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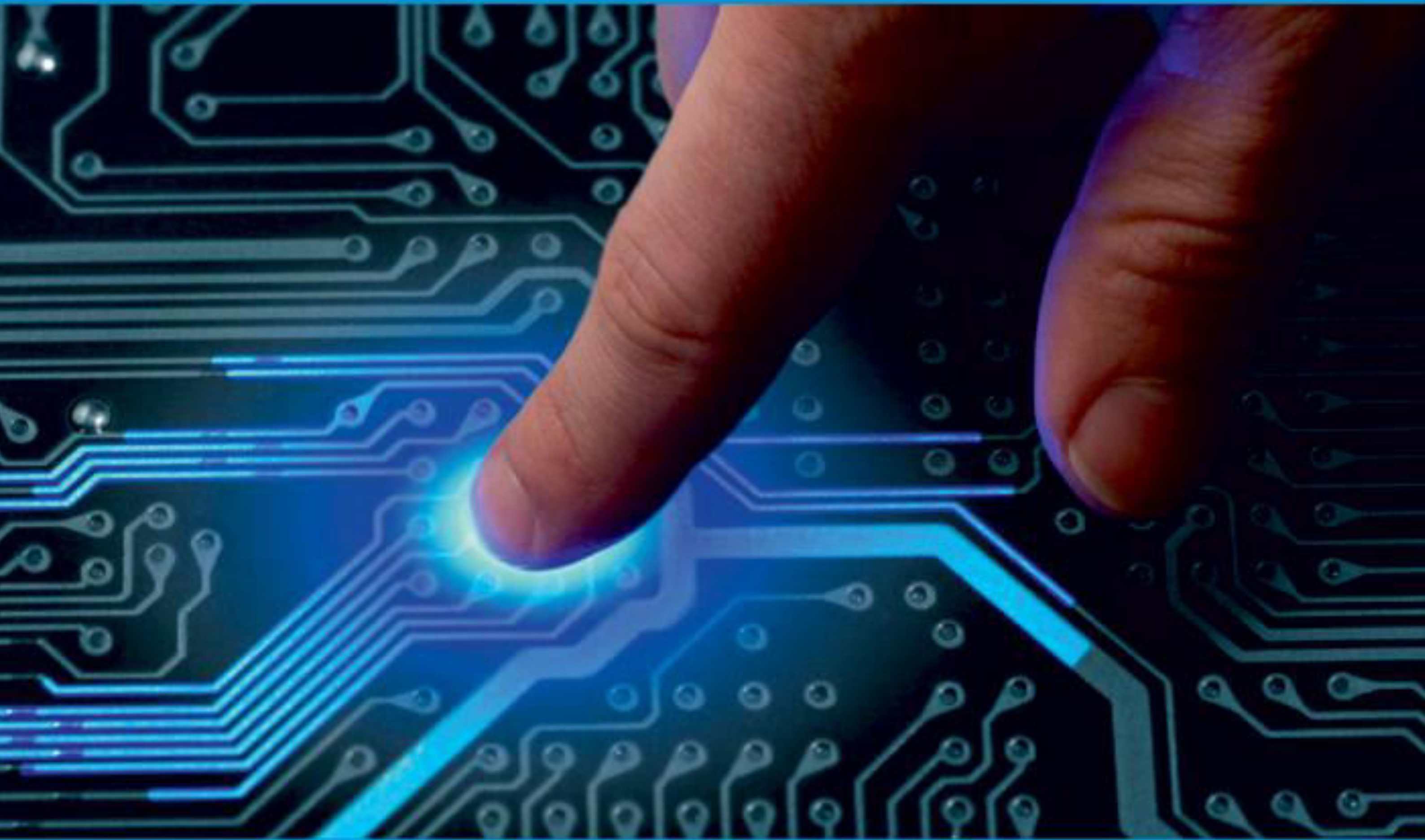

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Different PAPR Reduction Technique for MIMO-OFDM System: A Review

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ABSTRACT: Massive system is of great interest for researchers and research laboratories all over the world. OFDM is widely used in contemporary communication systems for its good robustness in multipath environment, and its high spectral efficiency. The capacity of wireless system can be increased dramatically by employing Multiple Input Multiple Output, (MIMO) antennas. The combination of MIMO and OFDM system is found to be very beneficial. A major drawback of OFDM-MIMO System is its high Peak to Average Power Ratio (PAPR) Reduction. The peak power of a signal is a critical design factor for band limited communication systems, and it is necessary to reduce it as much as possible. Many PAPR reduction techniques have been used to reduce PAPR. Select mapping (SLM) is one of the most well-known peak-to-average power ratio (PAPR) reduction techniques proposed for MIMO-OFDM systems. However the computational complexity of traditional PTS method is tremendous. In this paper studied of different PAPR technique, based on MIMO-OFDM system, which can achieve better PAPR performance at much less complexity.

