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Statistical Maximum Value Distribution Approach for Optimization of Peak to Average Power Ratio in Wireless Communication System

Bhalchandra M. Hardas* and Sanjay B. Pokle**

ABSTRACT

In recent time, the demand for transmission information services has huge up rapidly. One of the foremost promising multi-carrier system, Orthogonal Frequency Division Multiplexing (OFDM) [1,2] forms basis for all 4G wireless communication systems credit goes to its large ability to let the amount of subcarrier, high rate and gift coverage with top quality. OFDM is significantly plagued by peak-to-average-power quantitative relation (PAPR). Sadly, the high PAPR inherent to OFDM signal envelopes will typically drive high power amplifiers (HPAs) to figure inside the nonlinear region of their graphical record. The nonlinearity of the HPA exhibits amplitude and section distortions, that cause loss of orthogonality among the subcarriers, and hence, intercarrier interference (ICI) is introduced inside the transmitted signal. Not only that, high PAPR put together lands up in in-band distortion and out-of-band radiation. The PAPR reduction of OFDM system gives fair reduction in PAPR under partial transmits sequence (PTS) and DCT- SLM techniques. We tend to project a combination technique of PTS and DCT-SLM and an algorithm to cut back the PAPR. This hybrid combined technique reduces PAPR effectively and put together minimizes the complexity of PTS technique

Keywords: *DCT-SLM*, OFDM, Peak to average power ratio, PTS

1. INTRODUCTION

Demand for transmission information service has huge drastically that drive U.S. inside the age of fourth generation wireless communication system. This demand of multimedia system info service where user unit of measurement in large numbers and with finite spectrum, modern digital wireless communication system adopted technologies that unit of measurement information measure economical and powerful to multipath channel surroundings known multi-carrier communication system. Separate Fourier rework (DFT) was applied to get the orthogonal sub-carriers waveforms. In their projected model, baseband signals were modulated by the DFT inside the transmitter then demodulated by inverse

DFT (IDFT) inside the receiver. So, the implementation complexity is reduced by the employment of DFT algorithms (i.e. IFFT/FFT). The OFDM systems have some major problems (like high PAPR, temporal property and frequency synchronization, Inter-Carrier Interference (ICI) etc.) and heap of labor has been in keeping with unravel these problems.

2. DISTORTION BASED TECHNIQUES

The schemes that introduce spectral regrowth belong to distortion primarily based category. The clipping [11] is one of the sole distortion primarily based technique to cut back the PAPR of OFDM signal. It

* Assistant Professor, Electronics Engineering, *Email: hardasbm@rknec.edu*

** Professor, Electronics and Communication, *Email: poklesb@rknec.edu*
Shri Ramdeobaba College of Engineering and Management, Nagpur

reduces the peak of the OFDM signal by clipping the signal to the desired level but it introduces every in-band distortion and out of-band radiation. To limit out-of-band radiation and PAPR.

Another well-liked distortion based mostly technique is that the Companding that reduces the PAPR within the OFDM systems. Wang et al. projected a theme supported ¼-law companding to scale back the PAPR of the transmitted signal. In ¼-law companding the height worth is unbroken same before and once the companding. It keeps the height power of the OFDM signal same however the typical power once companding will increase plenty. This increase within the average power reduces the PAPR within the signal. However a serious disadvantage is that the error performance of ¼-law companding theme degrades.

