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MIMO OFDM Transmission Enhancement with Reduced PAPR Using Data Block Optimization

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Abstract

For high-speed transmission across a dispersive communication channel, multicarrier transmission is an extremely alluring technology. One of the crucial problems to be solved in the development of multicarrier transmission systems is the PAPR problem. We discuss a few multicarrier transmission PAPR reduction strategies in this paper. Numerous effective methods for lowering PAPR have been put forth; nevertheless, they might all result in significant PAPR reductions at the expense of increased computational complexity, transmit signal power, BER, data rate loss, and so on. For all multicarrier transmission systems, there isn't a single optimum PAPR reduction method. Instead, the PAPR reduction method needs to be carefully selected based on the different requirements of the system.

Keywords: ER, PAPR, Wimax, MIMO, OFDM

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1. Introduction

Some decades ago, both the sources and transmission system were on analog format but the advancement of technology made it possible to transmit data in digital form. The data payload capacity and transmission rate increased from kilobit to gigabit due to increase in speed of computers [3]. From wire to wireless concept emerged and researchers get success to invent wireless transmitter to transmit data. Applications like voice, internet access, instant messaging, SMS, paging, file transferring, video conferencing, gaming and entertainment etc. became a part of life. Wireless technology provided higher throughput, immense mobility, longer range, robust backbone to thereat. The vision extended a bit more to provide smooth transmission of multimedia anywhere with variety at low cost and flexibility even in odd environment.

Wireless Broadband Access (WBA) via DSL, T1-line or cable infrastructure is not available in rural areas. The DSL can covers only up to near about 18,000 feet (3 miles), that is why many urban, suburban, and rural areas cannot be served by WBA. The Wi-Fi standard broadband connection may solve this problem a bit but it has coverage limitations. But the Metropolitan-Area Wireless standard which is called WiMAX can solve these limitations [4].

There are certain differences between Fixed WiMAX and Mobile WiMAX. 802.16d (Rev 2004) is known as Fixed WiMAX and 802.16e standard is fondly referred as Mobile-WiMAX. The 802.16d standard supports fixed and nomadic applications whereas 802.16e Performance Evaluation of IEEE 802.16e (Mobile WiMAX) in OFDM Physical Layer standard supports fixed, nomadic, mobile and portable applications. The 802.16e carries all the features of 802.16d standard along with new specifications that enables full mobility at vehicular speed, better QoS, Performance and power control but 802.16e devices are not compatible with 802.16d base stations as 802.16e based on TDD whereas 802.16d is on FDD. Due to other compatibility issues with existing networks, 802.16e adopted S-OFDMA and 2048-FFT size. The main aim of mobile WiMAX is to support roaming capability and handover between Mobile Station (MS) and Base Station (BS) [3]. Several countries have already planned Mobile WiMAX for commercial services. The development included some new features on the link layer. Such features are, different types of handover techniques, robust power saving system and multiple broadcast supports etc.

2. Related Work

Michael A. Jensen *et al.* (2004), [9] according to them Multiple-input–multiple-output (MIMO) wireless systems use multiple antenna elements at transmit and receive to offer improved capacity over single antenna topologies in multipath channels. In such systems, the antenna properties as well as the multipath channel characteristics play a key role in determining communication performance. This work reviews recent research findings concerning antennas and propagation in MIMO systems. Issues considered include channel capacity computation, channel measurement and modeling approaches, and the impact of antenna element properties and array configuration on system performance. Throughout the discussion, outstanding research questions in these areas are highlighted.

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High peak-to-average power ratio of the transmit signal is a major drawback of multicarrier transmission such as OFDM or DMT. This article described by Seung Hee Han *et al*. some of the important PAPR reduction techniques for multicarrier transmission including amplitude clipping and filtering, coding, partial transmit sequence, selected mapping, interleaving, tone reservation, tone injection, and active constellation extension. Also, we make some remarks on the criteria for PAPR reduction technique selection and briefly address the problem of PAPR reduction in OFDMA and MIMO-OFDM.

