# Analysis for Multi user MIMO OFDM systems

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***Abstract*—In modern MIMO OFDM systems beamforming techniques have been widely adopted. The receive SNR of OFDM systems can be sufficiently improved by using beamforming techniques. But a major problem of OFDM systems is that the peak-to-average power ratio of signals degrades after using beamforming. High PAPR not only complicates the power amplifier design, but also increases power consumption. In this paper, theoretical analysis of PAPR performance of MIMO OFDM systems is done using either one of the two beamforming techniques, i.e. maximum ratio transmission and equal gain transmission. The output may provide important reference for practical designing of power amplifiers and power consumption. Moreover, the theoretical results show that PAPR of MRT OFDM systems is much worse than that of EGT OFDM systems. For both MRT OFDM and EGT OFDM systems PAPR reduction algorithms are proposed. The proposed algorithm for MRT OFDM systems can improve both PAPR and bit error rate; but the proposed algorithm for EGT OFDM systems only improves PAPR while it slightly degrades bit error rate.**

***Keywords*: MIMO OFDM, beamforming, precoding, peak-to-average power ratio, PAPR, low power, maximum ratio transmission, MRT, equal gain transmission, EGT, extreme value theory.**

## I. INTRODUCTION

In next generation broadband wireless communications Multiple-input Multiple-output orthogonal frequency division multiplexing is extensively used, because it can provide high data rate transmission over multipath fading channels.[2]. Among the MIMO techniques, beam forming has been widely adopted in communication standards, e.g., LTE, Wi- MAX and Wi-Fi applications, to obtain full diversity, which results in a reliable transmission. OFDM systems suffer from high peak-to-average power ratio. High PAPR leads to high effort in designing the power amplifier for preventing signal clipping, which results in hardware complexity and power consumption. When beam forming is applied in OFDM systems it worsens the PAPR, because after beamforming the dynamic range of the signals increases.[3]
Many methods have been proposed for reducing the PAPR including deliberate clipping, compounding, probabilistic methods, and coding. These methods may more or less distort signals and decrease the data rate. For example, the most PAPR reduction method is that the peak signals are initially clipped and this clipped signals are passed to the PA. However, clipping signals induces in-band and out-of-band distortion and requires additional signal processing techniques to reconstruct the received signals. Another category of methods to reduce the PAPR is through probabilistic schemes such as partial transmit sequence, selected mapping and sign adjustment[5][10]. The objective of probabilistic methods is to reduce the probability that peak power exceeds a certain PAPR threshold. In these methods the transmitter sends side information to the receiver but the data rate decreases due to the side information, also if the transmitted side information is polluted the transmitted signals cannot be correctly reconstructed. Moreover, although there has been extensive research for PAPR on OFDM systems, to the best of the authors knowledge, few studies have been conducted in analyzing the PAPR for beam forming MIMO OFDM systems and developing corresponding PAPR reduction methods, which are especially important in practice, since most modern communication systems adopt beam forming MIMO OFDM techniques and Green communications is a worldwide trend to save power consumption. The discussion above motivates us to explore how PAPR increases if beam forming is adopted in OFDM systems, and then propose the corresponding PAPR mitigation methods
In this proposed system we analyze the PAPR performance for single user MIMO OFDM systems adopting either one of the two most commonly used beam forming schemes, i.e., maximum ratio transmission and equal gain transmission. MRT is the optimal beam forming scheme in terms of receives SNR, but the PA design for MRT is more complicated than EGT. Here we use the Extreme Value Theory and order statistics to derive the CCDF of PAPR for EGT and MRT OFDM systems. First, we found that EGT OFDM systems have constant power property for different OFDM blocks and different RF transmits branches. Thus the PAPR characteristic can be approximately obtained by simultaneously considering Mt unprecoded OFDM systems, where Mt is the number of transmit antennas. In other words, the PAPR for EGT OFDM systems is the same as that of unrecorded OFDM systems simultaneously transmitting Mt data streams.

