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# PAPR reduction in Massive MIMO system using Hybrid SLM and ZCT Technique

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*Abstract:* **The future wireless communication systems are expected to completely revolutionize the society and user experience by providing the key services like deviceto-device communication, augmented reality, autonomous vehicles, smart homes, smart cities, smart wearable devices, smart healthcare, machine-to-machine communication, smart agriculture, industrial IOT and many more. To implement all these services, the capacity of the system has to increase exponentially. The 5 th Generation communication system is considered as the key technology enabler for enhancing the system capacity with uninterrupted connectivity and seamless service quality. The capacity of the system can be boosted by increasing the system bandwidth, therefore the use of millimeter wave spectrum is recommended for utilizing the full potential of large available bandwidth but associated heavy path losses due to environmental absorption are one of the prime challenges to be addressed. In this paper a hybrid SLM and ZCT for a MIMO-OFDM system with eight, sixteen and thirty two antennas has been proposed as a means of achieving superior PAPR performance. The simulation results demonstrate that the proposed method outperforms the prior technique in terms of PAPR reduction.**

*Index Terms –* ***Discrete Cosine Transform (*DCT), Zadoff Chu Matrix transform (ZCT), Massive System, PAPR**

## I. INTRODUCTION

Wireless communication technology has witnessed significant improvements especially in the past decade, as new services and applications were launched and continuously being launched at increasing pace. To effectively utilize these new services and applications, the seamless wireless connectivity has turned into an essential piece of our life. The community has already observed the revolution in streaming media and because of it services like cable TV, music/movies on demand and many more applications. In addition, the new services/applications of smart cities, smart healthcare, smart wearables, connected vehicles, intelligent transportations, connected machines, augmented reality, industrial IOT will need the uninterrupted wireless services almost on every corner of the world [1]. Consequently, the capacity of the system has to increase at exponential pace and the next generation 5G communication system is considered as the key technology enabler for enhancing the system capacity with uninterrupted connectivity and high service quality. The industry experts as well as academicians/researchers in the communication field form all parts of the world are inspecting various technical aspects of upcoming wireless networks to meet the requirements of data traffic in near future. This exponential growth in data traffic can be met by increasing the capacity of the system. The capacity can be enhanced by increasing the bandwidth or the Signal to Noise ratio or both [2]. Only marginal improvements can be delivered by improving SNR. Thus increasing bandwidth seems optimal solution and it can be said that the next step towards the 5G technology is the use of millimeter Waves. The before said statement is concluded by a number of authors [3, 4]. Therefore, with reference to previously done work in [5, 6], it can be said that the usage of millimeter Wave spectrum, large antenna arrays and beamforming will lead the probable advancement of existing cellular networks. Therefore, from the facts discussed above it can be said that there are several good reasons to have insights of massive MIMO developments in millimeter Wave Spectrum to meet growth in data traffic.

## II. BACKGROUND

Industry experts as well as academicians/researchers in the communication field form all parts of the globe are working for increasing system capacity to meet the demands of new services with increased amount of data exchange, uninterrupted connectivity and seamless service quality. The three predominant design aspects listed as under are currently under investigation by industry experts to realize anticipated increase in system capacity as compared to current wireless standard.

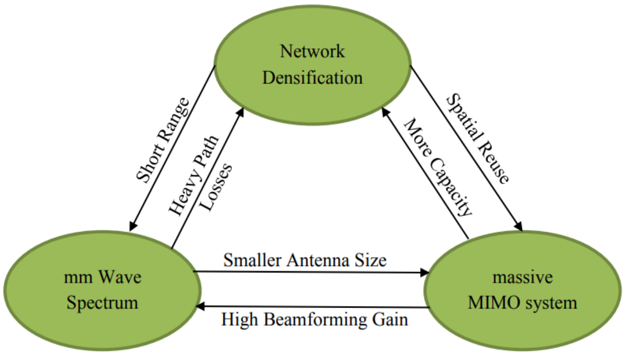


Figure 1: Relation between Three-design Aspects for Upcoming Wireless Communication Systems

- Millimeter Wave Spectrum - Shift towards higher available bandwidth
- Massive MIMO and Beamforming. - Higher Spectral Efficiency
- Small Cells - Network densification to overcome heavy path losses

