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A Peak to Average Power Ratio Reduction Technique using Threshold Detection for OFDM Transmission Systems

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ABSTRACT

Background: MIMO OFDM systems Performance has been analyzed, using A Peak to Average Power Ratio Reduction Technique by Threshold Detection. **Objective:** The performance of UWB channel models has been analyzed for MIMO OFDM systems. **Results:** OFDM symbols to effectively reduce the peak power for the MIMO OFDM system. **Conclusion:** In this paper, the performance of UWB channels is analyzed for MIMO OFDM systems. A Peak to Average Power Ratio Reduction Technique by Threshold Detection has been considered for different channel realizations. A new method is proposed to effectively reduce the peak power of OFDM symbols which can control a peak reduction signal level in each subcarrier by iterative signal processing. In the proposed method, the signals are adaptively clipping and threshold and the filtering to effectively remove out-of-band components without peak reduction effect is combined. The peak reduction effect of the proposed method was clarified by computer simulation.

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INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) is one of the key technologies in mobile communication it can remove the influence frequency selective fading by adding a suitable guard interval in each OFDM symbol. The principle of OFDM is to split a high-rate data stream into a number of lower rate streams that are transmitted simultaneously over number of sub carriers (Yoshizawa, R., H. Ochiai, 2012). The current areas of applications are digital audio broadcasting, digital video broad casting, wireless LAN and wireless MAN.

The main limitation of OFDM based transmission system is the high peak to average power ratio (PAPR) of the transmitted signals. To account for this issue, several PAPR reduction schemes have been proposed (Sharma, P., 2012; Kitaek Bae, J.G., 2010). One of the effective techniques for PAPR reduction is clipping, which deletes the signal component exceeding the fixed amplitude (Terry, K., 2005). Clipping, however, expands the transmission signal spectrum, which triggers interference to adjacent systems. The permission of threshold level is to be chosen adaptively based on average peak value of overall subcarriers. The combination of clipping and filtering to remove out-of-band components of the expanded each sub carriers.

In this paper, we propose a new PAPR reduction method which can realize highly flexible frequency band use. In the proposed method, a peak reduction signals computed for each subcarrier. In addition to this signal processing, the proposed method adaptively controls a peak reduction signal level in each subcarrier by iterative signal processing, and filtering to remove out-of-band components and adaptively threshold of the peak reduction signals. The peak power reduction capability and bit error rate (BER) performance with the proposed method are clarified by simulations results.

The rest of the paper is organized as follows; Section 2 addresses the OFDM system model. Section 3 describes the peak to average power ratio (PAPR). Section 4 introduces a novel PAPR reduction scheme is proposed using iterative signal processing. Section 5 highlights the simulation results and discussions under various conditions

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ii System Model:

OFDM is a special case of multicarrier transmission, where a single data stream is parallelly transmitted over a number of lower rate subcarriers. In a parallel data stream, the total signal frequency band is divided into N overlapping frequency sub channels (Taeokh, V. and H. Jafarkhani, 2011). Each sub channel is modulated with a separate symbol and then N sub channels are frequency multiplexed.

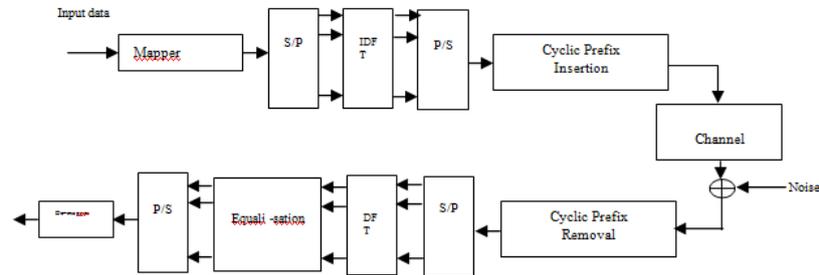


Fig. 1: system model.

The OFDM transmission system model is represented in Fig.1. The mathematical representation of OFDM symbol can be written as,

$$s(t) = \sum_{k=0}^{N-1} A_k e^{j2\pi k \Delta f t} \quad c \quad (0 < k < T_s) \quad (1)$$

Where N is the number of sub carriers, A_k is the m -ary data to be transmitted. k is the discrete sample points, T_s is the symbol duration, and Δf is the sub carrier frequency spacing. The different data carriers are each set apart by the frequency Δf . For orthogonality, $\Delta f T_s = 1$.

iii. Defination of papr:

In an OFDM system, the samples of the discrete time base band signal exhibit large peaks caused by the coherent addition of several independently modulated tones. Consequently, the continues time signal, obtained by passing the discrete samples to the D/A converter and filtering the outputs using a pulse sampling function exhibits even larger peaks. When the peak power, defined as the power of the sine wave with an amplitude equal to the maximum envelope value, is high. The PAPR is expressed by,

$$\text{PAPR} = \left\{ \frac{\max_{0 < t < T_s} |s(t)|^2}{\text{mean}_{0 < t < T_s} |s(t)|^2} \right\} \quad (2)$$

Where T_s is the symbol duration.

