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ROBUST AND EFFICIENT PAPR REDUCTION FOR OFDM SYSTEM USING OPSIPTS TECHNIQUE

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ABSTRACT

To achieve better performance using multi carrier modulation we should make the subcarriers to be orthogonal to each other i.e. known as the Orthogonal Frequency Division Multiplexing (OFDM) technique. But the great drawback of the OFDM method is its high Peak to Average Power Ratio (PAPR). As we are using the linear power amplifier at the transmitter side so it's operating point will go to the saturation region due to the high PAPR which leads to in-band distortion & out-band radiation. This can be evaded with growing the dynamic range of power amplifier which hints to high cost & high consumption of power at the base station.It is known that the PAPR reduction arrangements can be generallycategorized into two groups, i.e. distortion-less systems such as SLM & PTS & the pre-distortion systems such as clipping & companding. In this Paper, we demonstrate the performance of our proposed OPSIPTS algorithm which has been compared with the existing PAPR reduction approaches using MATLAB simulations. The proposed techniqueexploited traditional Partial transmit sequence technique& we advanceaidea of phase shifting/reversal& interleaving of sequence after dividing the OFDM symbols into sub-blocks.We proved that proposed PAPR reduction perform much better than standard methods like Amplitude clipping, selective mapping, PTS projected in [34] with respect to CCDF.

INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) has received much attention recently because it has high spectral efficiency and is robust against multipath fading [1]. OFDM has been adopted broadly in many modern transmission standards (e.g., IEEE 802.11 a/g/n and IEEE 802.16 [WiMAX]) and in 3GPP LTE/LTE-A systems [2]. However, the high peak-to-average power ratio (PAPR) of output signals is an inherent drawback of OFDM systems. A high-PAPR OFDM signal may result in severe in-band distortion and out-of-band radiation when it passes through a nonlinear device (e.g., a high-power amplifier).

Various PAPR reduction techniques have been proposed for OFDM systems [3], including clipping [4], tone reservation [5], [6], constellation extension [7], [8], selected mapping (SLM) [9]-[11], and partial transmit sequences (PTS) [12]-[18]. In the conventional PTS (CPTS) scheme [12], the input data blocks are divided into M disjoint subblocks. Then, the inverse fast Fourier transforms (IFFT) of the M subblocks are multiplied by various rotation factors and summed to form different candidate signals. The candidate signal with the lowest PAPR is selected and transmitted to the receiver. The CPTS scheme has good PAPR reduction performance for OFDM systems, but also has high computational complexity. In addition, the CPTS scheme must send side information to the receiver to decode the received signal.

Some techniques have been presented to resolve the drawbacks of the CPTS scheme, such as reducing the computational complexity [13]-[16] and eliminating the need to send side information [17], [18]. Among these techniques, the reduced-complexity PTS (RC-PTS) scheme in [15] uses the sample powers of M subblocks to generate cost functions. Only the samples with cost functions greater than or equal to a predefined threshold α are used to estimate the peak power in the optimization process. The RC-PTS scheme successfully reduces the computational complexity of the CPTS scheme; however, a high α degrades the PAPR reduction performance of the RC-PTS scheme.

One of the maindisadvantage of PTS arises from the computation of multiple IFFTs,causing in a high complexity proportional to the number of sub blocks. In an effort to decrease this complexity, intermediate signals within the IFFT using decimation in time (DIT) have been used to attain the PTS sub locks.

It is known that the PAPR reduction systems can be mainly categorized into two groups, i.e. distortion-less systems such as SLM & PTS & the pre-distortion systems such as clipping &$companding$. In this paper, we demonstrate the performance of our projected OPSIPTS algorithm which has been linked with the present PAPR reduction approaches using MALAB simulations. The projectedtechniqueconsumed traditional Partial transmit sequence technique& we progress a notion of phase shifting & interleaving of sequence after separating the OFDM symbols into sub-blocks.

This method is shared with by doing Interleaving &shifting phase for better PAPR reduction. Interleaving efforts to disruption the high correlation between the data symbols in the block. The reduction in the correlation consequences in reduced PAPR. Phase shifting is a supple way for PAPR reduction & it is based on appropriatecollection of time limited waveforms of the different subcarriers. The Phase shifting involves less computational difficulty because of one IFFT/FFT operation in the transceiver. Also, Phase shifting presents controlled inter-channel interference. So, optimum detectors with upright performance can be designed in frequency selective fading channels without any loss in bandwidth proficiency. In the performance assessment of the projected detection algorithm, no oversampling at the transmitter is used because oversampling method is useful for appropriately computing PAPR but has no result on BER unless a HPA is used at the transmitter. To make the scheme simple, the HPA is absent from the transmitter. Additionally, only a stationary channel (i.e., Additive White Gaussian Noise (AWGN) Channel) is measured throughout this simulation. Channel estimation is not accomplished here. The enlighteningstages of this paper are as follow: Chapter II& IIIcontain background of the problem area and existing approaches for PAPR reduction and a thorough literature review of overall PAPR reduction methods in OFDM system. Projected OPSIPTS technique is described in Chapter IV. An overview of simulation consequences along with comparative analysis is shown in Chapter V. And finally, the conclusion & references are pointed in Chapter VI and VII.