Daniel W. Bliss *et al.*, according to them wireless communication using multiple-input multiple-output (MIMO) systems enables increased spectral efficiency for a given total transmit power. Increased capacity is achieved by introducing additional spatial channels that are exploited by using space-time coding. In this article, we survey the environmental factors that affect MIMO capacity. These factors include channel complexity, external interference, and channel estimation error. We discuss examples of space-time codes, including space-time low-density parity-check codes and space time turbo codes, and we investigate receiver approaches, including multichannel multiuser detection (MCMUD). The 'multichannel' term indicates that the receiver incorporates multiple antennas by using space-time-frequency adaptive processing. The article reports the experimental performance of these codes and receivers.

A new method for PAR reduction in OFDM is introduced by Robert F.H. Fischer. It is based on periodically extending the signal constellations (modulo-congruent points) in each carrier and the application of a lattice decoder to find the best representative in each carrier. Main advantages of this scheme are that no side information has to be communicated to the receiver and, without changing operation, any (square) signal constellation can be used. Numerical simulations cover the performance of PAR reduction in OFDM based on lattice decoding.

3. Methodology

A general model of a MIMO communication system is represented in Fig. 1. For simplicity, the channel is assumed time invariant over the interval of a transmission block. The figure is divided into 1) signal processing and coding (bottom) and 2) the channel (top). The radio frequency (RF) components are included in the channel since they influence the end-to-end transfer function.

In this system, a set of independent data streams represented by the symbol vector (is a time index) are encoded into discrete-time complex baseband streams at the transmitter. The coding can distribute the input symbols over the outputs (space) and/or over samples (time). The pulse-shaping block converts the discrete-time samples into continuous-time baseband waveforms (is frequency) and feeds them to the channel inputs (RF chains and antennas). The channel combines the input signals to obtain the element output (receive) waveform vector. The matched filter then produces the discrete-time baseband sample stream, and the space/time decoder generates estimates of the transmitted streams. For linear channel elements, the MIMO channel input–output relationship may be written as

$$\underset{N_R\times 1}{\mathbf{y}(\omega)} = \underset{N_R\times N_T}{\mathbf{H}(\omega)}\ \underset{N_T\times 1}{\mathbf{x}(\omega)} + \underset{N_R\times 1}{\boldsymbol{\eta}(\omega)}$$

Where is additive noise produced by the channel (interference plus noise from the RF front end) and the matrix dimensions are as specified. Each element represents the transfer function between the transmit and receive antenna. Since the transmit vector is projected onto in (1), the number of independent data streams that can be supported must be at most equal to the rank of. More generally, the properties of, such as the distribution of its singular values, determine the performance potential for the MIMO system. Factors such as antenna impedance matching, array size and configuration, element pattern and polarization properties, mutual coupling, and multipath propagation characteristics influence these properties. Therefore, poor design of system components or incorrect assumptions about the channel could lead to drastic reduction in system performance. For convenience, we will usually drop the frequency dependence and consider narrowband communication, which is justified when the channel response is constant over the system bandwidth (flat fading) or when signals are divided into narrowband frequency bins and processed independently. This highlights the effect of the spatial dimension, a unique factor of MIMO communications, and ignores the complexity of the wide-band channel response.