## II. LITERATURE SURVEY

**1) “An overview of MIMO communications—a key to gigabit wireless”, A.Gore.**

In 2004 a brief overview of MIMO wireless technology was proposed covering channel models, capacity, coding, receiver design, performance limits, and MIMO-OFDM. High data rate wireless communications, nearing 1 Gb/s transmission rates, is of interest in emerging wireless local area networks and home audio/visual networks. Designing very high speed wireless links that offer good quality-of-service and range capability in non-line-of-sight (NLOS) environments constitutes a significant research and engineering challenge. A variety of cost, technology and regulatory constraints make such a brute force solution unattractive, if not impossible. The use of multiple antennas at transmitter and receiver, popularly known as multiple-input multiple-output (MIMO) wireless, is an emerging cost-effective technology that offers substantial leverages in making 1 Gb/s wireless links a reality. The paper provides an overview of MIMO wireless technology covering channel models, performance limits, coding, and transceiver design.[1]

**2) "A space-frequency transmitter diversity technique for OFDM systems", 1]D.B.Williams.**

In 2000 a transmitter diversity technique for wireless communications over frequency selective fading channels is presented. The proposed technique utilizes orthogonal frequency division multiplexing (OFDM) to transform a frequency selective fading channel into multiple flat fading subchannels on which space-frequency processing is applied. Simulation results verify that in a slow fading environment the proposed space-frequency OFDM (SF-OFDM) transmitter diversity technique has the same performance as a previously reported space-time OFDM (ST-OFDM) transmitter diversity system but shows better performance in the more difficult fast fading environments. Other implementation advantages of SF-OFDM over the ST-OFDM transmitter diversity technique are also proposed.[2]

**3) "Precoding technique for peak-to-average-power-ratio (PAPR) reduction in MIMO OFDM/A systems", T.Saventeesan**

In 2012 a new technique was introduced to reduce the peak to average power ratio (PAPR) in OFDM modulation for a MIMO system. The proposed method exploits the eigen-beam forming mode in MIMO a system which is a common feature in 4th generation standards: Wi MAX and LTE. These systems use the same beam forming weights for dedicated pilots and data so the weights are interpreted as a channel effect from the receiver perspective. There is no need to invert the weights at the receiver side since it is compensated for in channel equalization. Beam forming performance depends on the relative phase difference between antennas but is unaffected by a phase shift common to all antennas. In contrast, PAPR changes with the common phase shift. An effective optimization technique based on Sequential Quadratic Programming is proposed to compute the common phase shifts that minimize the PAPR.[3]

**4) "Amplitude clipping and iterative reconstruction of MIMO-OFDM signals with optimum equalization", D.Kim**

One main disadvantage of the MIMO-OFDM is the high peak-to-average power ratio (PAPR), which can be reduced by using an amplitude clipping. In 2009 D. Kim proposed clipped signal reconstruction methods for the MIMO-OFDMs with spatial diversity, such as space-time and space-frequency block codes. The proposed methods are based on the technique called iterative amplitude reconstruction (IAR) for SISO-OFDM. It consist of a new SFBC transmitter for clipped OFDM, which has approximately half the computational complexity of conventional SFBC-OFDM. The proposed clipping preserves the orthogonality of transmitted signals, and the clipped signals are iteratively recovered at the receiver. It gives the performance of IAR with optimum equalization, and also provide highly accurate channel estimation of the OFDM with amplitude clipping. It shows that the proposed receivers effectively recover contaminated OFDM signals with a moderate computational complexity.[9]

**5) "Existence of codes with constant PMEPR and related design" B.Hassibi**

Several coding methods have been proposed to reduce the high peak-to-mean envelope ratio (PMEPR) of multicarrier signals. It has also been observed that with probability one, the PMEPR of any random codeword chosen from a symmetric quadrature amplitude modulation/phase shift keying constellation is logn for large n, where n is the number of subcarriers. Motivated by a derandomization algorithm suggested by Spencer, in 2004 a deterministic and efficient algorithm was proposed to design signs such that the PMEPR of the resulting codeword is less than clogn for any n, where c is a constant independent of n. For symmetric q-ary constellations, this algorithm constructs a code with rate 1-logq2 and with PMEPR of clogn with simple encoding and decoding. [8]

**6) "Peak power reduction of OFDM signals with sign adjustment" M.Sharif**

In 2009 M. Sharif proposed a multisymbol encoding scheme to increase the rate of the code. In this scheme, one sign vector is chosen to simultaneously minimize the PMEPR of multiple codewords. This would lead to construction of codes with rate 1− 1 K logq 2 and PMEPR of c logKn for any n and K. He proposed a greedy algorithm to choose the signs based on p-norm minimization and prove that the resulting PMEPR is guaranteed to be less than c log n where c is a constant independent of n for any n. The proposed algorithm improve the performance by enlarging the search space using pruning. It also address the rate loss by proposing a block coding scheme in which only one sign vector is chosen for K different modulating vectors. The sign vector can be computed using the greedy algorithm in n iterations.[10]