BACKGROUND OF PROBLEM AREA

A. *PAPR of OFDM Systems*

In an N-subcarrier OFDM system, the continuous-time signal $x(t)$ of the input data block $\boldsymbol{X} = [X_0, X_1, \dots, X_{N-1}]^T$ can be represented as

$$x(t) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_k e^{j2\pi k \Delta f t}, \quad 0 \le t \le T \qquad \dots. (\mathbf{1})$$

Where,$X_k$represents the data symbol modulated by the kth subcarrier with $0 \le k \le N - 1$, Δf is the frequency difference between subcarriers, and $T = 1/\Delta f$is the symbol duration. The PAPR of $x(t)$ is defined as

$$PAPR = \frac{\max_{0 \le r \le T} |x(t)|^2}{E[|x(t)|^2]} \qquad \dots \mathbf{(2)}$$

Where,$E[\,]$ is the expected value operator. The discrete-time OFDM signal $x = [x_0, x_1, \dots, x_{N-1}]^T$of $\mathbf{X}$ is generated by sampling $x(t)$ at the Nyquist rate N/T, represented by

$$x_n = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_k e^{\frac{j2\pi kn}{N}}, n = 0,1, \dots, N-1 \qquad \dots \mathbf{(3)}$$

Which is easily implemented by an N-point IFFT. In general, L = 4 times oversampling is adopted to obtain $x_n$in PAPR reduction methods to approximate the PAPR of $x(t)$ [6].

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***B.** Conventional PTS Scheme*

In the conventional PTS (CPTS) scheme, the input data block **X** is partitioned into M disjoint subblocks evenly [12]. The mth subblock$\boldsymbol{X_m} = [\boldsymbol{X_{m,0}}, \boldsymbol{X_{m,1}}, \dots, \boldsymbol{X_{m,N-1}}]^{\boldsymbol{T}}$, 1≤ $m \leq M$, has N/Mnonzero elements. $\boldsymbol{X_m}$is multipliedby a rotation factor b_m^c selected from the set $\{e^{j\theta_i} \mid i = 0,1,\dots,W-1\}$ with Welements and then summed to form a new candidate signal $\boldsymbol{X^c}$, expressed as

$$X^c = \sum_{m=1}^{M} b_m^c X_m = [X_0^c, X_1^c, \dots, X_{N-1}^c]^T, 1 \leq c \leq C \dots \textbf{(4)}$$

Where,C ($\leq W^M$) is the number of candidate signals. The discrete-time domain signal of $\boldsymbol{X^c}$, i.e., $\boldsymbol{x^c} = IFFT\{\boldsymbol{X^c}\}$, $1 \leq c \leq C$, is expressed as

$$\begin{aligned}\boldsymbol{x^c} &= IFFT\{\sum_{m=1}^{M} b_m^c X_m\} \\ &= \sum_{m=1}^{M} b_m^c IFFT\{X_m\} \\ &= \sum_{m=1}^{M} b_m^c x_m \\ &= [x_0^c, x_1^c, \dots, x_{N-1}^c]^T. \end{aligned} \quad \dots \textbf{(5)}$$

Where,$x_m = [x_{m,0}, x_{m,1}, \dots, x_{m,N-1}]^T$ is the discrete-time domain signal of $\boldsymbol{X_m}$. Let $b^c = [b_1^c, b_2^c, \dots, b_M^c]^T$ be the vector of the rotation factor used to generate the candidate signal $\boldsymbol{X^c}$ In the optimization process, the optimal candidate signal $x^{c_{opt}}$with the lowest PAPR among the C candidate signals is selected and transmitted to the receiver. Generally, $b_1^c$is fixed without degrading PAPR reduction performance and the maximum number of candidate signals is W^{M-1}. Fig. 1 shows the basic block diagram of the CPTS scheme;

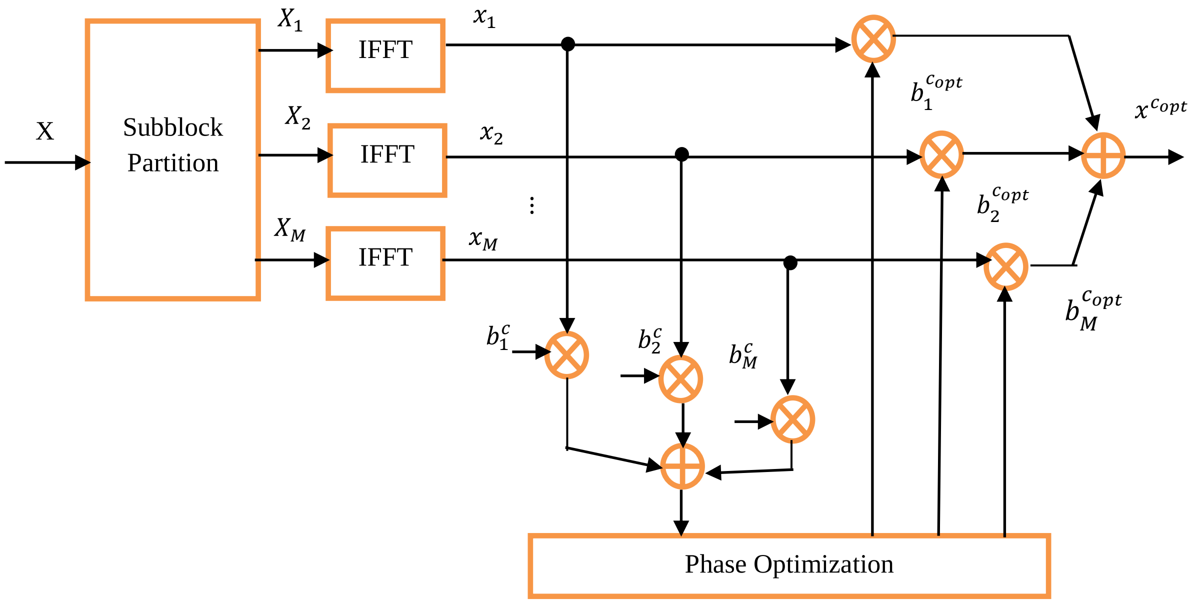

Figure 1 Block diagram of the conventional PTS scheme

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The CPTS scheme has good PAPR reduction performance, but it also has high computational complexity in the optimization process. In addition, the side information must be sent to the receiver to decode the received signal.