Jiang et al. projected exponential (EC) perform to remodel Lord Rayleigh magnitude of the signal into uniform distribution victimization AND function referred to as "Exponential companding". Exponential companding theme will effectively scale back the PAPR of the OFDM signal however its BER performance conjointly degrades with PAPR reduction. Huang et al. projected four companding transformation functions to scale back the PAPR of the OFDM signal that includes: linear symmetrical rework (LST), linear non symmetrical rework (LNST), non-linear symmetrical rework (NLST) and non-linear non-symmetrical rework (NLNST). It's determined that the performance of the LNST is relatively higher from all the four functions. Aburakhia et al. proposed, Linear Companding rework (LCT) to scale back the PAPR. Here giant and little signals area unit treated on totally different scales however they need 2 grammatical relation points to realize additional flexibility in coming up with the companding perform, this abrupt modification within the altered signal at the infection points degrades the facility spectral density thus minimizing the PAPR. Hou et al. proposed, quadrilateral Companding that is additionally AN economical methodology to scale back the PAPR of the OFDM signal with low BER. Here the Lord Rayleigh distributed magnitude is distributed in an exceedingly quadrilateral fashion. In TC piecewise perform within the 3 outlined intervals of OFDM magnitudes is greatly utilized. Like the previous method Jeng et al. projected methodology victimization multiple star distribution based mostly companding (TDBC) here the Lord Rayleigh distribution relies on linear trapezium. All the on top of techniques area unit forms of the distortion based mostly techniques. The most disadvantage here is that the form of the signal is compromised for PAPR reduction that effects the performance of the signal as a full. The second sort of techniques area unit the Non-Distortion based mostly PAPR reduction techniques. Here the form of the signal won't be compromised and no spectral re-growth takes place. One among the foremost basic and simplest technique of the non-distorted is that the cryptography Technique (CT). It will with efficiency scale back the PAPR of the signal however the information loss may happen during this technique.Other two techniques of distortion less PAPR reduction area unit partial transmit sequence (PTS) and therefore the selective mapping (SLM). within the PTS technique the subcarriers area unit portioned into multiple disjoint sub elements and therefore the rotating section issue is increased with all the sub elements and area unit combined to realize a sign with lowest PAPR whereas in SLM the parallel knowledge signal of N length is increased by a group of U section vectors of N length the set is planned and it generates U different signals. Out of them the smallest amount PAPR signal is chosen for transmission. In each of the schemes the knowledge concerning the section factors by that these sub blocks/data symbols area unit increased, must be sent to the receiver and it's referred to as facet info (SI). The SI has the importance as a result of its accustomed recover the first knowledge signal. If SI gets corrupted then entire OFDM image block is broken and error performance of SLM and PTS-OFDM system degrades severely.

In PTS if the quantity of sub blocks will increase then there's a rise within the procedure quality conjointly however it conjointly will increase the number of SI that is sent to the receiver at the receiving finish. If the SI is magnified the probabilities of knowledge loss within the signal conjointly will increase. Similar is that the case of SLM OFDM, here if the quantity of other signals area unit magnified then the quantity of bits for cipher conjointly will increase and thus leads to knowledge loss. Since the SI bits area unit extraordinarily vital for the information recovery and it's vital to administer some redundant

bits to make sure correct SI recovery rate. However aging if can have an effect on the information and loss could occur. There are a unit multiple schemes that area unit projected for embedding the SI within the OFDM systems. Once the signal reaches the receiver, SI is extracted from the received OFDM signal. It is then decoded to get the knowledge concerning the section issue accustomed scale back the PAPR. The regenerated signal is then increased by the reciprocal of recovered section factors, as a result of that the procedure quality at the receiving finish gets magnified. In multiple techniques a serious disadvantage is that the SI detection at lower values of SNR is incredibly poor and it ends up in error performance of the OFDM system degrades severely.

Another system MPSM-PTS is projected by Zhou et al. it extends the QPSK constellation points to disjoint points of 16-QAM constellation and eliminates the need of facet info. The theme that is totally free from the SI is MPSM-PTS theme. Once the signal is received the extraction of the SI isn't required and therefore the receiver structure of the theme projected in is computationally less complicated.

In systems like LTE OFDM is employed as downlink and therefore the mobile station act as receivers. Here the mobile station have solely a couple of resources so a PAPR reduction theme with less procedure quality at receiving finish are additional useful. As reviewed the schemes projected area unit computationally complicated receiver as compared to the schema projected. Thus MPSM-PTS theme may be a viable alternative for PTS-OFDM system.

OFDM is sensitive to tiny carrier frequency offset in between transmitter and receiver carrier frequencies will disturb the orthogonality of the subcarriers and causes ICI. The ICI interference degrades the performance of the system. It's usually characterized by carrier to interference magnitude relation (CIR).

Various ICI cancellation techniques are projected within the literature to eliminate the impact of ICI, these embody ICI self-cancellation, New ICI self-cancellation, General ICI self-cancellation theme, ICI conjugate cancellation theme, General section turned conjugate transmission ICI cancellation theme etc.