KEYWORDS: SLM, MIMO, OFDM, PAPR

I. INTRODUCTION

In this smart world the demand for the multimedia data service has grown drastically with the introduction of the 4th generation wireless communication. Here the number of users is much higher than the spectrum present for the communication. For this we have used OFDM as it gives Bandwidth efficiency, High data rates and is immune to fading marks. It is majorly used in Digital audio Broadcasting (DAB), Digital Video Broadcasting (DVB), Long Tern Evolution (LTE) and much more. The major disadvantages cased are tight frequency synchronization, time offset, peak to average power ratio (PAPR) and channel estimation [1, 2]. OFDM is the base of all 4G wireless communication system since it has a huge capacity of number of subcarriers, high data rate as high as 100 Mbps and ubiquitous coverage with high mobility. In the OFDM modulation High PAPR is one of the major issues, when N number of sinusoidal signals get added the peak magnitude will have a value of N where at some point of time the average might be low due to the interference in the signal or it could also be high due to constructive interference between the signal Therefore High PAPR signals is undesirable as due to high PAPR it would be an important requirement that a large range of dynamic linearity from the analog circuits which ultimately results in expensive devices and high power consumption making the device less efficient (For e. g. Power amplifier will have to operate with large back-off to maintain the linearity). In OFDM systems the input sequence needed are to be transmitted and would result in higher PAPR than other techniques. So an input sequence which requires all such carriers to transmit their maximum amplitudes would certainly result in a high output PAPR. Thus when we restrict the possible inputs sequence to smallest set of values then there might be probability that to obtain output signals with low PAPR [3, 4].

Highly Reliable: Since there are no cables and other infrastructure, the wireless system has no chance of failure and damage. Hence it is highly reliable.

Recovery after a disaster: Despite fires, floods, or other disasters, the loss of wireless communication infrastructure is low in wireless communication systems. Even though there are several benefits, there are certain disadvantages to wireless communication systems [5].

The disadvantages are:
Electromagnetic Interference: Since the transmission of signals is through space, there is a high possibility that the signals will interfere with each other.

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Insecure: The wireless system is highly insecure as the signals are transmitted through space from one point to another.

II. SYSTEM MODEL

MIMO in combination with OFDM is widely used nowadays due its best performance in terms of capacity of channels, high data rate and good outcome in frequency selective fading channels. In addition to this it also improves reliability of link. This is attained as the OFDM can transform frequency selective MIMO channel to frequency flat MIMO channels [6, 7]. So it is widely used in future broadband wireless system/communications. Cyclic prefix is the copy of last part of OFDM symbol which is appended to the OFDM symbol that is to be transmitted. It is basically 0.25% of the OFDM symbol. We can say that one fourth of the OFDM symbol is taken as CP (cyclic prefix) and appended to each OFDM symbol. IFFT is used at the transmitter and FFT is used at the receiver which substitutes the modulators and demodulators. Doing so eliminates the use of banks of oscillators and coherent demodulators. Moreover the complex data cannot be transmitted as it is; therefore it is first converted to analog form which is accomplished by IFFT. It basically converts the signal from frequency domain to time domain. Prior to IFFT operation symbol mapping is performed which is nothing but the modulation block. Any of the widely used modulation techniques can be applied like BPSK, QPSK, QAM, PSK etc. Further there are higher order modulations are also available which provide more capacity at little expense of BER performance degradation [8]. After IFFT block pilot insertion is done and then CP (cyclic prefix) is added. Figure 1 below shows the block diagram constituting MIMO and OFDM. Any antenna configuration for the MIMO can be used according to the system requirement. Higher the configuration more will be the capacity and more will be the computational complexity of the transceiver design. It is seen that in the case of estimating channel the computational complexity is increased. Mapper defines the modulation to be used. Symbol encoder takes the shape of the STBC (Space Time Block Code) if spatial diversity is to be used and it takes the shape of the de-multiplexer/multiplexer if spatial multiplexing is to be used.