***C.**Enhancement in PTS Scheme*

Numerous methods have been presented to reduce the computational complexity of the CPTS scheme. Among these, the a reduced-complexity PTS scheme in as in [15] and [28] uses the sample powers of *M* subblocks to generate cost functions to select samples for estimating the peak power of the candidate signals in the optimization process. The cost function of the sample with time index *n* is defined as

$$Q_n = \sum_{m=1}^{M} |x_{m,n}|^2, \; n = 0,1,\dots,N-1. \qquad \dots \textbf{(6)}$$

During the optimization process, only the samples with $Q_n$greater than or equal to a predefined threshold α are used toestimate the peak power of each candidate signal. This PTS scheme decreases the number of samples used tocompute the peak power of each candidate signal, thusefficiently reducing the computational complexity of theoptimization process of the CPTS scheme.

The PAPR reduction performance and the computational complexity of this PTS scheme are dominated by the number of selected samples. If this PTS scheme uses the higher threshold , then fewer samples are selected, which reduces the computational complexity but also leads to poorer PAPR reduction performance. In the next section, we develop a new optimization process to further reduce the computational complexity of this PTS scheme, but with better PAPR reduction performance.

PROPOSED PAPR REDUCTION TECHNIQUE

Different techniques can be used to reduce PAPR in OFDM system.A large peak-to-average power ratio (PAPR) would source the power amplifier used in an OFDM system to be determined in the saturation area, thus results in signal alteration.

1.1 Technical aspects and Overview of Procedure

The partial transmit sequence method is a phase optimization method which can offeranremaining PAPR reduction with a small amount of redundancy.With this method, separate subblocks of OFDM subcarriers are phase shifted distinctly after the IFFT is calculated. If the subblocks are optimally phase shifted, they display minimum PAPR &accordinglydecrease the PAPR of the combined signal. The number of subblocks (V) & the partitioning arrangementdefine the PAPR reduction. The main difficulty of PTS ascends from the computation of multiple IFFTs, subsequent in a high computational difficulty proportional to the amount of subblocks.

Subblock partition for PTS OFDM is a technique of separation of subbands into multiple disjoint subblocks. Generally, it can be categorized into 3 groups; interleaved partition, adjacent partition, & pseudo-random partition. For the interleaved technique, each subblock signal spread out isallotted at the similar subblock. In the adjacent system, consecutive subblocks are allocated into the similar subblock consecutively. And all subblock signal is allocated into any one of the subblocks arbitrarily in the pseudo-random arrangement. It can be distinguished that the computational difficulty of the interleaved subblock partitioning arrangement is condensedwidely as compared to that of the adjacent & pseudo-random partition system.In the PTS method, the input data block is divided into disjoint sub-blocks, there are three partition approaches for PTS arrangement

- Interleaved
- Adjacent
- Pseudo-random.

Between them, pseudo-random partitioned PTS arrangement can acquire the finest PAPR performance. The sub-carriers in all sub-block are weighted by phase issue rotations. This rotation issuecreates time domain data using which it chooses signal having lowest PAPR.

TABLE 1: Comparison of the reduction techniques

Different Techniques	Implementation Complexity	Bandwidth Expansion	BER Degradation	Distortion
CLIPPING	Low	No	Yes	Yes
CODING	Low	Yes	No	Yes
PTS	High	No	No	No

1.2 Explaination of Partial transmit sequence

The basic idea of partial transmit sequence arrangement is to distribute the original OFDM order into numerous sub sequences & for each sub sequence increased by dissimilar weights until anbest value is chosen. For executing PTS scheme possible phase features or weights are to be created depending on the mapping used. Every subsequence is increased with every weights created& PAPR is considered each time. The phase issues for which subsequence-weight product signals with minimum PAPR is acquired is selected as the best values for weight. Thus the signals with low PAPR is attained.

Let X is the random input signal in frequency domain with a length of N. X is divided into V disjoint sub blocks.

$$X_v = [X_{v,0}, X_{v,1}, \dots, X_{v,N-1}]^T \qquad \dots \textbf{(7)}$$

Where $v = 1,2, \dots v$. The dividing of input signal in to sub blocks is such that the summation of these sub blocks provides the input signal X, ie.

$$\sum_{v=1}^{V} X_v = X \qquad \dots \textbf{(8)}$$

Then these sub blocks are common in time domain. The sub block partition is based on interleaving in which the computational difficulty is less associatedto adjacent & Pseudo-random, however it has the worst PAPR performance between them. Then apply the phase rotation factor 'b_v' to the IFFT of each of the sub blocks.

$$b_v = e^{j\theta_v} \qquad \dots \textbf{(9)}$$

Where $v = 1,2, \dots, V$. The time domain signal after merging is given by:

$$x'(b) = \sum_{v=1}^{V} b_v x_v \qquad \dots \textbf{(10)}$$

Where $x'(b) = [x'_0(b), x'_1(b), \dots . x'_{NL-1}(b)]^T$ and L is the over sampling issue. The optimum signal $x'(b)$ with the lowest PAPR is to be found out.

Both b and x can be shown in matrix form as follows:

$$b = \begin{bmatrix} b_1, b_1, \ldots\ldots, b_1 \\ \vdots \quad\quad \vdots \quad\quad \vdots \\ b_V, b_V, \ldots\ldots b_V \end{bmatrix}_{VXN} \quad \ldots \textbf{(11)}$$

$$x = \begin{bmatrix} x_{1,0}, x_{1,1}, \ldots\ldots, x_{1,NL-1} \\ \vdots \quad\quad \vdots \quad\quad \vdots \\ x_{V,0}, x_{V,1}, \ldots\ldots x_{V,NL-1} \end{bmatrix}_{VXNL} \quad \ldots \textbf{(12)}$$

It should be distinguished that all the basics of each row of matrix b are of the similar values in this technique. In direction to have exact PAPR calculation, at least 4 times over sampling is essential. As the over sampling of x, add zeros to the vector, hence the amount of phase sequence to increase to matrix x will continue the similar.