3. PAPR REDUCTION METHODS

PAPR reduction methods are primarily divided into two domain methodology: frequency domain method and time domain methodology [3]. The basic notion of frequency domain methodology is to increase the cross correlation of the input before IDFT and cut back the output of the IDFT peak price or average price. Loosely PAPR reduction techniques unit of measurement classified into four sections one. Signal scrambling (Probabilistic) technique Signal Scrambling technique scramble each OFDM image with fully totally different scrambling techniques and select the sequence that has the tiniest PAPR price. It includes methods like Selective Mapping (SLM) and Partial Transmit Sequence (PTS). Signal distortion technique this system reduces the PAPR by distorting the OFDM signal non-linearly. The methods like clipping and filtering, peak windowing, and non-linear companding unit of measurement the instance of this methodology. These strategies unit of measurement applied once the generation of OFDM signals (after the IFFT). Secret writing technique the key writing technique used some error correcting codes for the PAPR reduction. These methods unit of measurement applied before the generation of OFDM signal (before IFFT). Once N signals unit of measurement else with identical section, they end up a peak power, that's N times the typical power. The basic arrange of all secret writing schemes for the reduction of PAPR is to chop back the incidence probability of identical section of the numerous signals. The cryptography methods select such code words that minimize or cut back the PAPR. It causes no distortion and creates no out of band radiation, but it suffers from system of measurement potency as a result of the code rate is reduced. It put together suffered from the complexity to hunt out the foremost effective codes and to store massive search tables for coding and cryptography, particularly for associate oversize style of subcarriers. The error correcting codes like block codes, cyclic codes, Golay complementary sequence, Reed-Solomon (RS) code, Reed-Muller (RM) code, Hadamard code and denseness parity check (LDPC) code is employed. Pre-distortion technique the pre-distortion

technique depends on the reorientation or spreading the energy of data image before taking IFFT. The pre-distortion theme includes DFT spreading, pulse shaping or pre-coding and constellation shaping. The foremost of the factors mentioned on prime of for selecting the PAPR reduction technique unit of measurement nearly glad by frequency domain methodology (i.e. signal scrambling and pre-distortion methods) as results of they are distortion less.

4. PROPOSED SYSTEM OF PAPR REDUCTION

Currently we are going to see those techniques that have a tendency to propose for higher output.

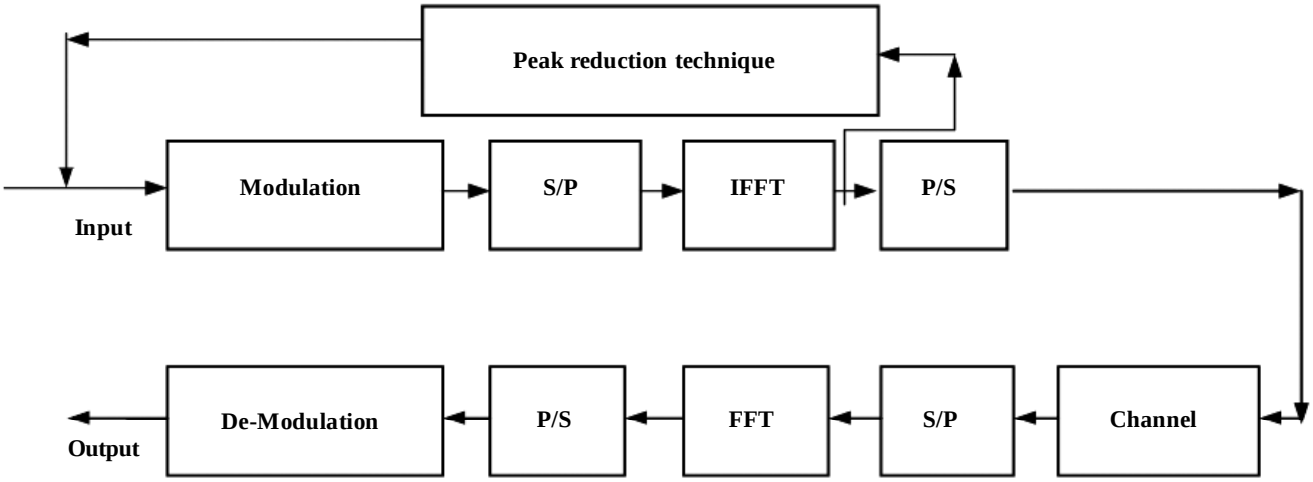

Figure 1: Proposed model of PAPR reduction system

5. PARTIAL TRANSMIT SEQUENCE

Partial Transmit Sequence (PTS) [6, 7] is one in all the foremost economical techniques to diminish PAPR. During this theme original OFDM signal is split into range of sub-blocks. Then section rotation is additional to develop range of candidate signal and select one with lowest PAPR. In the PTS Technique, the input image sequence is divided into variety of disjoint image subsequences. IFFT is then applied to every image subsequence and therefore the ensuing signal subsequences square measure summed once being increased by a collection of distinct rotating vectors.

