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Performance Improvement in OFDM using Combination of Signal Scrambling and DCT

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Abstract: ***Nowadays lot of enormous requirement for multimedia services which are data and text in nature and their demand is increasing to large extent. Considering more demand into picture a MC system called as OFDM which forms basis for all 4G communication which is wireless in nature is used. The high popularity OFDM has gained more importance because of its larger capacity which allows the increased count of subcarriers, capacity to carry huge amount of data and larger footprint and also more coverage region with high mobility. Unfortunately the PAPR problem is affecting the system to great extent. The amplifier which requires high power starts operating in the zone which is nonlinear of their characteristic curve because of its high range showing Peak to Avg. of power in an OFDM signal thereby degrading the condition of the principle related to the orthogonality among the subcarriers. This tends to the addition of ISI in the signal which is being transmitted. Here we implemented the techniques to lower PAPR value.***

Keywords: PAPR, HPA, DCT

1. Introduction

Introduction part reveals that recently, the usage for multimedia text services has grown lot which drive us in the era of 4th generation wireless communication system. This requirement of multimedia services in view of data where users are in large user are in large numbers and with bounded spectrum, modern digitized wireless medium has captured signals coming from multipaths in environment .Considering the advancement in context of its features multicarrier technique like OFDM is being adopted widely . OFDM is the base for all the communication systems in wireless network using 4G technology bcoz of its large capacity in view of accommodating number of subcarriers,huge data rate with more speed increased excess rate of 100 Mbps and unlimited coverage footprint with high mobility. The main problem through which a system comes across is the increased value of input Peak to avg. ratio of power of signal which is fed at the I/P which tends to deviate a HPA in the zone which is nonlinear in nature ultimately reducing the working and thereby affects the system. Hence it's important to consider a proper technique which can lessen PAPR at transmission end side.

OFDM symbol possess dynamic range which is large thereby resulting in increased count of PAPR. The issue of highest Peak To Avg Ratio in an OFDM essentially arises because of FFT/IFFT pre-processing (because a signal comprises large numbers of subcarriers which are modulated independently thereby results in large peak value when are summed up with same phases). Here, input msg symbols across sub-carriers have summed to produce value which is very high in regards of peak nature.

2. Literature Review

The main issue arising in MC systems is bcozof high value of PAPR which deteriorate the normal working of HPA used in non linear region of their characteristic curve. Therefore it is desired to adopt a proper technique for reduction of Peak to avg.ratio of power at transmitting side. There are widely used schemes for lessening PAPR are proposed in the review chapter such that the increased PAPR value get reduce in OFDM block. The schemes for reduction are classified in two categories.

- Schemes which are distortion based.
- Schemes which are non distortion based.

Techniques which are based on distortion are the straight forward and simple one reduction techniques as they introduces spectral regrowth .There are some schemes available for reduction but from them clipping technique is considered as most easy to implement as distortion based scheme. Here reg. this technique the clipping of the required signal is obtained to the certain desired threshold level such that reducing the peaker amplitudes of signal, but since the this is very simple it tends to introduce both the inside band and out band radiation issues. By considering these problems or issues the scientist named Armstrong proposed an iterative clipped and filtering schemes by considering in mind the out-band radiation.

There is another widely based distortion technique available called as the companding technique which will try to formulate the system PAPR to the minimum possible level. Hence a scientist named Wong et al. discussed a scheme based of μ-law companding such that PAPR value of signal input got reduced. In the μ-law companding scheme it was tried to keep the peak level value same before and after the companding part. Regarding this case after companding the avg value got increased a lot thereby keeping constant peak

power value. Having the ratio is peak to Avg power and therefore the avg power increases the ratio value automatically decreases.

After some time Jaing et al. discussed an exponentially related companding (EC) function which will try transforming the signal in context of magnitude from the Rayleigh function into uniformly distribution function using an "Exponential companding" scheme. This scheme will tends for minimizing the PAPR to certain extent but at same instant performance of BER also degrades to some extent. Later on prominent scholar named as Huuang *et al. also* proposed four transformation companding functions to lessen PAPR. It was seen that if performance is observed then the LNST was better as done comparison with the rest three ones. As the time passes later on Aburakhia et al. also proposed, a latest technique known as LCT minimizes the PAPR. In LCT two points known as inflexion are considered and large-small signals are treated on different scales and hence achieved more flexible situations when companding functions are designed. The abrupt occurred in signal which is changed at the inflexion points start degrading the PSD thereby minimizing the PAPR content.

