have weight which is the convoluted signal.

$$\int_{-\pi}^{\pi}e^{j2\pi f_k(t-\xi)}\phi(\xi)d\xi=2\pi\varphi(2\pi f)e^{j2\pi f_k t}$$

We express the convoluted signal as the following weighted OFDM signal

$$y_N(t)=\frac{1}{\sqrt{N}}\sum_{k=0}^{N-1}a_k\varphi(2\pi f_k)e^{j2\pi f_k t}$$

Since weight ϕ is non uniform, the BER performance could be reduced. In practice, by adding a suitable constant α which is positive to the original weight in order to become better the performance of BER we modify the weight.

$$\varphi_\alpha(x)=\varphi(x)+\frac{\alpha}{\log N}$$

logN is obtained by experiment and Where α is a shift parameter. Then, ϕ = ϕ0. After replacing the weight for a suitable constant which is positive α to get the signal in weighted form in the system.

$$z_N(t)=\frac{1}{\sqrt{N}}\sum_{k=0}^{N-1}a_k\varphi_\alpha(2\pi f_k)e^{j2\pi f_k t}$$

$0 \le t \le NT$
Weight ϕα(2πfk) is made to imposed on the discrete data ak, where k = 0, . . . , N − 1, and with the discrete data that is weighted we form an OFDM signal and thus we get OFDM signal which has weight z_N. We transmit OFDM signal with weighted z_N as time duration [0, NT] is similar to the original OFDM signal. We note that weight ϕ is positive on the real axis; therefore, the changed weight ϕα on the real line is positive.
Since ϕα (2πfk) ≠ 0 for any k = 0. . . N – 1.
The PAPR of the OFDM signal which is weighted z_N is given by

$$PAPR(z_N)=\frac{\max_{0\le t\le NT}|z_N(t)|^2}{E\left(|z_N(t)^2|\right)}$$

The PAPR of the OFDM signal which is weighted z_N is expressed by the OFDM signal have weight that signal possesses changed weight has PAPR is smaller than that of the C and F method. Performance of BER is better to this scheme when compared to C and F method. With computer simulations the proposed scheme effectiveness is evaluated. The time taken by the OFDM signal to transmit with weight is same as yN original OFDM signal time duration .Moreover, the real data in discrete form can be collected completely by the receiver with an extra 2N multiplications required in complex of complexity in computation, for transmission, and the cost also less for this transmission.

5. SIMULATION RESULTS

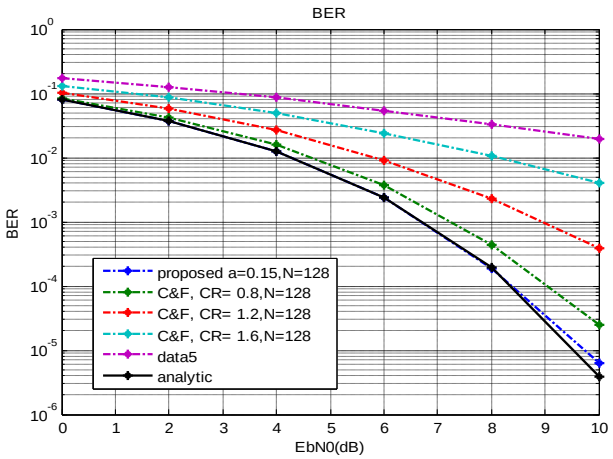

Fig: 3 Performance analysis of PAPR reduction in MIMO OFDM Systems BER of the C&F and proposed methods for N = 128

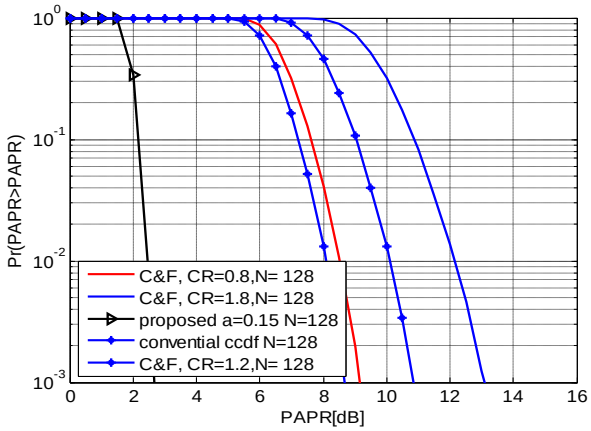

Fig: 4 Comparative PAPR reduction in MIMO OFDM Systems CCDF of the C&F and proposed methods for N = 128

From the results of simulation the performance of this suggested scheme is analyzed. Fig. 5 shows the CCDFs of the C&F method and the proposed method for N = 128, 256, 1024. The proposed method is simulated with a fixed shift parameter α = 0.03, and several C&Fs are simulated with various clipping ratios CR = 0.8, 1.2, 1.6, respectively.

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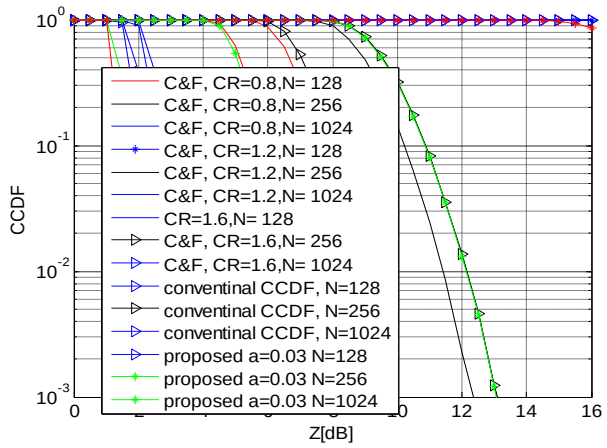

Fig: 5 Comparative PAPR reduction in MIMO OFDM Systems CCDF of the C&F and proposed methods for N = 128, 256, 1024

As shown in the figure, PAPR reduction can be done by this proposed scheme around 3 dB for N = 128 and 2 dB for N = 1024, respectively.

Note that the main OFDM signal of PAPR exceeds 14.8 dB for N = 128 and 16 dB for N = 1024, respectively. In Figs. 2 and 3, since the results induced by quadratic-amplitude modulation mapping are almost the same as those induced by QPSK mapping, here, we provide only the results induced by QPSK mapping. Fig.3 compares the C&F method to the proposed method for CCDFs and Fig.2 compares the BER performance.

6. CONCLUSION

To remove the weight such that no data is distorted at the receiver a signal namely weighted OFDM dependent PAPR reducing technique is proposed in the mathematical view. This Signal is formed by considering the discrete data which is weighted, that is defined on intervals of time same as that of the original OFDM signal, before HPA, where $\phi\alpha$ is used to impose the weights. It is shown that the OFDM method with weight has PAPR which is smaller than that of the C&F method, and this method also has improved BER performance over the C&F method the simulation results illustrates that the proposed novel technique effectively mitigate the PAPR and there by increasing the performance of the multiple-input and multiple-output OFDM (MIMO-OFDM) system. It is observed that BER performance of the MIMO OFDM signal have weight is improved compared to clipping and filtering method this can be specified from the numerical results.

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