Hybrid Tone Reservation Approach for Reduction of PAPR in MIMO-OFDM System

Sunkari Sridhar, R. P. Singh

Abstract**: *OFDM is a system in which information stream at high rates are separated into many low information streams for synchronous transmission of information in a channel. It is one of the powerful methods utilized for fast transmission of information over a correspondence channel. It is a modulation method. The primary constraint of OFDM system is high Peak-to-Average Power Ratio (PAPR). So keeping in mind the end goal to accomplish low complexity PAPR, there is a need to apply a successful method on these systems. In this research paper, a hybrid approach is connected for the lessening of PAPR in OFDM systems. The techniques connected are Tone Reservation-clipping based and Partial Transmit Sequence.***

Index Terms**: *Peak-to-Average Power Ratio, Partial Transmit Sequence, OFDM system, Tone Reservation-clipping.***

I. INTRODUCTION

Orthogonal Frequency-Division Multiplexing (OFDM) is a method that is being utilized broadly and is an appealing system for transmission of high information rate over a correspondence channel. Inverse Fast Fourier Transform (IFFT) and FFT are being utilized so modulators and demodulators introduce in OFDM systems can be executed to make the system more proficient and successful. OFDM systems are being utilized as a part of 3G, 4G and 5G communications of mobile. In a communication channel, information is being modulated into a solitary carrier frequency. The conceivable data transfer capacity is being secured by every symbol. This kind of system will prompt ISI (inter-symbol-interference). In OFDM, the accessible spectrum is isolated into various orthogonal sub-channels and these channels will encounter a level fading. Information rates are huge in OFDM systems and are having adequate robustness. There are particular groups working for the enhancement of OFDM systems [1].

In a specific OFDM system, considerably number of orthogonal signals and thin sub carriers are being transmitted parallel. The accessible data transfer capacity to be transmitted is partitioned by the carriers. The sub carriers are isolated such that unearthly usage is extremely minimized. Sub channels can cover in a frequency domain which will build the transmission rate in an OFDM system. Henceforth it enhances transfer speed productivity and bandwidth efficiency. Limit of the system is likewise expanded so dependable transmission is given. The thought behind OFDM system is to isolate information stream of high rate into various information floods of low rate in order to transmit these information streams all the while over various sub carriers [2]. Covering of sub carriers to each other is there. By presenting a guard time ISI is totally evacuated. One of the significant issues in OFDM systems is high Peak to Average Power proportion (PAPR).

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II. PAPR IN OFDM

High PAPR is an issue in OFDM systems, which is an after effect of aggregate of sine waves and a non-consistent envelope. Huge PAPR will bring down the effectiveness of radio frequency (RF) power amplifier and will build the many-sided quality of Digital to Analog convertor (DAC). In a large linear region, RF power amplifiers are worked. Signal contortion is there when signals enter a non-linear area. This bending brings about inter modulation of sub carriers and out of band radiation. In the event that the PAPR is low at that point power amplifier will work proficiently. On the off chance that the PAPR is high then the signal peak will move into a non–linear area which will bring about low effectiveness of RF power amplifier. In the event that the estimation of the PAPR is high then the estimation of DAC determination and ADC determination will be high at the transmitting end and the less than receiving end at the same time. Any non-linearity will prompt distortion like ISI and ICI (inter-carrier-interference). Effectiveness of PAPR can be measured utilizing Cumulative Distribution Function (CDF). CCDF (complementary CDF) is utilized typically to measure productivity of PAPR when it overcomes the point of threshold. The Peak to Average Power Ratio (PAPR) might be characterized as the square of peak value divided by the square of root mean square value [3].

Crest factor C is defined as modulus of signal peak $|X|_{peak}$ divided by rms value of the signal X_{rms}.

$$C = \frac{|X|_{peak}}{X_{rms}} \quad (1)$$

$$PAPR = \frac{|X|_{peak}^2}{X_{rms}^2} = C^2 \quad (2)$$

Crest factor and Peak to Average Power Ratio (PAPR) are dimensionless quantities and are equal when these are expressed in decibels (dB).

III. ISSUES WITH EXISTING SYSTEM

In the wireless communication system, Orthogonal Frequency Division Multiplexing is one of the generally utilized modulation methods.

