Reduction of PAPR in MIMO-OFDM Broadcasting System

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ABSTRACT
OFDM technique is spread over wireless communication since a long time. Still, there is the scope of research in this field. In this paper a simple approach has been considered for OFDM application in MIMO channel. The BER analysis proofs its validity as MIMO-OFDM model in wireless communication. To strengthen it, the PAPR is analyzed to reduce in a new technique along with in the comparison. The performance can be exhibited in the result.

Keywords
Orthogonal Frequency Division Multiplexing (OFDM), MIMO, peak-to-average-power ratio (PAPR), multicarrier (MC)

1. INTRODUCTION
Wireless communication is an interesting area of research for the modern society in many aspects like, efficient technology in terms of error rate and occupation bandwidth. A MIMO communication system, combined with OFDM (MIMO-OFDM) modulation technique can achieve a reliable high data rate transmission over wireless channels. It achieves this by higher spectral efficiency and link reliability or diversity (reduced fading). The requirement to provide reliable high data rate communication over the wireless channel has led to the development of efficient modulation and coding schemes. A wireless channel suffers from time-varying impairments like multipath fading, interference and noise. Diversity is an effective method to combat the fading of the wireless channel [1]. Coherent detection and accurate channel estimation is required at the receiver to obtain reasonable performance. The estimation of channel response can be obtained by LS estimation scheme but in wireless application, the MMSE, BER and SER for data transmission are most important.

One of the major challenges of Orthogonal Frequency Division Multiplexing (OFDM) is that the output signal may have a potentially very large peak-to-average power ratio (PAPR). The resulting technical challenges, as well as PAPR-reduction techniques and related issues, have been widely studied and reported in the research literature [1], [2].Since the actual signal that enters the power amplifiers is a continuous-time signal, we ultimately want to reduce the PAPR of the continuous-time OFDM signal (we call this the "continuous-time PAPR" for convenience).However, the evaluation of the continuous-time PAPR is analytically non- trivial and computationally expensive. Therefore, most PAPR-reduction techniques focus on discrete-time approximations of the continuous-time PAPR. The discrete-time approximations result in what we call the "discrete-time PAPR". In this paper, a computational method is introduced to find the peaks for OFDM signals with arbitrary complex-valued modulations.

The paper is summarized as follows. Section 2 is for the reduction of PAPR. Section 3 follows the result. Finally section 4 concludes the paper with the scope for future work.

2. PAPR reduction in OFDM
There are many factors that should be considered before a specific PAPR reduction technique is chosen such as reduction of PAPR capability, increase of power & BER at the transmitter & receiver, loss in data rate, computational complexity increase etc. It is absolutely an important factor while choosing a PAPR reduction technique as it may result in other harmful effects. There are some techniques that require a power increase in the transmit signal after using PAPR reduction method. Increase in BER is closely related to the power increase in the transmit signal. In some cases the data rate gets reduced after applying PAPR technique as one among the information symbols is to be dedicated for controlling PAPR. Besides all the above, computational complexity also plays a vital role in choosing a PAPR reduction method.

2.1 Clipping & Filtering
The clipping approach is the simplest PAPR reduction scheme, which limits the maximum of transmit signal to a pre-specified level.

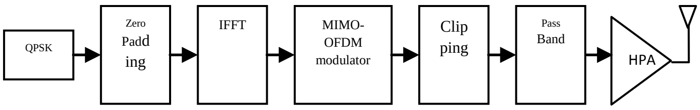

Figure 1. MIMO-OFDM transmitter with filtering after clipping

The Figure (1) shows a block diagram of a PAPR reduction scheme using clipping and filtering where, L is the oversampling factor and N is the number of subcarriers. In this scheme, the L-times oversampled discrete-time signal x'[m] is generated from the IFFT of following equation(X'[k] with N.(L-1) zero padding in the frequency domain), i.e.,

$$X[k] \equiv \begin{cases} X[k], \text{ for } 0 \le k < N/2 \text{ and } NL-N/2 < k < NL \\ 0, \quad \text{elsewhere} \end{cases} \quad \ldots\ldots \quad [1]$$

And then modulated with a carrier frequency fc to yield a pass band signal xp[m]. Let xpc[m] denote the clipped version of xp[m], which is expressed as

$$x^p_c[m] = \begin{cases} -A & x^p[m] \le -A \\ x^p[m] & |x^p[m]| < A \\ A & x^p[m] \ge A \end{cases} \quad \ldots \quad [2]$$

Where, A is the pre-specified clipping level. Let us define the clipping ratio (CR) as the clipping level normalized by the RMS value σ of OFDM signal, such that

CR= A/σ

It has been known that $\sigma = \sqrt{N}$ and $\sigma = \sqrt{N/2}$ in the baseband and passband OFDM signals with N subcarriers, respectively.

Although MIMO-OFDM system can reduce PAPR through average power of the original signal increase, it requires a larger linear operation region with large dynamic range in HPA and thus resulting in degradation of BER performance.