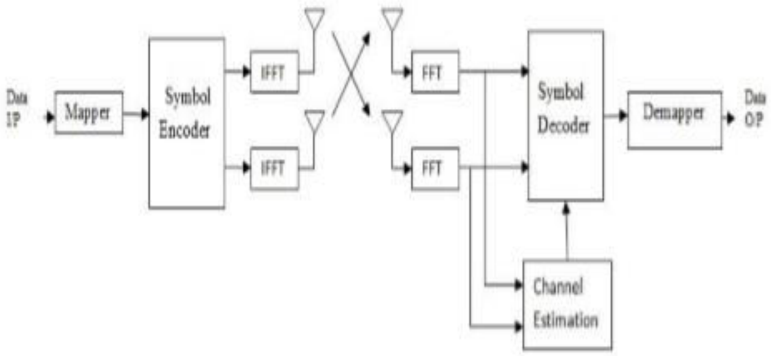

Figure 1: MIMO-OFDM system model

The sequence on each of the OFDM block is then provided to channel estimation block where the received pilots altered by channel are compared with the original sent pilots. Channel estimation block consists of the algorithms that are applied to estimate the channel.

III. LITERATURE REVIEW

Zhitong Xing and others [1], isolated balanced repeat division multiplexing (f-OFDM) is seen as one of the competitor for future compact correspondence because of its versatile limit arrangement for different circumstances. Regardless, the unique handset structure of f-OFDM makes impedance testing extremely challenging, particularly in the uplink with non-ideal synchronization. This review examines the uplink obstruction of f-OFDM frameworks under non-ideal synchronization; taking into account the transporter recurrence offset (CFO) and timing offset (TO) of numerous client equipment (UE). A few sub-impedances separate the obstruction. After inferring the close structure articulations of each sub-obstruction and its distinction, reproductions are used to validate the inferences. First, the effects of non-ideal variables and framework boundaries like CFO, TO, watch band (GB), and subcarrier dividing (SCS) on the uplink impedance of f-OFDM frameworks are reproduced and examined on the basis of the inferred shut structure articulations. This study is affirmed by automatic encounters, and the speculative derivation of hindrance agrees with the multiplication result. Second, previous f-OFDM frameworks utilized Hanning window channels, which resulted in piece blunder rate (BER) awkwardness between subgroups. Accordingly, the effect of waveform channel on

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the impedance and BER is similarly analyzed in this assessment. Results show that ideal hindrance and BER displays over Hanning window channels can be gotten by using reasonable channel settings. Plus, a couple of channel design rules are shut. By and large, the assessment and reenactments uncover various normal impedance ascribes of f-OFDM, which will help the future f-OFDM system plans.

Ebubekir Memisoglu and Associates [2], due to its numerous advantages, OFDM will probably continue to be utilized in previous 5G (B5G) correspondence frameworks in addition to being sent in 5G frameworks. However, the high top-to-average power proportion (PAPR) of OFDM systems is a major drawback, particularly when transmitting large amounts of data. A regularization improvement based adaptable cross breed companding and cutting plan (ROFHCC) for reducing PAPR in OFDM frameworks is presented in this paper. The companding capacity has two sections to simplify the plan. It restricts the sign examples with amplitudes greater than a predetermined value to a consistent incentive for both low power pay and peak power loss. For signals with tests under a given sufficiency, they are stretched out by a direct companding limit. For bit error rate (BER) and power unearthly thickness (PSD) execution, we develop a regularization enhancement model to mutually improve the companding contortion as well as the congruity of the companding capacity. The reproduction results show that the proposed companding plan outperforms the referred to companding plans for the same PAPR execution. For example, when the typical sign power is normalized to be 1, we pick both PAPR for ROFHCC plan and two-piecewise companding (TPWC) scheme as 4 dB, then, we can find that at BER=10 - 4 , the base required E b/N 0 for ROFHCC plot is around 2.3 dB lower than TPWC contrive.