The before stated three predominant design characteristics are technically interconnected with each other in several ways. The drift towards millimeter Waves will facilitate the utilization of reasonably large available bandwidth in licensed as well as unlicensed spectrum to realize anticipated system capacity. As millimeter Waves has relatively much shorter wavelengths, because of it the physical dimensions of an antenna and hence the antenna array will reduce significantly. Consequently, we will be able to fabricate the relatively large number of antenna elements in comparatively smaller physical dimensions and encourages for the utilization of large dimensional massive MIMO systems. In addition, the Small Cell Technology [3, 4] will enable us to conquer with hefty path losses linked with millimeter Wave communication. Industry experts/Academicians/Researcher are working on all three design aspects to realize anticipated increase in system capacity for 5G and other upcoming wireless communication applications/standards. The figure 1 presents a symbolic view of the evolution of associated user services from 2G to 5G.

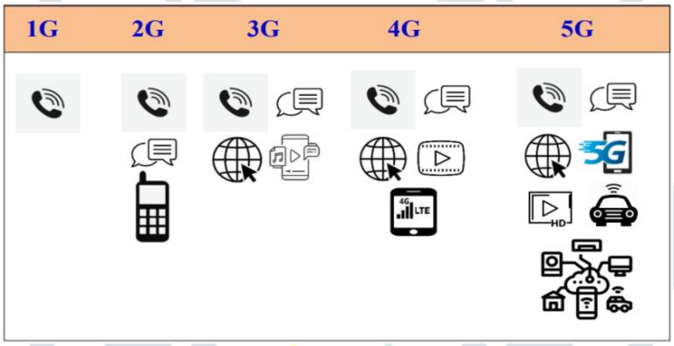


Figure 2: Evolution of Services form 2G to 5G

The upcoming wireless communication applications/standards targets both public and private sectors. These also support diverse nature of devices and associated technologies.

## III. SCHEMES FOR SLM

According to the SISO-SLM scheme [11]

$$X = \sum_{v=1}^{M} X_v \quad (1)$$

The new frequency sequence can be obtained by multiplying a few weighting coefficients on all of the subcarriers in each subblock.

$$X' = \sum_{v=1}^{M} b_v X_v \quad (2)$$

Finally, the candidate sequence with the lowest PAPR is selected for transmission at each transmitting antenna, where (V-1) sub blocks need to be optimized. Assume that there are W phase weighting factors that can be used. Combinations should be checked to get the minimum PAPR in order to get the best weighting factors for each transmitting antenna [5, 6].

This means that phase weighting factors are optimized only for the remaining subblocks, which reduces computational complexity, beginning with the first subblock. PAPR performance suffers as a result.

The optimal weighting coefficient conversion is then discussed. We should use the inverse conjugate and symmetric transformation to change for antennas 2 is b (opt) = [1, 1, -j, j] when the optimal weighting coefficient for a (opt) is [1, 1, j, -j]. With more transmit antennas, the MIMO-OFDM system can also use the SLM scheme.

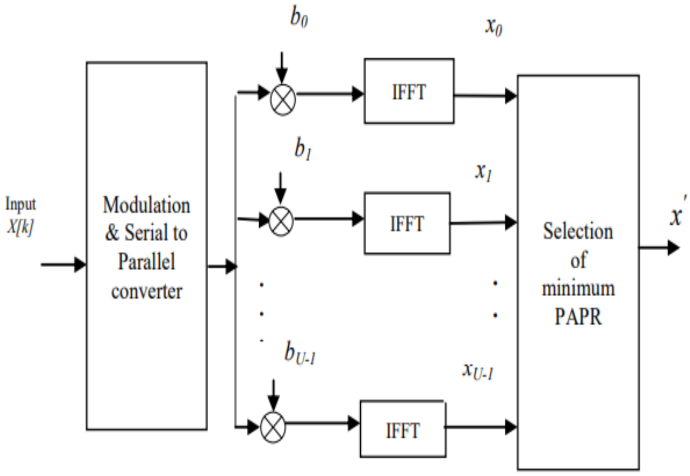


Figure 3: Diagram of Schemes for SLM

An approach to reconciling the STBC MIMO-OFDM system's PAPR performance and computational complexity is proposed on the basis of advanced PTS. Let's take a look at an Alamouti-based STBC MIMO-OFDM system. This is the coding matrix:

$$G = \begin{pmatrix} x_1 & -x_2^* \\ x_2 & x_1^* \end{pmatrix} \quad (3)$$

Using the SLM technique, simulation experiments are carried out to evaluate the MIMO-OFDM scheme's transmit spectrum, bit error rate (BER), and peak average to peak ratio (PAPR) reduction performance.