## III. Problem Definition

Many methods have been proposed for reducing the PAPR including deliberate clipping, companding, probabilistic methods, and coding,. These methods may more or less distort signals and decrease the data rate. For example, the most straightforward PAPR reduction method is via clipping peak signals before passing them to the PA [9]. However, clipping signals induces in-band and out-of-band distortion and requires additional signal processing techniques to reconstruct the received signals. Another category of methods to reduce the PAPR is through probabilistic schemes such as partial transmit sequence (PTS) [5], selected mapping (SLM) and sign adjustment [10]. The objective of probabilistic methods is to reduce the probability that peak power exceeds a certain PAPR threshold. These methods demand that the transmitter sends side information to the receiver. Consequently, the data rate decreases due to the side information, and the transmitted signals cannot be correctly reconstructed if the transmitted side information is polluted. Moreover, although there has been extensive research for PAPR on OFDM systems, to the best of the authors knowledge, few studies have been conducted in analyzing the PAPR for beamforming MIMO OFDM systems and developing corresponding PAPR reduction methods, which are especially important in practice, since most modern communication systems adopt beamforming MIMO OFDM techniques and Green communications is a worldwide trend to save power consumption. The discussion above motivates us to explore how PAPR increases if beamforming is adopted in OFDM systems, and then propose the corresponding PAPR mitigation methods. The resulting analysis of algorithms is linear in the number of subcarriers. Furthermore, to make sure that the BER performance of the system is not affected by the PAPR precoding an additional constraint is appended to the CMA objective function which requires the weights to be on the unit circle. Like CP-PTS, the existing technique is transparent to the receiver; this means that it only affects the base station (BS) and it does not require any signal processing in the mobile station (MS). In this content the domain signals are varied from others and error rates increased.

We have to analyze the PAPR performance for multi user MIMO OFDM systems to adopt either one of the two most commonly used beam forming schemes. In addition, for MRT OFDM systems, we have to reduce the PAPR and improve the bit error rate performance..

## IV. Research Methodology

### *4.1 PROPOSED SYSTEM*

In this Proposed System, We have to analyze the PAPR performance for multi user MIMO OFDM systems adopting either one of the two most commonly used beam forming schemes. In addition, for MRT OFDM systems, the proposed algorithm not only can reduce the PAPR but also can improve the bit error rate performance.

The proposed algorithm makes an effort to adjust the power at some subcarriers after beam forming. Since the subcarrier power is equalized in a certain level, both the PAPR and the bit error rate performance are improved simultaneously. For EGT OFDM systems, the proposed algorithm can reduce the PAPR, while at the same time it only slightly degrades bit error rate performance. Many methods have been proposed for reducing the PAPR including deliberate clipping, companding, probabilistic methods, and coding, see *e.g.,*. These methods may more or less distort signals and decrease the data rate.

Without proper PAPR reduction algorithms, designers may be in a dilemma to determine which performance index to pursuit, receive SNR or PAPR? Therefore, we further propose PAPR reduction methods for both MRT OFDM and EGT OFDM systems. It is worth to emphasize that, unlike conventional PAPR reduction methods, there is no need to send side information from the transmitter to the receiver in the proposed algorithms.

### *4.2 ADVANTAGES OF PROPOSED SYSTEM*

1) Power consumption is less.
2) Performance is improved.
3) Accurate results provided.
4) Hardware complexity is less.