Let input data blocks X = $\{X_k\}$, where (k = 1, 2…N -1), N is number of sub-carriers. Make M is the frequency domain (FD) data sequences X•, (• = 1, 2, … M) by multiplying phase sequences

$$X^{\varepsilon} = \left\{P_K^{\varepsilon}\right\}\left(K = 0,\ 1,\ 2,\ \ldots N-1\right)$$

With X elements provide following results

$$X^{\varepsilon} = \left[P_0^{\varepsilon} X_0, P_1^{\varepsilon} X_1 \ldots \ldots P_{N-1}^{\varepsilon} X_{N-1}\right]\varepsilon = \left(1,\ 2,\ \ldots,\ M\right)$$

Where $P_K^{\varepsilon} = \exp\left(j\varphi_K^{\varepsilon}\right), \varphi_K^{\varepsilon}$ is uniformly distributed in [0, 2π].

To get M candidates' time domains using IDFT

$$X^{\varepsilon} = IDFT\left\{X^{\varepsilon}\right\}, \varepsilon = \left(1,\ 2,\ \ldots,\ M\right)$$

All the candidates have same info x give totally different PAPRs. One with smallest PAPR in X^• is chosen for transmission.

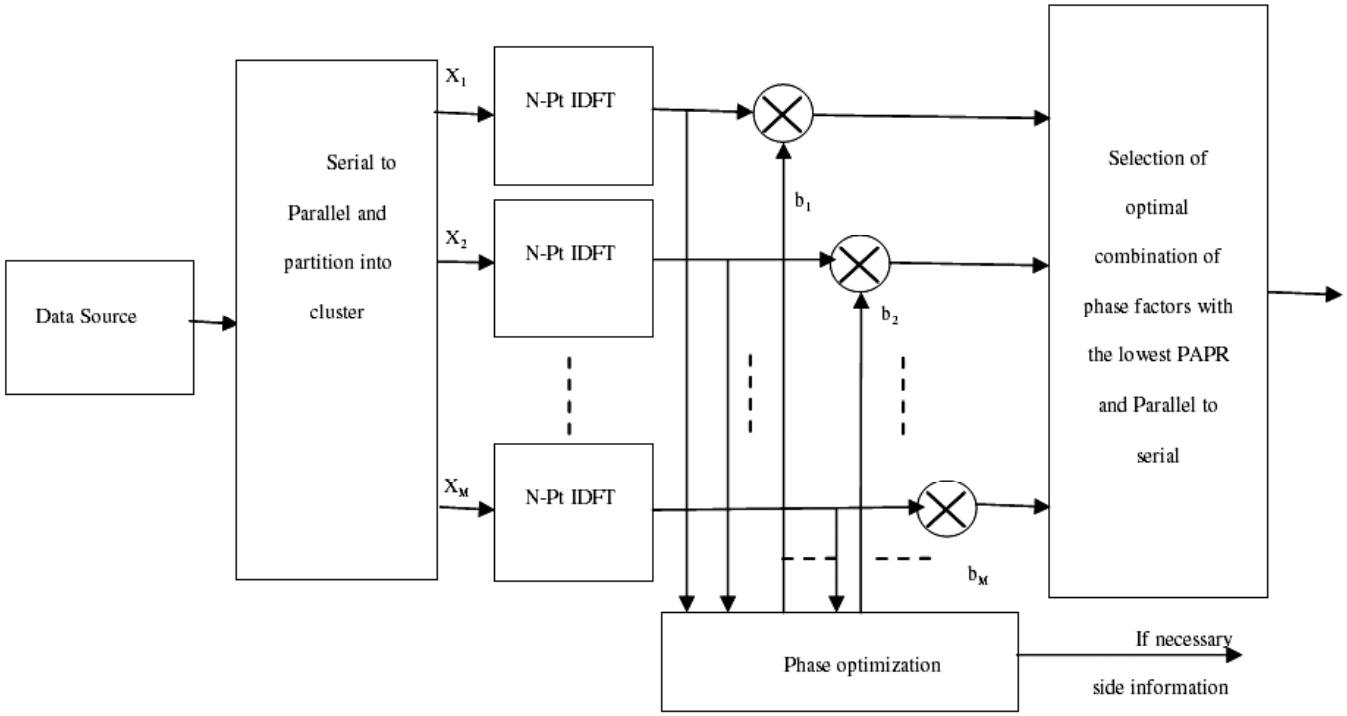

Figure 2: Typical PTS theme.