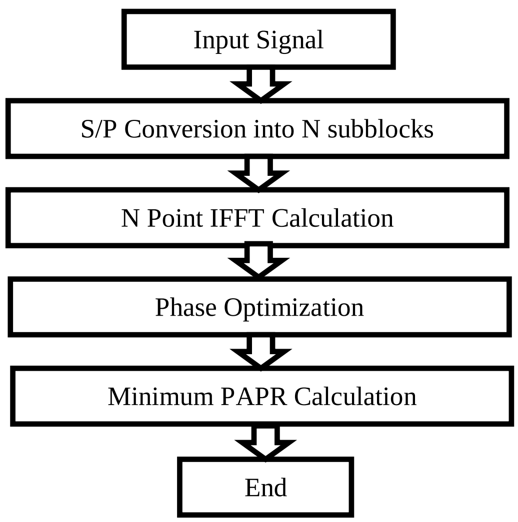

Figure 2: Flowchart for the PTS

The PTS contain of numerous inverse fast Fourier transform (IFFT) operations & complicated designs to obtain best phase sequence which consequences in growing the computational difficulty of PTS.

1.3 Overview of Proposed Optimum phase shifted interleaved partial transmit sequence method

Consider the OFDM system shown in Fig. 4.3 with N orthogonal subcarriers. Each symbol in the data block will modulate one of N subcarriers. The symbols in the block is given by,

$$X_d[k] = [X_d(0), X_d(1), \ldots, X_d(N-1)]^T, 0 \le k \le N-1 \quad \ldots \textbf{(17)}$$

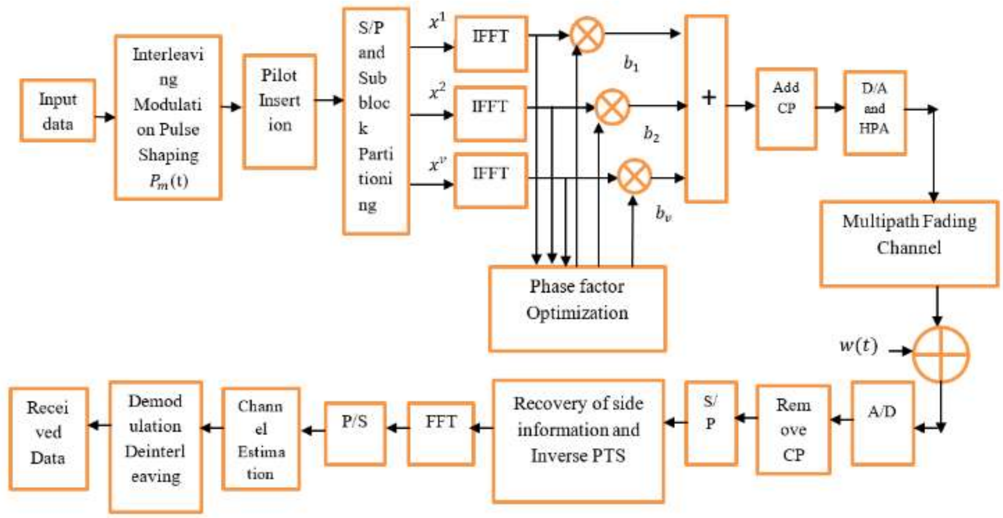

Figure 3: Block diagram of OFDM system using proposed PTS combined with sequence are interleaved and phase shifted.

Each element of the vector $X_d[k]$is an independently modulated data symbol. The OFDM signal is the superimposition of modulated subcarriers using IFFT operation. So, the transmitted signal in time domain is,

$$x(n) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_d(k) e^{\frac{j2\pi kn}{N}}, 0 \le n \le N-1; 0 \le k \le N-1 \qquad \text{… } \mathbf{(18)}$$

The ratio of the maximum power to average power of the OFDM signal is defined as PAPR and it is given by,

$$PAPR\big(x(n)\big) = 10 \log_{10} \frac{\max_{0\le n\le N-1} |x(n)^2|}{E[|x(n)^2|]} \qquad \text{… } \mathbf{(19)}$$

where $E[.]$ is the expectation operator. The PAPR performance is analyzed by using the complementary cumulative distribution function, since the distribution of P APR is stochastic in nature. CCDF is defmed as the probability of PAPR of the OFDM signal exceeding a threshold value $PAPR_0$ and it is given by,

$$CCDF\left(PAPR\big(x(n)\big)\right) = \Pr\big(PAPR\big(x(n)\big) > PAPR_0\big) \qquad \text{… } \mathbf{(20)}$$

The power amplifier at the transmitter is operated with a large backoff due high PAPR. This results in reduced efficiency of the power amplifier. The power efficiency is an important factor that is to be considered in the design of the amplifier.