The fundamental principle of OFDM is the division of bandwidth use into numerous subcarriers. Data rates also rise as the system becomes more resistant to frequency selective fading as the number of subcarriers increases. However, the system's complexity and symbol lengths increase when the number of subcarriers is increased arbitrarily, making transmission extremely susceptible to the timing incoherence of the channel. OFDM wireless communication technologies require a large number of sub-carriers to meet their requirements, including 512, 2048, and 8192 sub-carriers, for greater data rates and portability. PAPR will rise as a result of a higher proportion of sub-carriers, but computing complexity will also rise significantly.

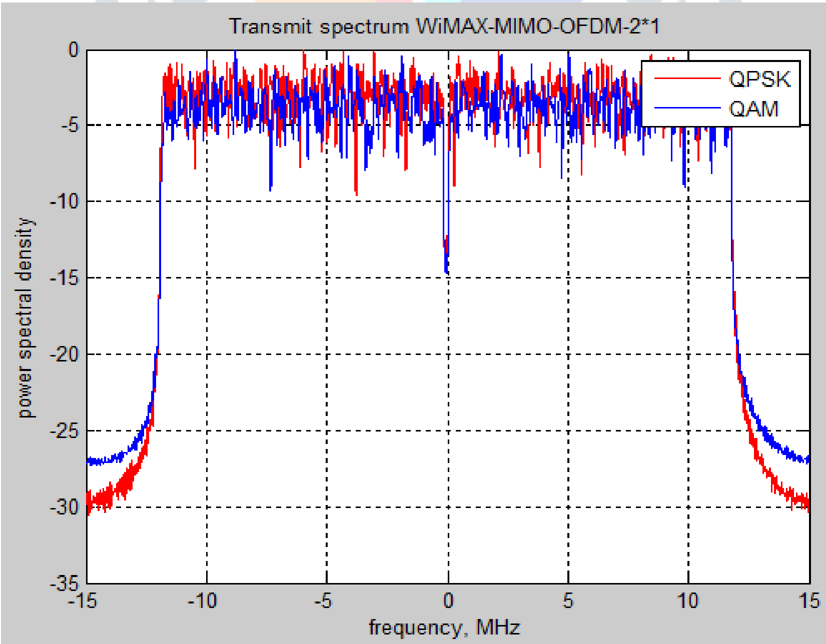


Figure 4: Density of 2×2 MIMO Systems

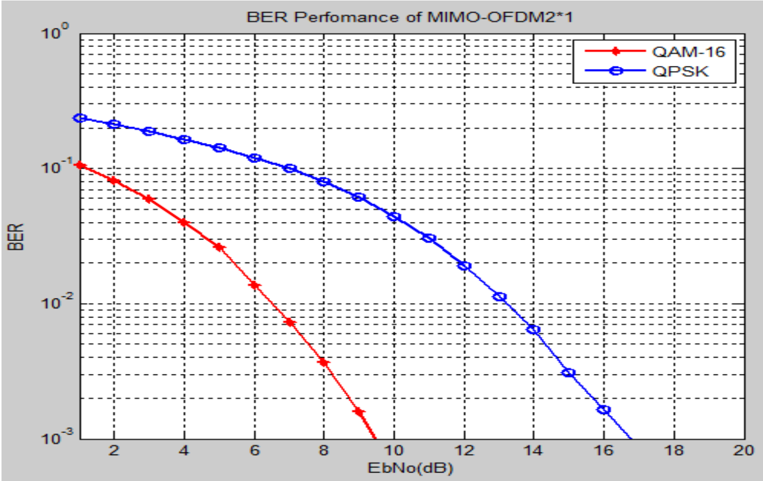


Figure 5: BER of 2×1 MIMO Systems

Probabilistic methods have become more sophisticated as the number of sub-carriers has grown.
This study aims to develop an efficient PAPR reduction strategy that also reduces computing complexity [7, 8]. In addition, maintaining the high data rate of the program is one of the objectives of the suggested strategy. For instance, conventional schemes and combinational techniques (parallel or in series structure) result in a significant reduction in PAPR while simultaneously increasing the computing complexity of the system. Consequently, a brand-new hybrid system is needed.