Another scientist named as Hou et proposed, TC known as Trapezoidal Companding an efficient method to combat with the issue of OFDM technology that too with less BER. In this trapezoidal companding function the Rayleigh function is distributed in a trapezoidal fashion. This scheme has promoted the piecewise parameters in the defined three intervals of magnitudes of system as utilized greatly. Considering all Jung scientist proposes another technique which employs the Trapezium distributed based on companding function (TDBC) where the Rayleigh function distribution has the basis on linear trapezium. The above related techniques comes under distor-tion based category. The major consequence here is all the features related to spatial part of the signal which are transmitted needs compromise for lessening the PAPR content but the overall working of process gets affected.

The next type of Techniques comes under the Non-Distortion based reduction methods. In these techniques the compromise is not done which are related to the spatial features of signal and no phenomenon of spectral regrowth comes into picture. Coding technique (CT) is considered as the simple technique among many techniques available. In this case few amt of loss of data occurs during the process thereby reducing PAPR to bit extent.

There are distortion less reduction PAPR schemes and they are partially transmitting sequence of data (PTS) and selectively mapping (SLM) algorithm. In PTS as per its name, instead of transmitting the whole input data we partition the data into blocks which are known as subblocks and therefore all the SC are also partitioned into multiple disjoint sub parts and afterwards the phase factor for rotation (+1,-1,+j,-j) will be multiplied with all the subparts parts and later on they are combined at last of receiving from which selection of signal is done based on low PAPR. Here the whole data signal which is parallel of N length needs multiplication by rotating phase vectors sets U having the N length and afterwards the whole set is predetermined as it will generates many alternative signals. Considering U many alternative signals the signal showing less PAPR value will undergo selection for transmission. In the above schemes the detail knowledge of phase factors from where the sub blocks /data symbols has to be multiplied, and requires sending information at the receiving point in view of (SI). The SI is main feature such that recovery of an original signal obtained easily. If by some means SI corruptes and it's not received at receiving point then the whole symbol block of OFDM will be lost and BER performance related to SLM and PTS will be destroyed.

Apart from having many advantages in relation with PTS scheme like good error performance there is an issure involved as the sub blocks number increases after partition i.e. because the rate of data is very high then the amt. of SI which conveys at the reception end just to revert back the normal signal also increases. This process ultimately increases the computations of the whole system. On other side if the SI value is increased then the data loss chances comes under the signal also get increases. Now if SLM OFDM technique is considered then as the count or no. of alternative U signals also got increased and the no. required for encoding the data also got increased resulting in no gain of data. SI bits have a more importance as they are used for data recovery at last point and hence much necessary to use and to add some redundancy in form of bits for recovery. But at some moment of time some part of loss of data also comes into picture.

There are schemes proposed just for incorporating the SI in the systems. In those schemes the SI got embedded without using any redundant or extra bit. Here SI will be to reception point. Then the decoding is done just to get back the phase related information to lessen the PAPR effect . The signal which needs conversion will get multiplies by the reciprocal recovered phase factors, and hence the computations will get increased at the end. In various techniques the major cons is that if SNR value is low then the error performance is very poor and thereby tends to deteriorates the system value.

By considering the above issues related to SI another model known as MPSM-PTS has given by Zhou scholar in which all the constellation points of QPSK has been extended to every disjoint constellation pts. of 16-QAM and thereby helps to lessen the need of side information. This scheme MPSM-PTS is totally free from SI . Here no need of any SI information is required and hence it is less computationally complex.

LTE-OFDM systems are used for downlink purpose and BSC's for mobiles acting as receivers. The base station for mobiles always have a handful of resources and hence the technique used for lessening PAPR with less complex structure at last is more beneficial. MPSM-PTS scheme has to come to a suitable option for PTS-OFDM system as it's less computationally complex compared to other schemes

3. Proposed System

There are various techniques adopted to minimize PAPR value from transmission medium thereby helps in improving

the efficiency of system from transmitting end. Now we will see those techniques which we propose for better output.

1) Partial Transmit Sequence

There is efficiently used method for reducing PAPR is the Partially Transmitting Sequencing of data known as (PTS) .Here the method demonstrates the working in which the whole incoming data getting partitioned into the sub-blocks number. The required signal is developed after getting multiplied with any other phase rotation and hence the signal having the min. PAPR value needs selection for transmission at the end.