In PTS technique, the data block of N symbols is divided into V disjoint sub blocks of equal size, represented as $X_d^v = [X_d^1, X_d^2, \dots, X_d^V]^T$. The symbols in each subblock is rotated in phase by multiplying each subblock with a phase factor N, where $v = 1,2,3, \dots\dots, V$. After phase factor multiplication, the OFDM signal in time domain is given by,

$$x = IFFT\{\textstyle\sum_{v=1}^{V} b_v X_d^v\} = \sum_{v=1}^{V} b_v x^v \qquad \text{… } \mathbf{(21)}$$

where x^v is the partial transmit sequence &b_v is the finest phase issueselected from an acceptable set $b_v = \{+1, -1, +\mathrm{j}, -\mathrm{j}\}$. The OFDM signal with small PAPR in time domain is,

$$\tilde{x} = \textstyle\sum_{v=1}^{V} b_v x^v \qquad \text{… } \mathbf{(22)}$$

In PTS technique, the computational complexity increases exponentially with increase in the number of subblocks. In proposed PTS technique, a neighbourhood search algorithm is definite as a function of the present PAPR & threshold PAPR value ($PAPR_0$), is engaged to discover the finest set of phase features. In the defmed region, a novel phase feature set is attained& PAPR is calculated. If the new P APR is less than $PAPR_0$ then the threshold value is changed with the novel value. The process of finding the optimum set of phase factors to yield less PAPR is repeated for finite number of searches. If the PAPR is not under the threshold value, the present values of PAPR and phase factor set are taken as the optimal solution. PAPR reduction performance is improved with modified PTS technique at reduced computational complexity. This technique is combined with by doing Interleaving and shifting phase for better PAPR reduction. Interleaving attempts to break the high correlation among the data symbols in the block. The reduction in the correlation results in reduced PAPR. The long correlation patterns present in the N symbols of a data block is reduced by using $(S-1)$ interleavers, where S is the interleaving factor. The process of interleaving will reorder the N data symbols present in the input data blockX_d. Phase shifting is a flexible way for PAPR reduction and it is based on proper selection of time limited waveforms of the different subcarriers. The Phase shifting involves less computational complexity because of one IFFT/FFT operation in the transceiver. Also, Phase shifting introduces controlled inter-channel interference. So, optimum detectors with good performance can be designed in frequency selective fading channels without any loss in bandwidth efficiency. Considering a time waveform $P_m(t)$ with constant energy ($E_s = 1$) and uncorrelated symbols within each OFDM block, the maximum PAPR given by,

$$PAPR \le PAPR_{max} = \frac{1}{N} \max_{0 \le t \le T} [\sum_{m=0}^{N-1} |P_m(t)|]^2 \quad \ldots \textbf{(23)}$$

The maximum PAPR is a function of the number of subcarriers N and the phase shape $P_m(t)$ of each subcarrier. The sequence (are interleaved and phase shifted) of the different subcarriers with the same shape will only increase the peak amplitude of the transmitted signal without changing the correlation properties between the different samples of the same block. The new set of phase values indicates that each subcarrier phase has a different shape all derived from the same phase by cyclic shifts. This will reduce the P APR of the transmitted OFDM signal since the peak of the different phase never occur at the same time. Raised cosine phase is a widely used phase shifting employed in wireless communication and it is considered to analyses the P APR performance of the OFDM system.

A linear HPA at the transmitter will have low power efficiency because of larger dynamic range. The efficiency of the power amplifier descibe as the ratio of RF output power to DC input power is given by, $\eta = P_{out}/P_{in}$. After PAPR reduction, the DC input power consumed by the power amplifier is less. The decrease in power feeding is the change between the DC input power without P APR reduction and DC input power with PAPR reduction. Accordingly, the efficiency of the amplifier will increase with decrease in DC input power due to PAPR reduction. The DC input power is decreased by a factor of (P_{PAPR}/P), where P_{PAPR} and P are the P APR of OFDM signal with and without P APR reduction, respectively. So, the efficiency of the amplifier will increase by a factor of (P/P_{PAPR}). The increase in efficiency of the power amplifier due to proposed PTS technique combined with sequence are interleaved & phase shifted is understood as rise in effectual SNR. The actual SNR which disturbs the BER of the OFDM system is proportional to $(P_{out}/PAPR/N_0)$.

1.4 Genetic Algorithm Optimization

Genetic algorithm is a part of evolutionary computing, which is a rapidly growing area of artificial intelligence. We can see that; genetic algorithm is inspired by Darwin's theory about evolution. The evolution usually starts from a population of randomly generated individuals and happens in generations. In each generation, the fitness of every individual in the population is evaluated, multiple individuals are stochastically selected from the current population (based on their fitness), and modified (recombined and possibly randomly mutated) to form a new population. The new population is then used in the next iteration of the algorithm. Commonly, the algorithm terminates when either a maximum number of generations has been produced, or a satisfactory fitness level has been reached for the population. If the algorithm has terminated due to a maximum number of generations, a satisfactory solution may or may not have been reached.

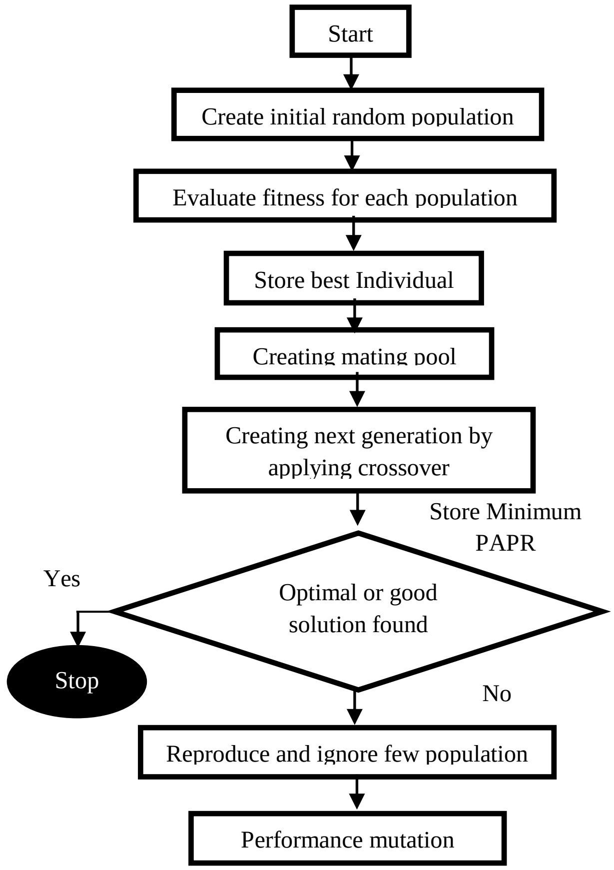

Figure 4: Flow chart of Genetic Algorithm Optimization.