6. SELECTIVE MAPPING

Selective Mapping is promising technique to mitigate PAPR in OFDM system. Elementary plan behind theme is section rotation. Signal with low PAPR is chosen from totally different freelance section sequences that have same information at transmitter side.

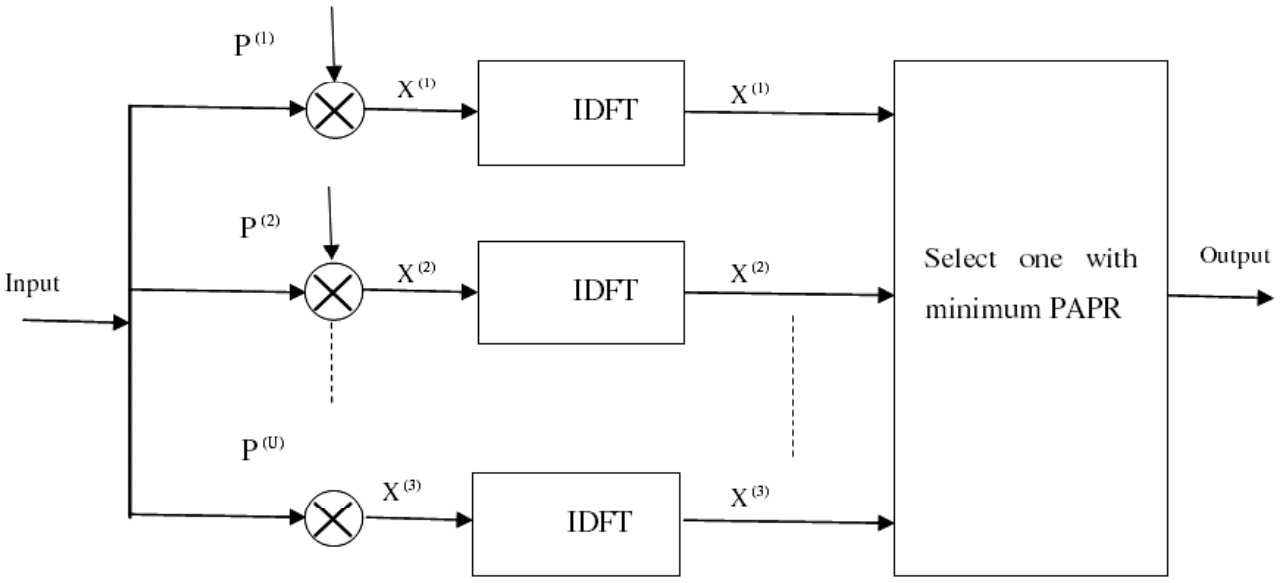

Figure 3: Typical SLM technique

Let input data blocks be

$$X = [X_0, X_1, X_2, \ldots\ldots X_{N-1}]^T$$

When multiply with independent phase sequence results

$$p^u = \left[P_0^u, P_1^u \ldots X_{N-1}^u \right]^T, u = (1,\ 2,\ \ldots,\ U-1)$$

U = number of phase sequence

Keep length of computer file and section sequence same. Then get time domain signal by applying IFFT we have a tendency to get information block with totally different PAPR worth and section sequence.

$$X^u = \left[X_0^u + X_1^u + . \ldots X_{N-1}^u \right]^T$$

Select one with low PAPR and transmit. CCDF is employed to live the chance that the PAPR of a definite information block exceeds the given threshold. CCDF of PAPR in SLM is going to be

$$P(PAPR > PAPR0) = (1 - (1 - e^{-PAPR0})^{\alpha N})^U$$

N = Number of sub-carriers

N_IIFT = N-point IFFT operation

U = independent section sequence

PAPR = threshold worth

• = oversampling issue

7. DCT-SLM

The main plan of the theme is to use hybrid model of two acceptable strategies. One is that the DCT [8-11] matrix networks technique and other is the SLM technique. The transmitter block is shown in Figure 4(a). Within the transmit finish, the information stream is foremost remodeled by DCT matrix, then the remodeled information is processed by the SLM unit. If information block glided by DCT matrix before IFFT, the autocorrelation coefficients of IFFT input is reduced, then the PAPR of OFDM signal can be reduced. In this DCT matrix uses o SLM to scale back the PAPR of signal. In his fashion, the autocorrelation of the signal has been processed by SLM is reduced by DCT matrix rework.