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In OFDM the subcarriers are utilized to transmit data signal OFDM signal is having low noise, has high spectral efficiency and low non-linear contortion, because of all these it give high information rates, adequate strength and robustness. It additionally gives low implementation complexity nature [17].

OFDM is very profitable strategy yet it has some constraint likewise, that is the high peak-to-average power ratio (PAPR) of transmitted signal because of the superposition of numerous subcarriers. This issue can be measured as the PAPR. At the receiver side the signal the output that is received is non-uniform because of rise in PAPR. This leads to saturation in power amplifier and quality of the signal is degrades. So there is need to PAPR should be reduced. It can likewise cause numerous issues in the OFDM system at the transmitting end. In the analog to digital and digital to analog converter of the signal the gain is reduced and there is increase in computational complexity.

To reduce the PAPR, earlier different types of techniques have been proposed, like PTS, Clipping, SLM, filtering, coding [10]-[13] and so forth, however were not that much effective. A large portion of these strategies can't accomplish at the same time a substantial decrease in PAPR as its intricacy and coding overhead is low and there is no corruption in the performance[4]-[6]. These procedure accomplished PAPR decrease to the detriment of the transmit signal power increment, increment in bit error rate (BER), loss of information rate; increment in computational unpredictability [7]-[9], [14]. A technique must be discovered that could reduce the impact of PAPR. As this is one of the real issues of the OFDM modulation method, new techniques should be proposed to decrease its effect.

IV. PROPOSED TECHNIQUE

In OFDM modulation, the huge peak to average power ratio (PAPR) of transmitted signal because of the superposition of numerous subcarriers is one of the major issues. The quality of the signal is degraded because of rise in PAPR; also the analog to digital and digital to analog converter there is increase in computational complexity. So there is a need to reduce the impact of PAPR, many methods or techniques have been proposed for decreasing PAPR, at various levels of unpredictability and achievement. Numerous techniques like clipping, SLM, PTS, filtering etc., were proposed however these techniques accomplish PAPR decrease at the cost of transmit signal power increment, increment in BER and computational complexity and also degrade in loss of data rate so on. So there have to propose some different methods that can reduce PAPR, as it were, by concentrate past PAPR decrease strategies, another technique is proposed in this research paper.

In this research paper the main idea of combination of Partial Transmit Sequence and TR-clipped Based Technique is used to reduce PAPR and also minimization of Computational complexity.

A. Partial transmit Sequence (PTS)

In an OFDM system, PAPR is decreased utilizing Partial Transmit Sequence (PTS). Fig.1 shows the conventional Partial Transmit Sequence technique. In this, the data block is furnished with a contribution to X which is separated into various disparate sub-blocks M and is represented as [14]

$$\{X^{(m)}, m=0,1,\ldots\ldots M-1\} \qquad (3)$$

Hence

$$X = \sum_{m=0}^{M-1} X^{(m)} \qquad (4)$$

Where $X^{(m)} = [X_0^{(m)} X_1^{(m)} \ldots \ldots .. X_{N-1}^{(m)}]$ with $X_k^{(m)} = X_k$ or 0 ($0 \leq m \leq M-1$). PTS can be grouped into three classifications: adjacent portioning, interleaved partitioning and pseudo random partitioning. The sub blocks are changed over into M time domain PTS. These are represented as

$$X^{(m)} = [X_0^{(m)} X_1^{(m)} \ldots \ldots .. X_{LN-1}^{(m)}] = IFFT_{LN*N}[X^{(m)}] \qquad (5)$$

These sequences independently rotate by phase factors (b). Here b is given by

$$b = b_m = e^{j\theta}{}_m \text{ where } m= \{0, 1 \ldots .M-1\} \qquad (6)$$

The main aim is to obtain low PAPR by combining the M sub blocks optimally.

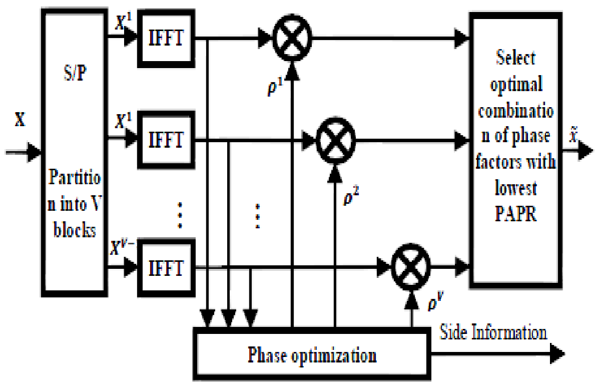

Fig.1: Block diagram of PTS [16].