Here GA is used to calculate the optimum value selection for phase, Interleaved pattern, transmission sequence for Proposed PTS method for PAPR reduction.A standard representation of the solution is as an array of bits. Arrays of other types and structures can be used in essentially the same way. The fitness function is defined over the genetic representation and measures the quality of the represented solution. The fitness function is always problem dependent.

RESULTS &ANALYSIS

In this section, the practical PAPR performance of theproposed scheme has been evaluated. In this section, we illustrate the performance of our proposed algorithm which has been compared with the existing PAPR reduction methods using MALAB simulations. The simulation has been done with an OFDM system which had 1024 symbols and uses M-QAM constellation modulation scheme on each sub carrier under Gaussian noise. The oversampling rate factor 4 to approximate the continuous time peak signal.

The Complementary Cumulative DistributionFunction (CCDF) is used to measure of PAPRreduction in OFDM system.Generally, the original OFDM system has the PAPR of 12dB. And it is well known by us that the 12dB is the conventional OFDM PAPR without applying any PAPR reduction methods to OFDM system. Comparison considers four algorithms: Amplitude Clipping, Selective Mapping, PTS proposed in [28] and proposed OPSIPTS methods for different values with their complimentary cumulative distributed function (CCDF). The auto-correlation function is a standard method tomeasure the degree of correlation within the sequence orperiodic nature.In OFDM, the high peak occurs at the output of IFFT whenthe input data sequence applied at the input of IFFTs is stronglycorrelated. Therefore, to reduce the auto correlation at the inputof IFFT, the input data sequences are multiplied with anothersequence with low autocorrelation magnitude.

To make the system simple, the HPA isomitted from the transmitter. In addition, only a static channel(i.e., Additive White Gaussian Noise (AWGN) Channel) isconsidered throughout this simulation. Channel estimation is notperformed here. Our aim is to just detect the symbols andsee the effect of wrong detection on overall BER and in terms of results we proved that proposed PAPR reduction perform much better than standard methods.

The OFDM receiver performance employing Proposed OPSIPTS technique, partial transmit sequence are (dividing OFDM symbols into sub-blocks) are calculated from OFDM symbol after interleaving and phase shifting is analyzed with benefit of simulation factors listed in Table 2. LS channel estimation is employed to analyses the receiver performance in terms of MSE and BER. The PAPR performance of the OFDM system for N=250 and different sub blocks is shown in results. At CCDF between 0 to 1, the reduction in PAPR is about 28.18%, 40.91%, 54.55% and 62.73% for V=2, 4, 8 and 16 when compared to OFDM system without PAPR reduction. To illustrate the performance, an N subcarrier OFDM systemwith M-QAM modulation is considered. For an accurateestimation of PAPR, the signal is oversampled by a factor of 4 (L = 4), and the 1024 random OFDM blocks havebeen generated to obtain the numerical results. The numericalresults are illustrated using the CCDF, and PAPR is measuredwith and without the proposed PAPR reduction technique.In this proposed protocol result analysis is based on these parameters:

TABLE 2: Lists the simulation parameters used.

Simulation parameters	**Type value**
Size of FFT	1024
Symbols per Carrier	50
Number of carriers 'N'	200
Number of sub blocks 'V'	2,4,8 and 16
Phase factors	$+i, -i, +j, -j$
Interleaving factor'S'	4
Pulse shaping filter	Raised cosine
SNR	10

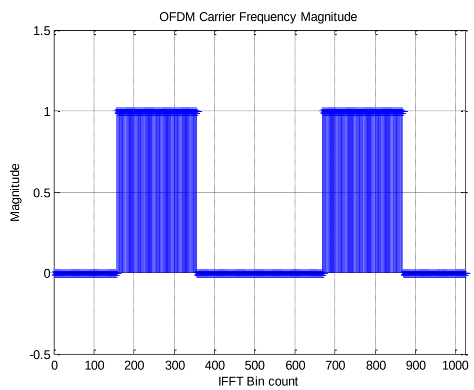

Figure 4: Shows the Magnitude of signal with respect to IFFT bin count for transmitted OFDM signal.

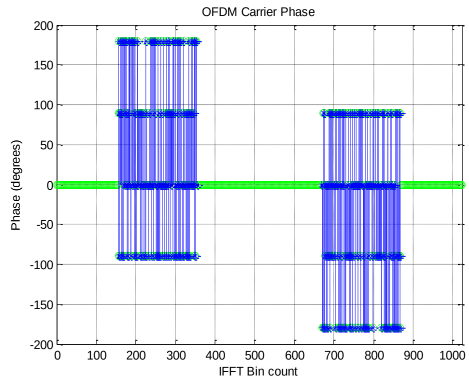

Figure 5: Shows the OFDM carrier phase, in which phase in degrees of OFDM signal is extracted with respect to IFFT bin count for transmitted OFDM signal.

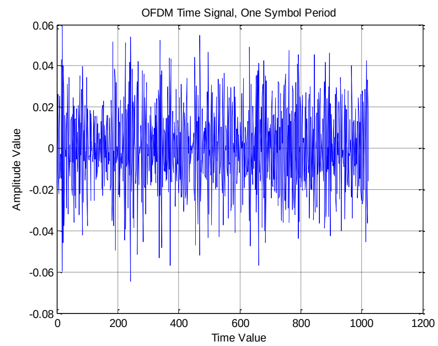

Figure 6: shows Amplitude value of signal with respect to time slot (1024) taken for transmitted OFDM signal.