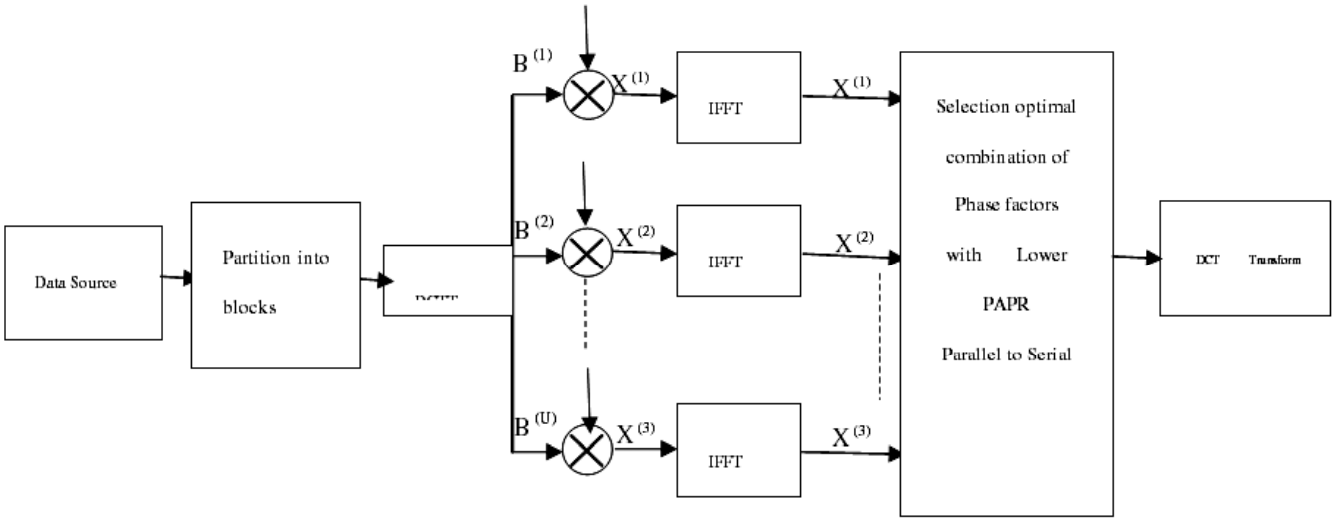

Figure 4: DCT-SLM theme

Proposed Algorithm: In this part of the paper methodology of proposed algorithm is explained which will again filter the PAPR and will increase the efficiency of the system. The algorithm is as follows:

Step 1: Give the signal and the PAPR as inputs,

Step 2: Initialize Max Value of OFDM to “M”,

Step 3: find interval value Z

Z = OFDM/Max

Step 4: interval value = Max/length

Step 5: now Z = Z + interval value,

Step 6: Calculate PAPR (Z).

In the above algorithm the signal and its PAPR are given as an input and from that the maximum value is initialized and the Z and the interval value are calculated by the system and are added to create a new Z, now the PAPR of Z is to be calculated by the system, the brief implementation is explained in the next section.

8. IMPLEMENTATION

In this section of the paper we are going to see the simulation of the planned system to scale back the PAPR within the signal to offer economic output to the end user.

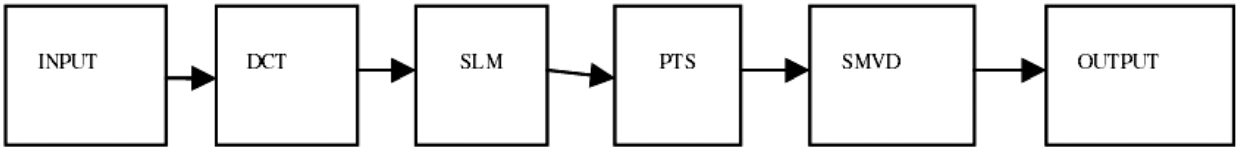

Figure 5: Hybrid model

The figure 5 shows the flow of the system enforced, as ascertained within the system there is an associate signal given to the planned technique block, within the technique the signal is initial sent to the DCT block, then to the SLM then PTS and finally the planned formula [19, 20] is employed and with these analysis the PAPR of the signal is calculated and is given out by the system. All the components square measure explained as follows:

8.1. Input Signal

In this a part of the system, the input is given to the process unit of the system, allow us to say that the signal is shipped with a series of ten digits say1 2 3 4 5 6 7 8 9 10. This set of information and also the signal are going to be sent for any process by the block.