J. Yli-Kaakinen et al. [3], this paper proposes a generalized model and methods for fast-convolution (FC)-based waveform generation and processing with specific applications to fifth generation new radio (5G-NR). Following the progress of 5G-NR standardization in 3rd generation partnership project (3GPP), the main focus is on subband-filtered cyclic prefix (CP) orthogonal frequency-division multiplexing (OFDM) processing with specific emphasis on spectrally well localized transmitter processing. Subband filtering is able to suppress the interference leakage between adjacent subbands, thus supporting different numerologies for so-called bandwidth parts as well as asynchronous multiple access. The proposed generalized FC scheme effectively combines overlapped block processing with time- and frequency-domain windowing to provide highly selective subband filtering with very low intrinsic interference level. Jointly optimized multi-window designs with different allocation sizes and design parameters are compared in terms of interference levels and implementation complexity. The proposed methods are shown to clearly outperform the existing state-of-the-art windowing and filtering-based methods.

H. Chen et al. [4], filtered orthogonal frequency division multiplexing (f-OFDM) is considered one of the candidates for future mobile communication because of its flexible parameter configuration for different scenarios. However, the interference analysis of f-OFDM is considerably challenging due to its special transceiver structure, especially in the uplink with non-ideal synchronization. The uplink interference of f-OFDM systems under non-ideal synchronization, in which carrier frequency offset (CFO) and timing offset (TO) of multiple user equipment (UE) are considered, is investigated in this study. The interference is classified into several sub-interferences. The closed-form expressions of each sub-interference and its variance are first derived, and then verified via simulations. On the basis of the derived closed-form expressions, first, the influences of non-ideal factors and system parameters, such as CFO, TO, guard band (GB), and subcarrier spacing (SCS), on the uplink interference of f-OFDM systems, are simulated and analyzed. This study is verified by computer simulations, and the theoretical derivation of interference agrees with the simulation result. Second, Hanning window filters are employed by previous f-OFDM systems, resulting in bit error rate (BER) imbalance between sub-bands. Hence, the effect of waveform filter on the interference and BER is also investigated in this research. Results indicate that better interference and BER performances than Hanning window filters can be obtained by employing reasonable filter settings. Furthermore, several filter design rules are concluded. Overall, the analysis and simulations reveal many intrinsic interference characteristics of f-OFDM, which will benefit the future f-OFDM system designs.

C. B. Barneto et al. [5], this paper studies the processing principles, implementation challenges, and performance of OFDM-based radars, with particular focus on the fourth-generation Long-Term Evolution (LTE) and fifth-generation (5G) New Radio (NR) mobile networks' base stations and their utilization for radar/sensing purposes. First, we address the problem stemming from the unused subcarriers within the LTE and NR transmit signal passbands, and their impact on frequency-domain radar processing. Particularly, we formulate and adopt a computationally efficient interpolation approach to mitigate the effects of such empty subcarriers in the radar processing. We evaluate the target detection and the corresponding range and velocity estimation performance through computer simulations, and show that highquality target detection as well as high-precision range and velocity estimation can be achieved. Especially 5G NR waveforms,

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through their impressive channel bandwidths and configurable subcarrier spacing, are shown to provide very good radar/sensing performance. Then, a fundamental implementation challenge of transmitter–receiver (TX–RX) isolation in OFDM radars is addressed, with specific emphasis on shared-antenna cases, where the TX–RX isolation challenges are the largest. It is confirmed that from the OFDM radar processing perspective, limited TX– RX isolation is primarily a concern in detection of static targets while moving targets are inherently more robust to transmitter self-interference. Properly tailored analog/RF and digital selfinterference cancellation solutions for OFDM radars are also described and implemented, and shown through RF measurements to be key technical ingredients for practical deployments, particularly from static and slowly moving targets' point of view.

A. S. Rajasekaran et al. [6], Sparse code multiple access (SCMA) is a non-orthogonal multiple access (NOMA) uplink solution that overloads resource elements (RE's) with more than one user. Given the success of orthogonal frequency division multiplexing (OFDM) systems, SCMA will likely be deployed as a multiple access scheme over OFDM, called an SCMA-OFDM system. One of the major challenges with OFDM systems is the high peak-to-average power ratio (PAPR) problem, which is typically studied through the PAPR statistics for a system with a large number of independently modulated sub-carriers (SCs). In the context of SCMA systems, the PAPR problem has been studied before through the SCMA codebook design for certain narrowband scenarios, applicable more for low-rate users. However, we show that for high-rate users in wideband systems, it is more meaningful to study the PAPR statistics. In this paper, we highlight some novel aspects to the PAPR statistics for SCMA-OFDM systems that is different from the vast body of existing PAPR literature in the context of traditional OFDM systems. The main difference lies in the fact that the SCs are not independently modulated in SCMA-OFDM systems. Instead, the SCMA codebook uses multi-dimensional constellations, leading to a statistical dependency between the data carrying SCs. Further, the SCMA codebook dictates that an UL user can only transmit on a subset of the available SCs. We highlight the joint effect of the two major factors that influence the PAPR statistics - the phase bias in the multi-dimensional constellation design along with the resource allocation strategy. The choice of modulation scheme and SC allocation strategy are static configuration options, thus allowing for PAPR reduction opportunities in SCMA-OFDM systems through the setting of static configuration parameters. Compared to the class of PAPR reduction techniques in the OFDM literature that rely on multiple signalling and probabilistic techniques, these gains come with no computational overhead. In this paper, we also examine these PAPR reduction techniques and their applicability to SCMA-OFDM systems.