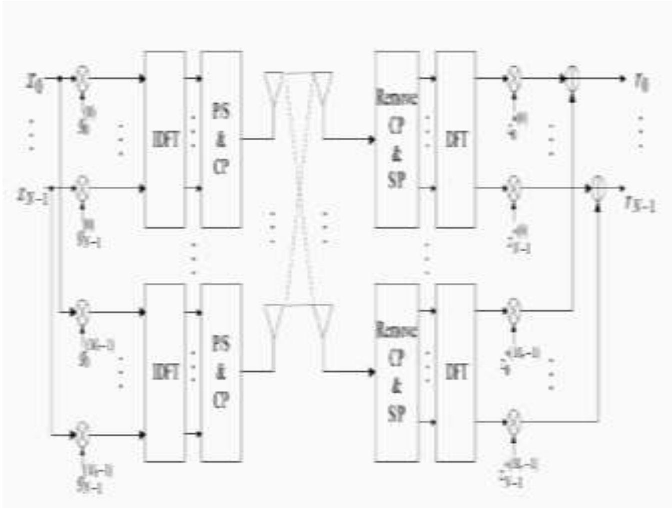



*Figure 4.1 A MIMO OFDM system with transmit beamforming and receive combining.*

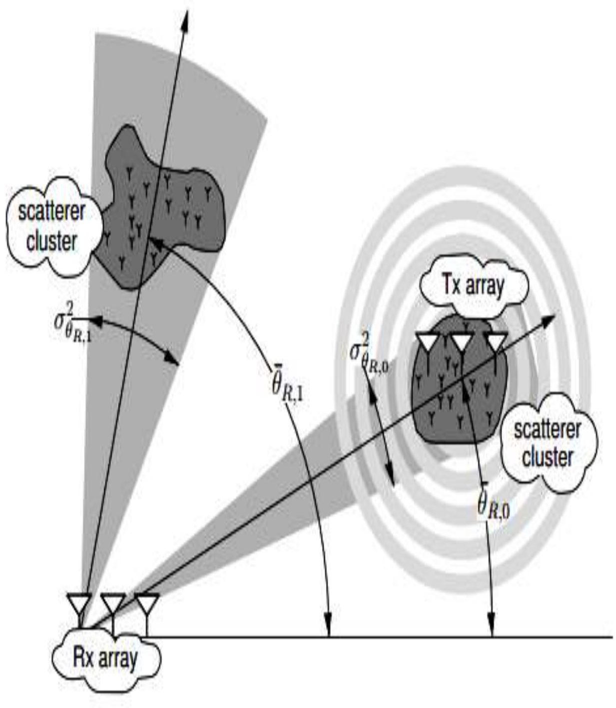
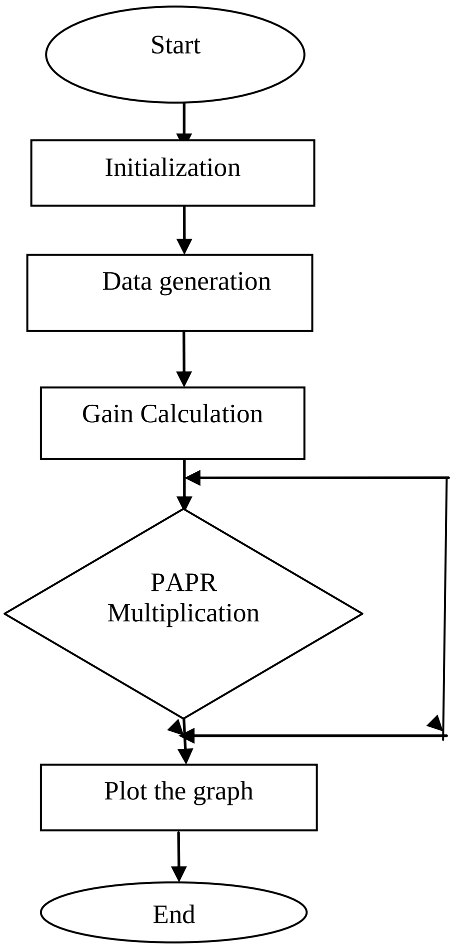



*Figure 4.2 Proposed system figure*

*4.3 FLOWCHART*




## V. DESIGN STEPS

*ALGORITHM DESCRIPTION*

*5.1 Design steps for PAPR reduction algorithm for MRT OFDM systems.*

1) Initialization:-Determine $M$ and $\delta$. Let $\Psi$ be system PAPR for current OFDM block
2) Sort γk in descending order and obtain ordered effective gains γki .
3) Let Δ(ki, kN−i) be the system PAPR obtained by multiplying **g**ki by δ, and **g**kN−i by 1/δ.
4) for i = 0 : M − 1 do
5) if Δ(ki,N − ki) > Ψ then
6) gki = δgki , gkN−i = gkN−i/δ,
Ψ = Δ(ki,N − ki).
7) end if
8) end for

*5.2 Design steps for PAPR reduction algorithm for MRT OFDM systems*

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1) Initialization: Determine M and φ. Let Ψ be system PAPR for the current OFDM block.
2) Sort γk in descending order and obtain ordered effective gains γki .
3) Let Λ(ki, φ) be the system PAPR obtained by multiplying gki by ejφ.
4) for i = 0 : M − 1 do
5) ˆφ = arg min Δ(ki, φ), Ψ = Δ(ki, ˆφ).
Φε{−φ,0,φ}
6) end for

## VI. CONCLUSION

The performance improvement using the proposed algorithm is more pronounced in MRT OFDM systems; that is, both the PAPR and the bit error rate performance can be improved simultaneously.

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