8.2. DCT

In this section of the system, the signal is processed with the matrix of the DCT to calculate the PAPR of the signal. The DCT is analogous to Fourier remodel however with real numbers. Once the process of the DCT is finished the signal and also the worth is then sent to the SLM.

8.3. SLM

In the SLM sub-block, here the signal with low PAPR is chosen from whole completely different freelance section sequences that have same information at transmitter. Once the SLM [4, 5] has computed the PAPR it then sends the signal to the PTS.

8.4. PTS

In this sub-block the signal is split into vary of sub-blocks. Then section rotation is further to develop vary of candidate signal and choose one with lowest PAPR. Once these three processes and offers a final PAPR then the signal and also the PAPR is shipped to the planned algorithm:

8.5. Proposed Algorithm

The proposed algorithm is implemented using the FPGA. Here the signal and also the PAPR calculated is given because the input that is as follows:

1 2 3 4 5 6 7 8 9 10

PAPR: 8.9526

Now liquid ecstasy worth = 10,

Z = OFDM/Max associate equally interval worth = max/ length

Here OFDM is that the signal values, liquid ecstasy as declared is ten, and length is additionally ten. After this we have calculated the PAPR. Currently the PAPR obtained is 7.27 dB that is two hundredth of original.

Output: During this sub-block the signal and also the PAPR is given. The results of the enforced technique square measure as follows.

9. RESULTS

The figure 6 shows the graph between the normal PAPR calculated and the PAPR after the proposed system. The simulation is implemented in MATLAB. The first row shows the original signal and the FFT. The difference between the FFT readings is 5 whereas on the second row is the proposed PAPR reducing technique and then the FFT of the signal comes out to be 1 which is just 20% of the original signals.