Z. Xing et al. [7], the μ-law companding function has been applied widely in orthogonal frequency division multiplexing (OFDM) to reduce the peak-to-average power ratio (PAPR). However, nonlinear distortion caused by the μ-law companding function is considered a key impairment in OFDM communication systems. Few studies have addressed theoretical nonlinear distortion caused by μ-law companding function for OFDM systems. In this paper, we derive a closed-form expression of signal distortion as well as the closed-form bit error rate (BER) of OFDM system caused by the μ-law companding function. Based on the theoretical signal distortion and BER expression, the theoretical BER value and signal distortion value can also be calculated, which can guide us to choose appropriate μ value for different BER condition and bit-to-noise (Eb/Nö) condition efficiently. Then the PAPR performance can also be predicted. The results show good agreement on the Monte-Carlo simulation results and the obtained theoretical BER results.

IV. PAPR REDUCTION TECHNIQUE

In wireless communication systems, mitigating the Peak-to-Average Power Ratio (PAPR) is crucial to avoid power inefficiency and distortion in signal transmission. Several PAPR reduction schemes have been developed to address this challenge. This section provides a detailed exploration of various PAPR reduction techniques, each designed to enhance the efficiency and reliability of signal transmission.

1. Selected Mapping (SLM):

Selected Mapping is a widely used technique that involves generating multiple versions of the same signal with different phase sequences. The version with the lowest PAPR is selected for transmission. Mathematically, this can be expressed as:

$$x_m[n] = x[n].\, e^{j\theta_m}$$

Where, $x_m[n]$ is the modified signal, $x[n]$ is the original signal, and $\theta_m$is a random phase.

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2. Partial Transmit Sequence (PTS):

PTS divides the signal into non-overlapping blocks, and different phase sequences are applied to each block. The combination with the lowest PAPR is selected. Mathematically, this is represented as:

$$x_{PTS}[n] = \sum_{i=0}^{N-1} x_i[n]$$

Where $x_i[n]$ is the signal with phase sequence i and N is the total number of phase sequences.

3. Clipping and Filtering:

Clipping involves limiting the amplitude of high peaks in the signal, followed by filtering to mitigate distortion. This technique can be expressed as:

$$x_{clipped}[n] = \begin{cases} x[n] & if\ |x[n]| \leq \alpha \\ \alpha e^{j arg(x[n])}, & if\ |x[n]| > \alpha \end{cases}$$

Where α is the clipping threshold

4. Tone Reservation (TR):

TR reserves specific tones in the signal to cancel or suppress high peaks. Mathematically, this can be described as:

$$x_{TR}[n] = x[n] + \beta r[n]$$

Where r[n] is the reserved signal and β is the scaling factor.

5. Active Constellation Extension (ACE):

ACE modifies the constellation points by adding extra points to the constellation diagram. This extension creates additional space for signal representation, reducing PAPR. Mathematically, this involves adjusting the signal constellation points.

6. Geometric Signal Constellation Techniques:

Various geometric shaping techniques optimize the signal constellation geometry to inherently reduce PAPR. This can involve altering the arrangement of constellation points in the complex plane.

V. CONCLUSION

The summation of subcarriers could result in a sign with very large amplitude or one with very small amplitude, depending on the user data. Therefore, the signal's peak power is much higher than the average power. A nonlinear power amplifier creates out-of-band radiations due to the high PAPR. This would result in low power conversion efficiency in the transmit power amplifier if it were operated in the linear region. Furthermore, the multicarrier modulation OFDM has been replaced by MIMO-OFDM, reducing the transmit signal's PAPR value. The shortcomings of the pre-existing PAPR reduction drove the need for innovative and effective PAPR reduction strategies.

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