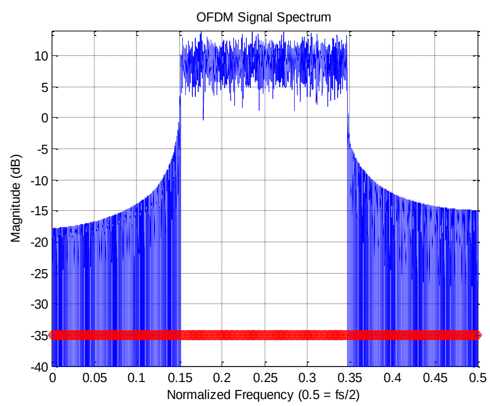

Figure 7: shows a signal spectrum of Proposed OFDM system. X axes shows the normalized frequency defined for proposed system and Magnitude in dB is shown in Y axes for transmitted OFDM signal.

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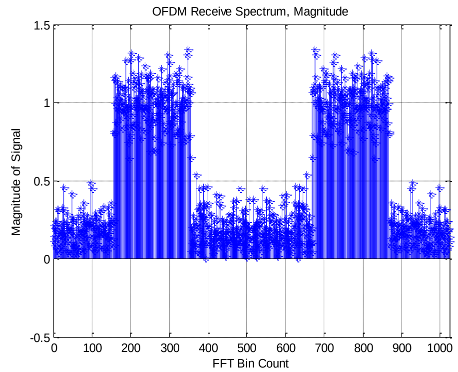

Figure 8: shows a OFDM received signal spectrum. It shows the magnitude of signal received with respect to the FFT bin count for the signal received at Receiver.

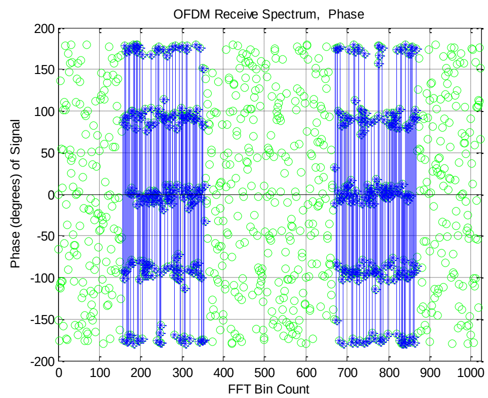

Figure 9: shows phase information of received signal spectrum. In figure, phase of the received signal is plotted with respect the FFT bin count for the signal received at the receiver after adding noise within the channel.

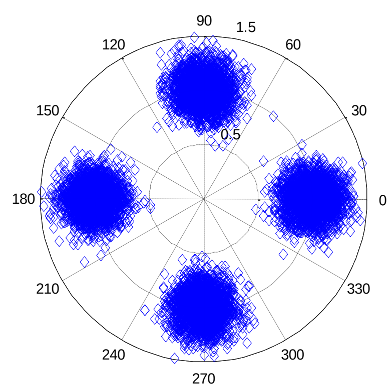

Figure 10: Figure above shows the polar plot of the received signal spectrum with respect to the channel information. It shows distribution of signal spectrum across a polar spectrum.

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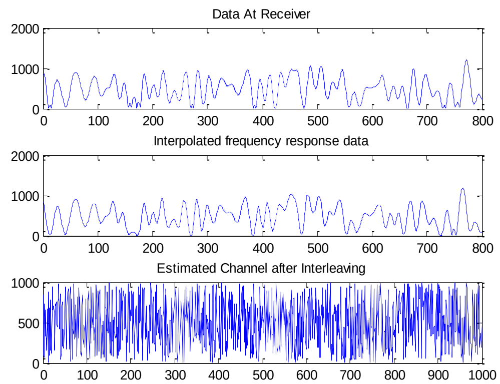

Figure 11: shows the comparative view of signal magnitude for data received at the receiver, interpolated frequency response data and estimated channel after interleaving for the proposed work.

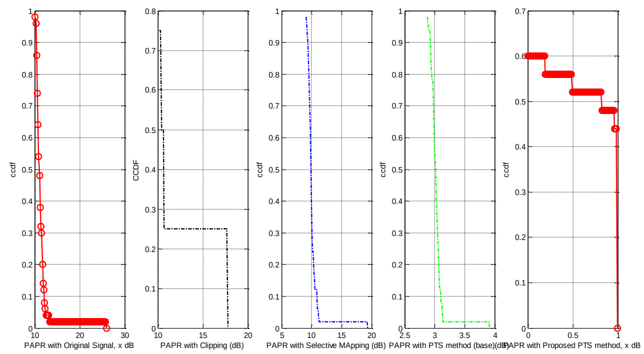

Figure 12: Depicts the Comparative view of PAPR values with respect to CCDF for all the techniques used for the simulation. It is clear from the figure that line shown in red for the proposed having lower values of PAPR for all values of CCDF.

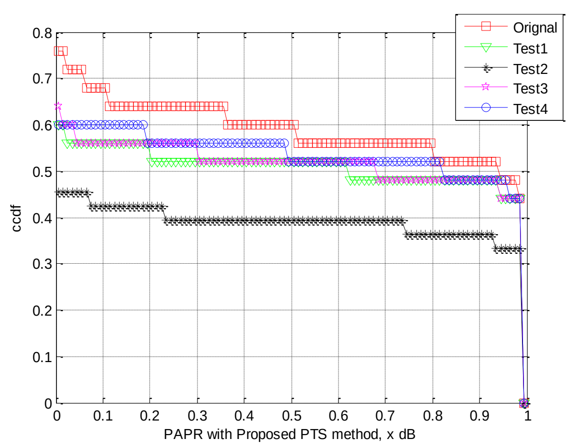

Figure 13: shows a comparative view of obtained PAPR values with proposed system by taking various number of sub-blocks for experiment purpose. It is clear from the figure that we are getting minimum PAPR values while taking 4 sub-blocks in proposed work.