High PAPR is a major problem in nonlinear environment like High power amplifier (HPA). Non-linearity of HPA creates spectral growth of OFDM signal in the form of inter-modulation among subcarriers and out-of-band radiation which requires highly linear amplification at the transmitter, or a HPA becomes inefficient because of large back-off. Large PAPR also introduces as increased complexity of the analog to digital and digital to analog converters and degrade the efficiency of RF power amplifier. Therefore, it is desirable to reduce the PAPR

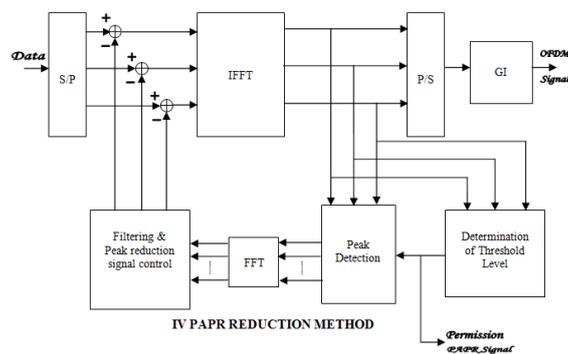


Fig.2 The Proposed transmitter

Iv Papr Reduction Method:

1. Peak Reduction Method:

The proposed OFDM transmitter is shown in Fig.2. The transmitted signals are mapped to modulation signal points and over-sampled. The over-sampled signals are transformed OFDM signals with low peak power by low peak OFDM signal generator shown in Fig.2. The generator performs peak reduction for each OFDM symbol using both Inverse Fast Fourier Transform (IFFT) and FFT. The peak power components, which exceed

permission PAPR in each OFDM symbol after IFFT are detected in a peak detector, and the components exceeding the permission PAPR become peak detector output signals. The value of permission of PAPR is set according to the peak average value of an each subcarrier. When an IFFT output signal is less than permission PAPR, the peak detector output signals set to be 0.

The i -th peak power component

$$u_i(i) = \begin{cases} 0 & : |s_t(i)| \leq c_{th} \\ s_t(i) - (s_t(i) / |s_t(i)|) c_{th} & : |s_t(i)| > c_{th} \end{cases} \quad (3)$$

Where $s_t(i)$ is the i -th sampling signal in each OFDM symbol. The value of c_{th} is computed from i -th sampling signal in each OFDM symbol is,

$$C_{th} = \left(\sum_{i=0}^n s_t(i) \right) / n \quad (4)$$

Where n is the number of sub carriers present in the each OFDM symbol.

The peak reduction signals spread not only inside the OFDM signal band but also outside the OFDM band. A filtering and peak reduction signal control circuit controls the level of the peak reduction signals according to a permission peak reduction signal level. The out-of-band components of the peak reduction

signals are set to be 0, and the unusable band components are set to be less than the permission peak reduction signal level for each unusable band. These controlled peak reduction signals are added to the original transmitted signals.

2 .Iterative Signal Processing:

The peak reduction becomes imperfect because the peak reduction signals out of the usable frequency band are removed and the levels of the peak reduction signals in the unusable bands are controlled. In IFFT output signals, peak power components exceeding the permission PAPR occur again. In order to remove the remaining peak components, the signal processing for generating peak reduction signals in the OFDM signal generator is repeated for each OFDM symbol. This iterative signal processing is repeated until the peak power decreases to the permission of PAPR without expanding the spectrum both outside the system band and into unusable bands inside the system band. Because the proposed method can adaptively generate peak reduction signals for each subcarrier, the various application techniques can be considered such as frequency band use and frequency reuse concepts.

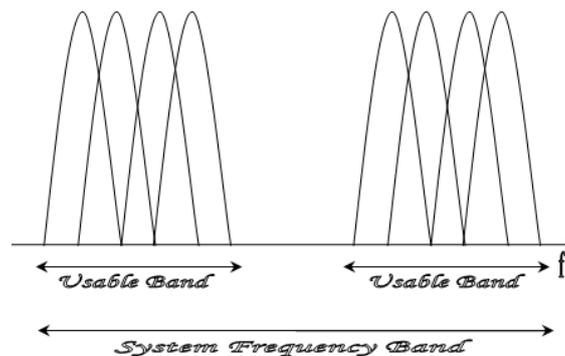


Fig.3 The Frequency Band Use

In Fig.3 shows a frequency band use in which the system frequency band includes an unusable frequency band. In this case, the permission peak reduction signal level in the unusable frequency band is set to be 0, and a peak reduction signal controller in the proposed transmitter removes the peak reduction signal in the unusable frequency band.

V. Simulation results and discussions:

In this section the BER performance of proposed peak reduction method is analyzed. BER performance is evaluated in Additive White Gaussian Noise (AWGN) channel, and the carrier frequency and symbol timing are assumed to be recovered perfectly. The number of orthogonal carriers comprising an OFDM block is said to $N=128$ and a cyclic prefix length $L=32$ is added. QPSK modulation scheme is employed for simulation and the 512 FFT points are considered. In Fig.4 shows the BER performance is analyzed for various clipping levels in

the proposed method. When the Clipping ratio CR=3 dB the number peak reduction iterations consider as Ni=1 and CR=6 dB with Ni=5 and also without cyclic prefix and clipping the AWGN channel signal is evaluated.

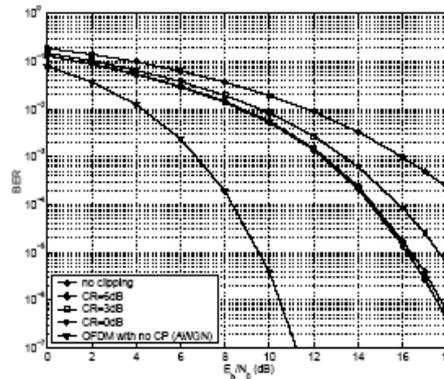


Fig. 4: BER performance analysis for various clipping levels in the proposed method.

Conclusion:

In this paper, a new method is proposed to effectively reduce the peak power of OFDM symbols which can control a peak reduction signal level in each subcarrier by iterative signal processing. In the proposed method, the signals are adaptively clipping and threshold and the filtering to effectively remove out-of-band components without peak reduction effect is combined. The peak reduction effect of the proposed method was clarified by computer simulation. The result given in this paper is of greatest importance in design and analysis of future OFDM systems.

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