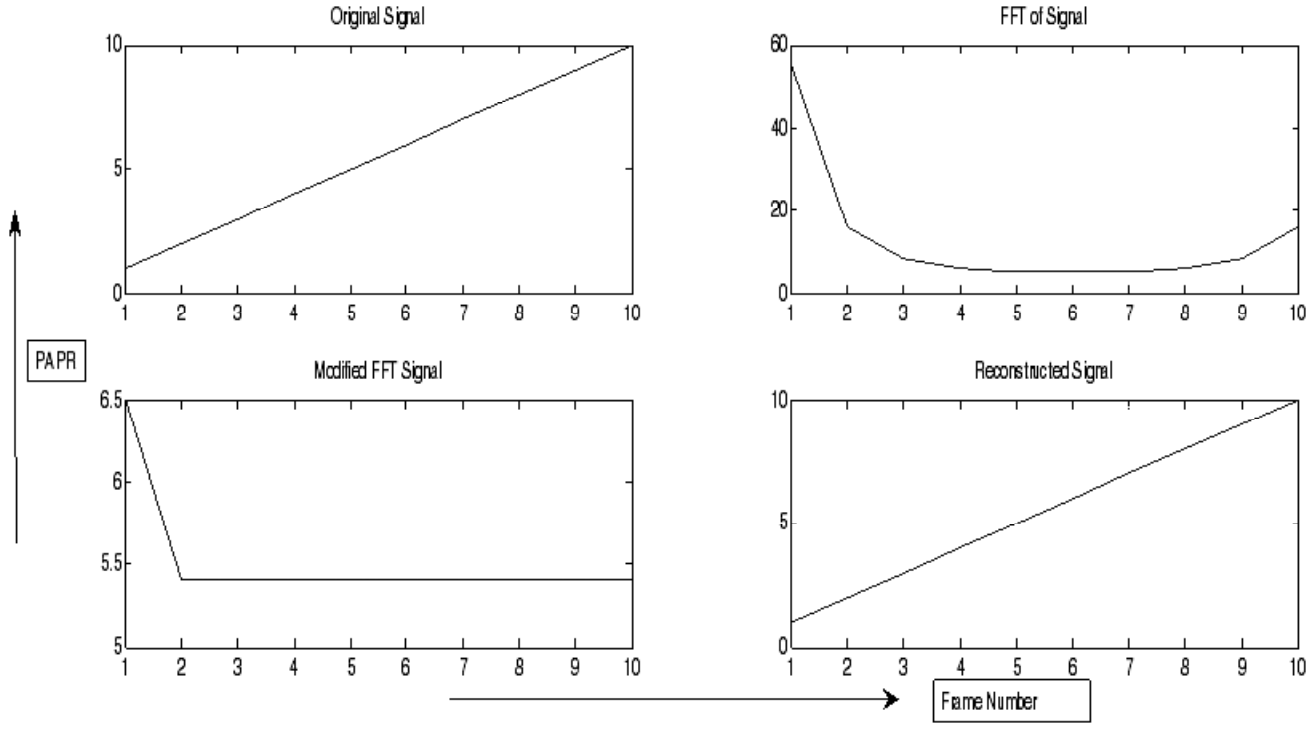

Figure 6: PAPR before and after proposed technique

PAPR for original signal = 8.9526 dB

PAPR after technique = 1.4043 dB

Improvement = 84.3144 %

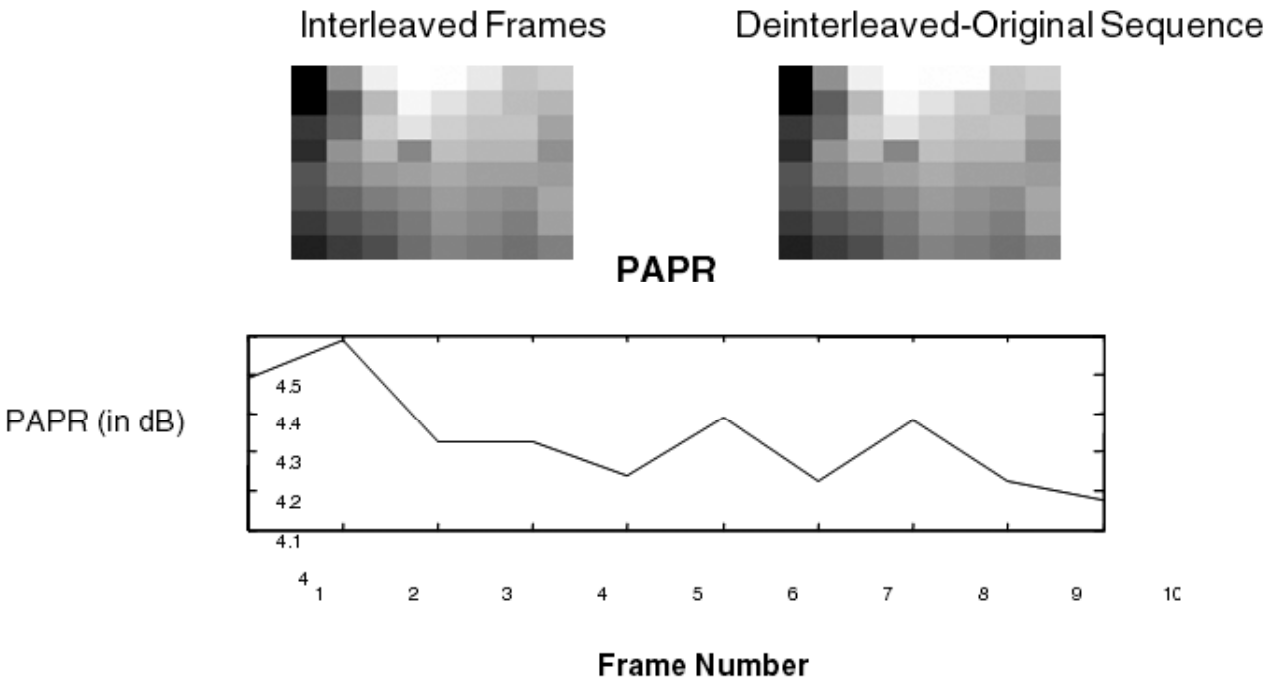

Figure 7: PAPR of the image

10. CONCLUSION

Table 1
Comparison of PAPR

Video Size	*Normal OFDM PAPR*	*With technique DCT- PTS*	*With Statistical Maximum Value Distribution Approach*	*Improvement*
100 kb	14dB	5 dB	4.21dB	30 %
500 kb	14.6dB	5.1 dB	4.25 dB	29.10 %
1000kb	13.7dB	5 dB	4.33 dB	31.60 %
2000 kb	14.2dB	8.9526dB	1.4043 dB	84.31 %

Using Statistical Maximum Value Distribution Approach it is observed that there is significant improvement in Peak to average Power ratio. No significant loss of data is observed. As compared to all other techniques it is giving improvement (reduction) in PAPR as shown in Table 1. In a short using statistical maximum value distribution approach, one can optimize PAPR in wireless communication in general and in OFDM in particular. VHDL implementation of statistical maximum value distribution (SMVD) approach for PAPR reduction is also carried out successfully.

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