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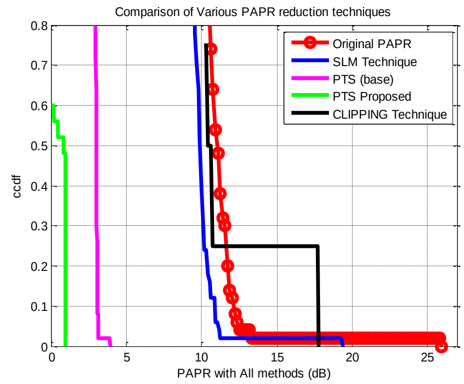

Figure 14: shows a comparative view of PAPR with respect to different values of CCDF for all 4 techniques used for the simulation. From figure, it is clear that the proposed PAPR reduction technique perform much better than other techniques and also outperform the PTS technique proposed in [28]. We are getting a very lower value of PAPR of approximately ~1 to ~2 dB by using the proposed optimized phase shifted interleaved partial transmit sequence method.

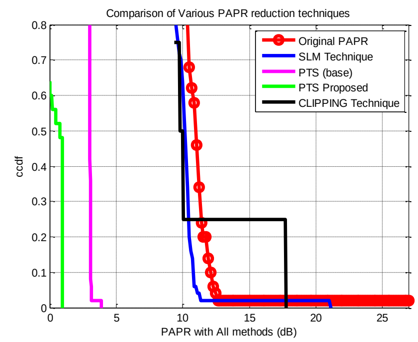

Figure 16: shows a comparative view of PAPR with respect to different values of CCDF for all 4 techniques used for the simulation while increasing number of carriers in transmitter model (Number of carriers = 300). From figure, it is clear that the proposed PAPR reduction technique perform much better than other techniques and also outperform the PTS technique proposed in [28].

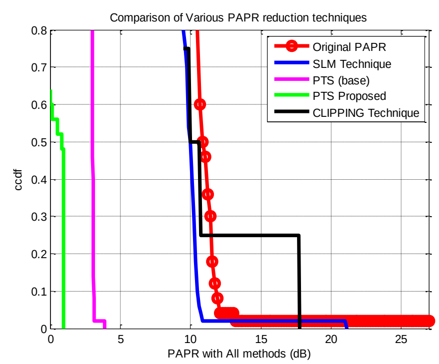

Figure 17: shows a comparative view of PAPR with respect to different values of CCDF for all 4 techniques used for the simulation while decreasing value of SNR or increasing effect of white Gaussian noise in channel side model (Signal to Noise ratio = 5). From figure, it is clear that the proposed PAPR reduction technique perform much better than other techniques and also outperform the PTS technique proposed in [28].

TABLE 3.BER COMPARISON OF PROPOSED SCHEME AND SCHEME PROPOSED BY BASE PAPER

SNR	**BER (traditional)**	**BER (Proposed)**
1	0.487510000000000	0.421900000000000
2	0.479150000000000	0.417200000000000
3	0.466870000000000	0.409200000000000
4	0.451020000000000	0.397400000000000
5	0.442350000000000	0.382300000000000
6	0.429740000000000	0.373400000000000
7	0.415170000000000	0.371350000000000
8	0.408820000000000	0.363550000000000
9	0.381890000000000	0.349850000000000
10	0.376790000000000	0.345950000000000

TABLE 4:PAPR values with respect to CCDF for all the techniques considered in simulation.

CCDF	Value of PAPR			Original PAPR	Proposed PAPR
	Clipping	**SLM**	**PTS [28]**		
0.8	**9.3582**	**9.4254**	**3.3695**	**10.8653**	**1.9365**
0.6	**9.1956**	**9.7881**	**3.1974**	**10.7844**	**2.1652**
0.4	**10.1647**	**9.8752**	**3.1526**	**10.9672**	**1.8841**
0.2	**20.4691**	**10.7383**	**3.2648**	**11.8564**	**2.0936**
0.0	**20.7095**	**21.1958**	**3.9167**	**27.7624**	**1.9699**

This sectionconclude that and also here results shows that, this proposed PAPR reduction technique successfully extends the stable region to more than ~2dB&the PAPR reduced to less than ~1 to ~2 dB and outperformed successfully other techniques considered in simulation along with the base problem [28].

CONCLUSION

Peak value of the independently modulated sub-carriers in the OFDM system is actual high compared to the average value. Ratio of this value is called the peak-to-average power ratio (PAPR). Though the OFDM has many benefits such as the high spectral efficiency, robustness to the channel fading, immunity to impulse the interference, capacity to handle very robust echoes & the less non-linear distortion it also has disadvantage of high PAPR. The Complementary Cumulative Distribution Function (CCDF) is used to measure of PAPR reduction in OFDM system.

Generally, the original OFDM system has the PAPR of 12dB. And it is well known by us that the 12dB is the conventional OFDM PAPR without applying any PAPR reduction methods to OFDM system. Comparison considers four algorithms: Amplitude Clipping, Selective Mapping, PTS proposed in [28] and proposed OPSIPTS methods for different values with their complimentary cumulative distributed function (CCDF). Our aim is to just detect the symbols and see the effect of wrong detection on overall BER and in terms of results we proved that proposed PAPR reduction perform much better than standard methods.

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