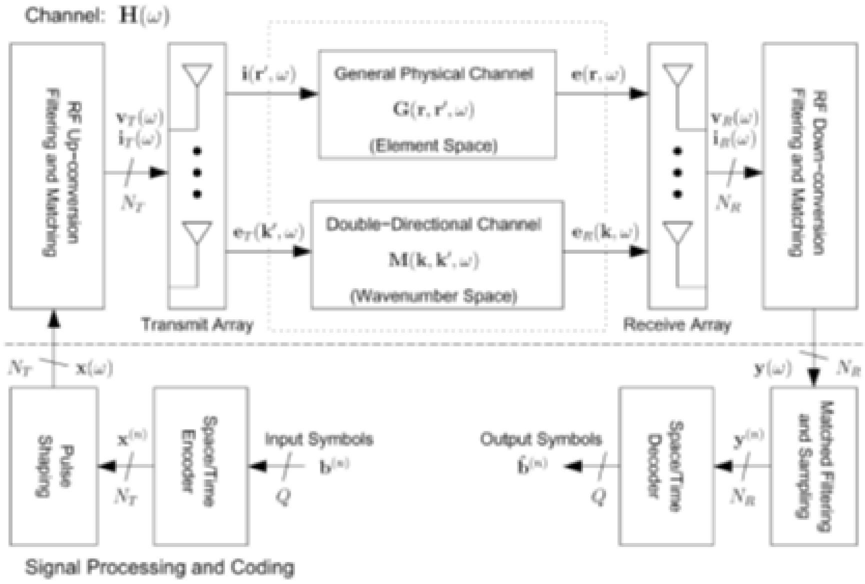

Fig 1: Block diagram of a generic MIMO wireless system.

4. Result and Discussion

Above discussed results are collectively shown in a combined form on a common plot as shown in figure for symbol error convergence for Mt=1 in solid line-,Mt=2 in-.-line and Mt=3 in … line. Figure shows the collective plot of CCDF vs. PAPR for demonstrating the effect of number of antennas using CMA algorithm in Mt=1 in solid line-,Mt=2 in-.-line, Mt=3 in … line and without PAPR reduction as---line.

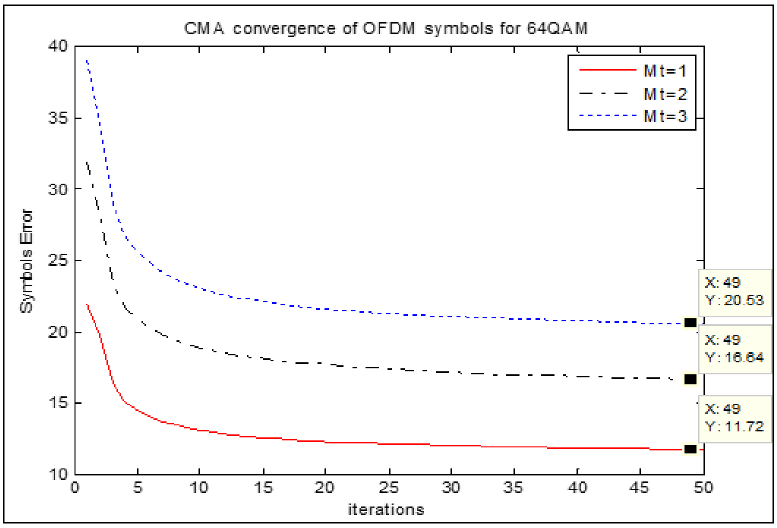

Fig 2: Collective plots for symbol error convergence using CMA algorithm for PAPR reduction for 64QAM MIMO OFDM data transmission.

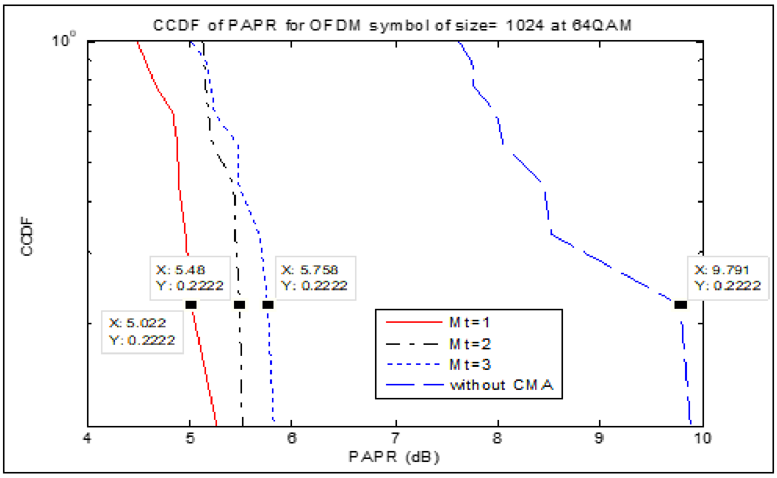

Fig 3: Collective plots for CCDF vs. PAPR using CMA algorithm for PAPR education for 16QAM MIMO OFDM data transmission.