B. Tone Reservation

In Tone Reservation [15] - [16], transmitter and receiver will hold a subset of tones with the goal that reducing PAPR signals c can be produced. For transmission of information these tones are not utilized. In this, time domain signal c is discovered with the goal that it can be added to the original time domain signal x as to reduce PAPR. Complex symbols for TR are written to as {c= cn|n = 0, 1… N-1}.

Handling of TR will change information vector to x+c and another modulated OFDM signal will be created.

$$X_v = IFFT(x + c) = X + C \qquad (8)$$

Where C=IFFT (c). Thus, the primary reason for TR is getting the exact estimation of c in order to get the estimation of vector X_v with low PAPR.Fig.2 shows the conventional Tone Reservation Technique.

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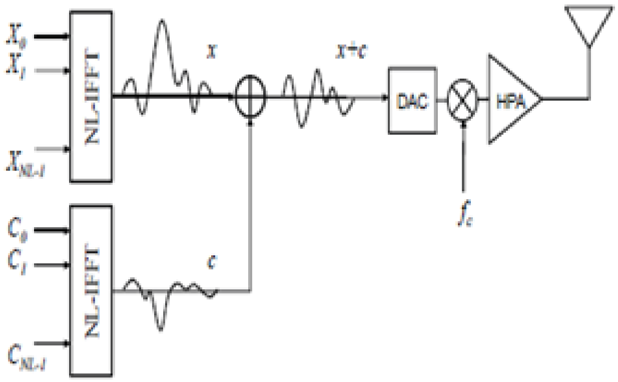

Fig.2 Tone Reservation Method [15].

C. Tone Reservation – Clipped Based Technique

This technique comprises on applying a hard clipping to the input OFDM signal [18]-[19]. At that point, the clipped signal is subtracted from the input signal to acquire the adjustment signal. From that point onward, the adjustment signal or correction signal is passed to a FFT/IFFT filter to agree to the TR idea. The clipping signal can be represented as follows:

$$y_n = \begin{cases} x_n & if \quad |x_n| \le A \\ Ae^{j\phi_n} & if \quad |x_n| \ge A \end{cases} \quad (9)$$

Where $x_n =| x_n | e^{i\varphi n}$ is the signal of input, y_n is the clipping signal and A is the magnitude level of the clipping. The remedy signal is acquired from the contrasts between the samples of the valuable multi-carrier signal x_n and its clipped variant y_n.

$$c_n = x_n - y_n \quad (10)$$

To comply with the TR idea, just the estimations of the reserved tones at the PRT positions are kept, the others are reset to zero, hence:

$$C_k = FFT(C_N) \quad (11)$$

$$\widetilde{C_k} = \begin{cases} C_k \; if & k \in PRT \\ 0 \;\; if & k \notin PRT \end{cases} \quad (12)$$

At every iteration, the calculation refreshes the vector $X_k(X_k = FFT(x_n))$ by adding to it the vector$\widetilde{C_k}$.