2.2 Over sampling Method

In this section, we estimate the PAPR for discrete-time signal x[n] and in particular, we set the PAPR of x[n] is same as continuous-time baseband signal x(t) if it is L-times oversampled (interpolator). We have the pass band signal with a carrier frequency of fc in the continuous time domain. Since fc is much higher than 1/ Ts , a continuous-time baseband OFDM signal x(t) with the symbol period Ts and the corresponding pass band signal x~ (t) with the carrier frequency fc have almost the same PAPR. The interpolator inserts (L-1) zeros between the samples of x[n] to yield w[m] as follows:

$$W[m] = \begin{cases} x[m/L], \text{ for } m=0,\pm L,\pm 2L,\ldots \\ 0, \text{elsewhere} \end{cases}$$

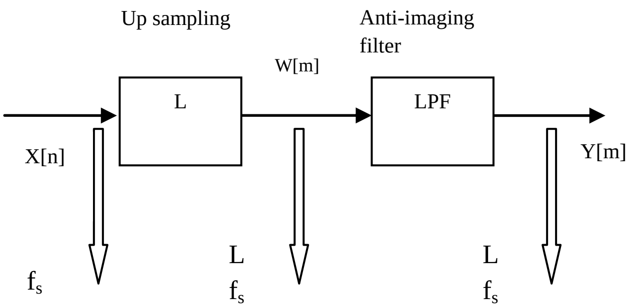

Figure 2. Block diagram of L-times Interpolator

A low pass filter (LPF) is used to construct the L-times-interpolated version of x[n] from w[m]. For the LPF with an impulse response of h[m], the L-times interpolated output y[m] can be represented as

$$Y[m] = \sum_{k=-\infty}^{\infty} h[k]w[m-k] \quad \ldots\ldots\ldots \quad [3]$$

The L-times interpolated version after IFFT operation is as

$$X^*[m] = 1/\sqrt{L.N}\; X^*[k].\, e^{j2\Pi m\Delta f k} /L.N,$$

$$\text{where, } m=0,1,\ldots\ldots NL-1 \quad \ldots \quad [4]$$

3. RESULTS

The excellent results have been found and shown as follows:

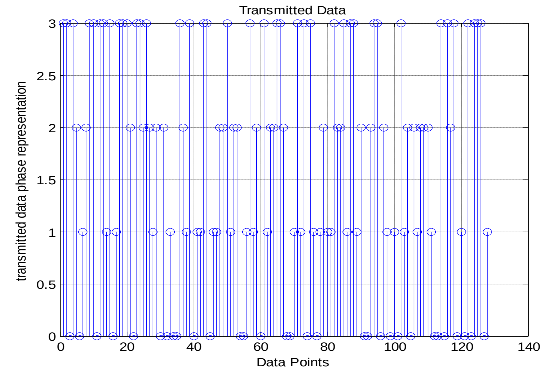

Fig 3. Transmitted data

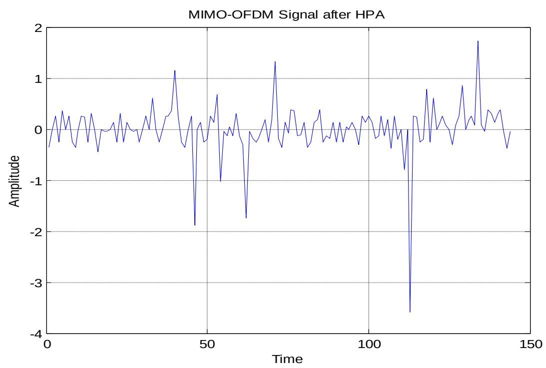

Figure 4. Clipped signal

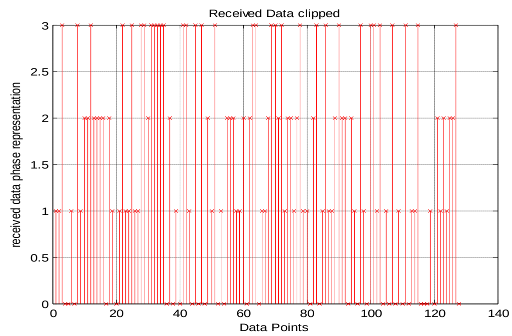

Figure 5. MIMO-OFDM signal after HPA

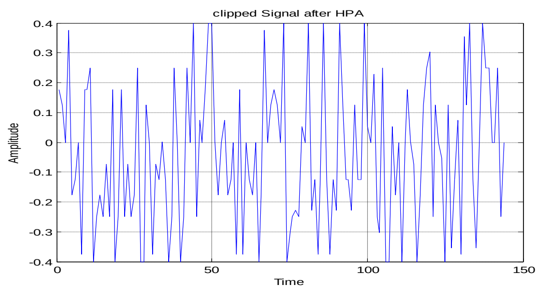

Figure 6. Clipped received data

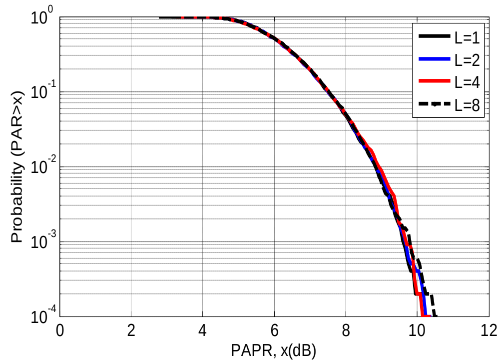

Figure 7. PAPR reduction by oversampling method

4. CONCLUSION

From the simulation result it has been observed that in OFDM-MIMO systems are giving the better than that of previous techniques. Further the performance of different modulation schemes may be investigated for various other types of models and channel equalizer techniques for future scope.

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