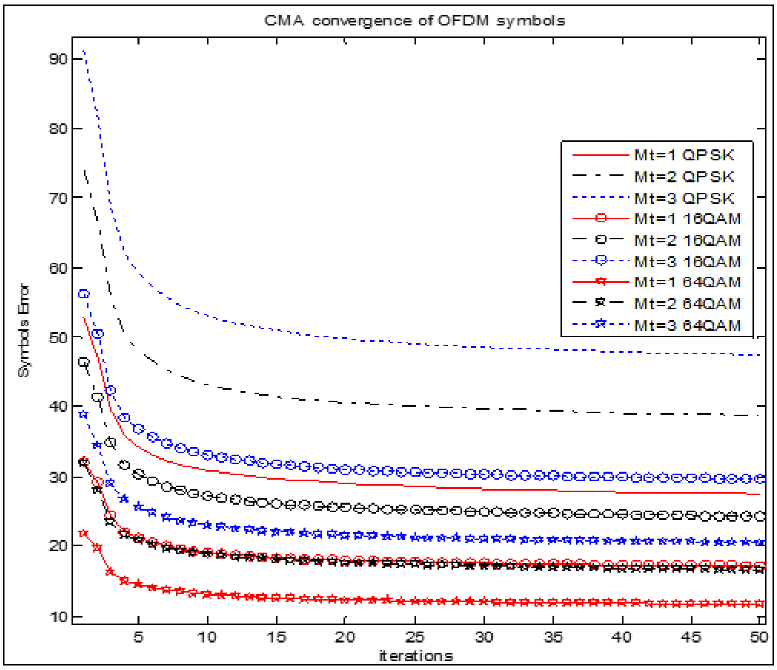

Fig 4: Collective plots for symbol error convergence using CMA algorithm for PAPR reduction for QPSK, 16QAM and 64QAM MIMO OFDM data transmission for Mt=1,2 and 3.

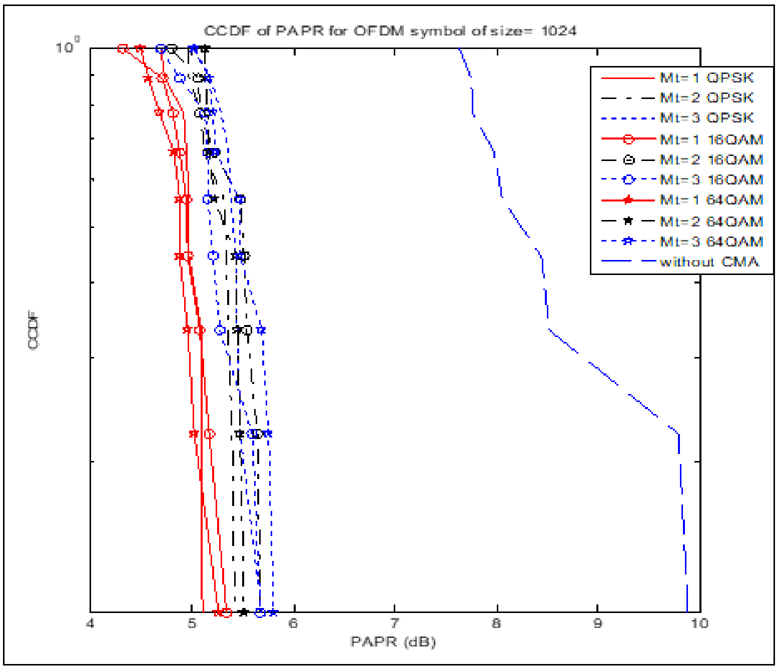

Fig 5: Collective plots for CCDF vs. PAPR using CMA algorithm for PAPR reduction for QPSK, 16QAM and 54QAM MIMO OFDM data transmission for Mt=1, 2 and 3.

5. Conclusion

In this work PTS is used but we are not applying non-convex optimization objective to solve the PAPR reduction problem but the quality assurance objective is based on a cost function evaluated by constant modulus algorithms (CMAs). A block-iterative algorithm applied to find the pre-coding PAPR weights. The complexity of data processing mode is linear in the number of subcarriers. Like PTS the proposed developed algorithm is transparent to the receiver hence the performance only affects the base station (BS) and there is no need of any kind of signal processing at the mobile station ends.

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