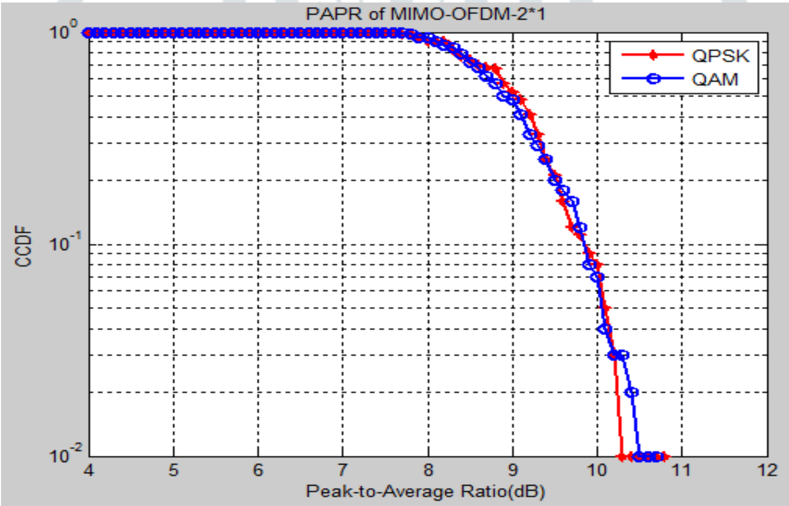


Figure 6: PAPR of 2×1 MIMO Systems

## IV. PROPOSED METHODOLOGY

One of OFDM systems' primary drawbacks remains the transmitting signal's high PAPR. Because it reduces the SNR of the ADC and DAC and reduces the effectiveness of the transmitter's power amplifier, its high PAPR is one of the most damaging aspects. The PAPR problem is especially bad in the uplink, where the power amplifier's performance is especially important because the mobile tower only has so much storage space.
PAPR reduction strategies have been proposed to address these issues. In this paper, hybrid PAPR reduction strategies and computationally efficient PAPR reduction strategies are planned and developed using MATLAB.

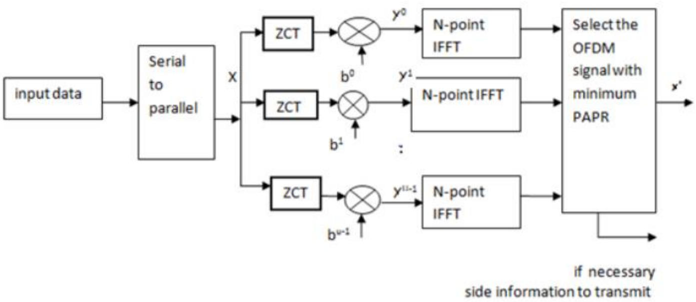


Figure 7: Diagram of Proposed Methodology

The SLM technique is an optimized algorithm is used to generate the phase values. This helps reduce the input signal's PAPR. Following that, the ZCT which is transmitted over the AWGN channel, is used. The transmitter will be inverted at the receiver.

The enhanced transmitter block diagram of the presented work is depicted in Figure 7. For the purpose of reducing PAPR, the SLM and ZCT are used first, followed by conventional OFDM, and the reverse is simulated. In order to calculate the BER, both the transmitter and the receiver are simulated.

## V. SIMULATION RESULT

For statistical pair of view is both equal to zero is what is referred to as the CCDF.

$$PAPR\{Y\} = \arg \underbrace{\max}_{k=1,2,3,\ldots\ldots N_T} (PAPR\{Y_k\})$$

Where, denotes the k-th antenna's time-domain transmitted signal.

$$CCDF(PAPR_0) = \Pr(PAPR\{Y\} > \{PAPR_0\})$$

QAM-16 offers the most efficient PAPR when compared to BPSK. Zhitong Xing et al. [1] provide a 3.9 dB PAPR for companding methods, 4.3 dB PAPR for HCC, FHCC and MHCC methods. Ebubekir Memisoglu et al. [2] provide a 10.8 dB PAPR for numerology =1, 9.9 dB PAPR for numerology<1 and 10.9 dB PAPR for numerology>1. The proposed method provides 7.8 dB PAPR of QAM-16, 9.8 dB PAPR of QPSK and 10.1 dB PAPR of BPSK. Clearly, the proposed methods represent a 41.41% improvement over Ebubekir Memisoglu et al. [2].