$$X_k^{i+1} = X_k^i + \mu\widetilde{C_k} \quad (13)$$

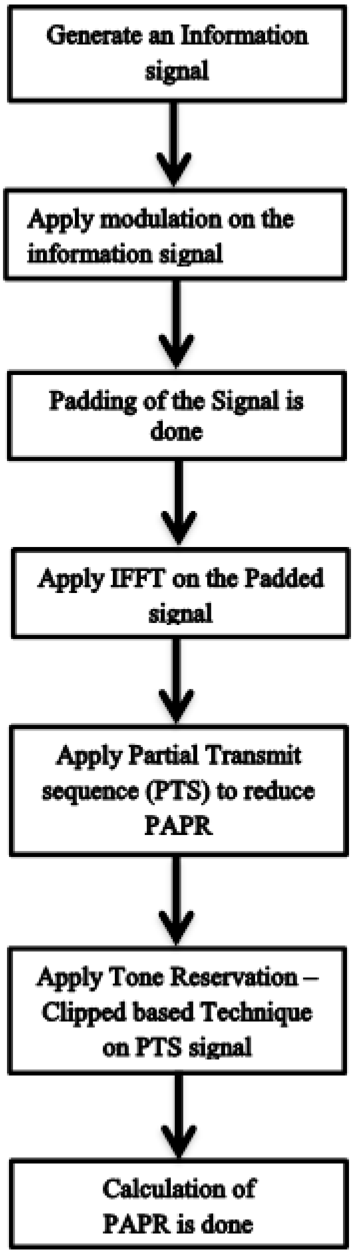

Fig.4 Implementation of flow chart

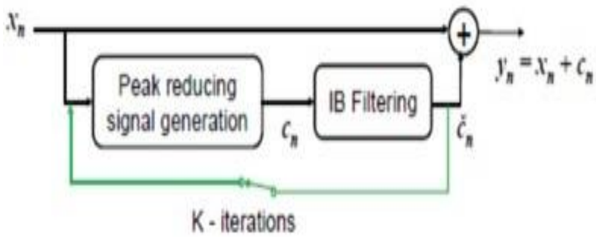

Fig. 3 Tone Reservation- Clipped based technique.

FIG.3 demonstrates the principle of adding signal technique for PAPR decrease with TR-Clipping Based technique. The IB filtering the descending similarity by considering at PRT positions just frequency components of the correction signal by simply limiting the power of the reserved tones.

Fig.4 shows the implementation steps of Hybrid Tone Reservation technique.

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It is the combination of PTS and Tone Reservation-Clipped based technique. .

V. SIMULATION RESULTS

All performances were evaluated based on the CCDF (Complementary Cumulative Distribution Function), which will give the probability PAPR > $PAPR_0$. Simulation results using MATLAB shows that the hybrid technique has better performance in terms of PAPR reduction gain that the original OFDM and conventional TR technique.

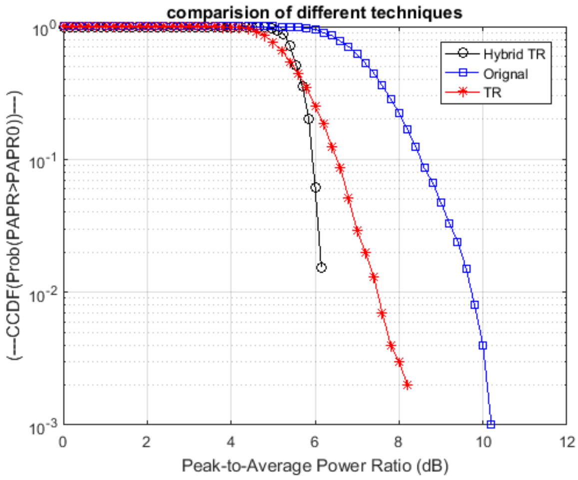

Fig.5 Comparison of Hybrid TR with TR, Orginal OFDM

The advantage of the TR Clipping Based Technique that the updates rule is performed in the frequency domain. Therefore this algorithm can simply incorporate the necessary spectral constraint, by simply limiting the power of the reserved tones. This algorithm evaluates the correction signal c_n . The correction signal is passed to filter based on FFT/IFFT pair in order to comply with the TR concept. The complexity of calculating c_n is very low to the complexity of the filtered correction signal c_n can be omitted $\widetilde{c_n}$.

VI. CONCLUSION

OFDM systems are extremely efficient for wireless communication as their channel is vigorous. Be that as it may, PAPR is considered as a fundamental disadvantage of the OFDM systems. In this paper, noise can be reduced by proposed techniques of particular Partial Transmit Sequence and Tone Reservation clipping Based technique. Hybrid technique is compared with the conventional OFDM and conventional TR scheme. Its performance is measured as far as PAPR reduction. This will accomplish a PAPR decrease of 6.3 dB approximately. The hybrid technique simulation results prove that the PAPR decreased and this technique requires less iterative computation to reach a certain PAPR reduction. By the reduction of complexity of the system will improve the performance of the system. There will be a productive utilization of the correspondence channel and loss of information rate will be low.

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