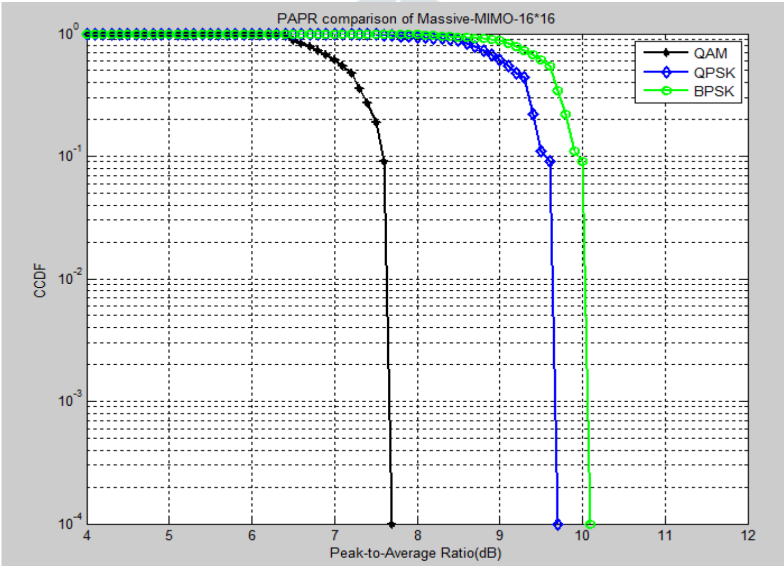


Figure 8: Estimating the PAPR of a Massive 16×16 System using ZCT and SLM

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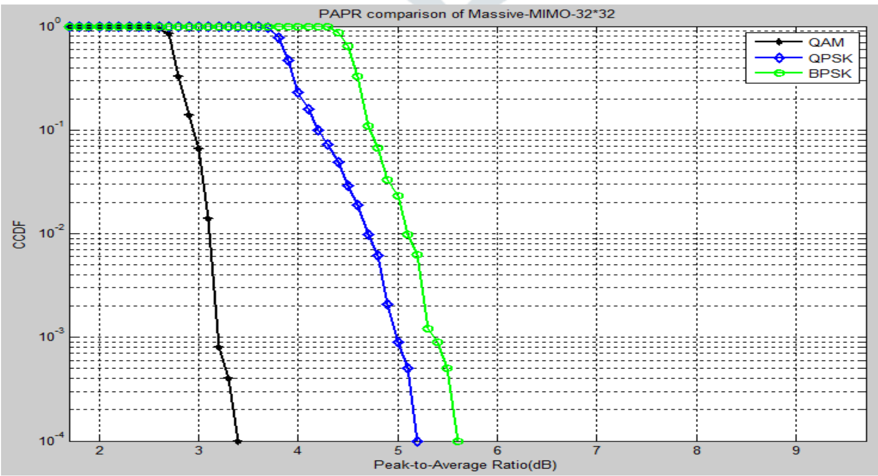


Figure 9: Estimating the PAPR of a Massive 32×32 System using ZCT and SLM

## VI. CONCLUSION

The prime aim of the research work carried in the thesis is to propose an optimal hybrid beamforming technique for millimeter Wave massive MIMO systems with respect to spectral efficiency and computational complexity. The optimal hybrid beamforming technique is key enabler technology for future wireless communication systems. The future wireless communication systems are expected to completely revolutionize the user experience by providing the key services like device-to-device communication, augmented reality, autonomous vehicles, smart homes, smart cities, smart wearable devices, smart healthcare, machine-to-machine communication, smart agriculture and industrial IOT. Community has already experienced the revolution in streaming media, video on demand, cable TV and high-speed broadband. A PTS-based approach is proposed in this paper to minimize PAPR in MIMO-OFDM systems. In order to make the MIMO-OFDM system more effective and reduce peak power, the SLM is joined to the ZCT processing algorithm.

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