The module of IFFT is applied for every sub sequence and therefore the resulting subsequences of signal needs summation after multiplication with the distinct rotating vectors set.

Consider the input block of data as X = $\{X_K\}$, where value of k resides in the interval of (k = 1, 2…N -1), N denoting the no. of sub carriers used. In the domain of frequency (FD) data sequences, $X^{\varepsilon}(\varepsilon = 1,2,\dots M)$, by multiplying with the sequences of phase.

$$X^{\varepsilon} = \{P_K^{\varepsilon}\}(K = 0,1,2,\dots N-1) \quad (1)$$

All the X elements given above are providing the following given result

$$X^{\varepsilon} = [P_0^{\varepsilon}X_0, P_1^{\varepsilon}X_1 \dots \dots P_{N-1}^{\varepsilon}X_{N-1}] \quad (2)$$

where $\varepsilon = (1,2,\dots,M)$

Where $P_K^{\varepsilon} = \exp(j\varphi_K^{\varepsilon})$, φ_K^{ε} is distributed in uniform fashion in [0, 2π].

To get M candidates' using IDFT in domain of time

$$X^{\varepsilon} = IFFT\{X^{\varepsilon}\}, \varepsilon = (1,2,\dots,M) \quad (3)$$

It was observed that even candidates having same information provides different PAPRs and the signal having least PAPR from the X^{ε} needs selection for transmission purpose.

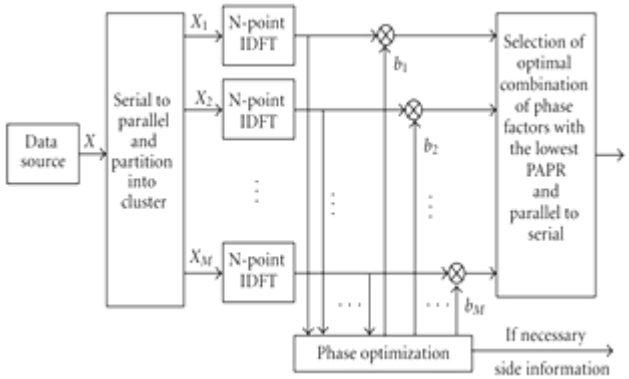


Figure 1: Basic block of conventional PTS scheme

To get M candidates' time domains using IDFT

$$X^{\varepsilon} = IDFT\{X^{\varepsilon}\}, \varepsilon = (1,2,\dots,M) \quad (4)$$

All the candidates have same information x provide different PAPRs. The signal having least PAPR from X^{ε} will undergoes selection for transmission.

2) Selective Mapping

Selection Mapping algorithm is a scheme used to mitigate PAPR in system. The concept behind this scheme is phase rotation. Signal having less PAPR value needs selection from all the different independent phase sequences that is showing same sort of information at I/P end.

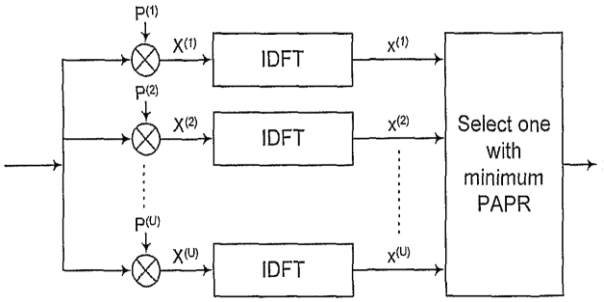


Figure 2: Basic block of SLM technique

Suppose the block of input end can be represented like

$$X = [X_0, X_1, X_2, \dots X_{N-1}]^T \quad (5)$$

When multiplication with phase sequences of input blocks is done of independent nature it results

$$P^u = [P_0^u, P_1^u \dots X_{N-1}^u]^T, u = (1,2,\dots,U-1) \quad (6)$$

where U denotes the no.of phase sequences

Here we keep the data length of an input and also the phase sequence as same. Afterwards obtain the domain of time signal by applying IFFT and hence we will obtain the blocks with the different PAPR and phase sequence.

$$X^u = [X_0^u + X_1^u + \dots X_{N-1}^u]^T \quad (7)$$

Selection of the min. PAPR scheme is done and then it is transmitted. There is another parameter known as CCDF which is being used to measure the probability and thereby indicating as the value particular block exceeding the given threshold. The CCDF showing PAPR of SLM system will be

$$P(PAPR > PAPR0) = (1 - (1 - e^{-PAPR0})^{\alpha N})^U \quad (8)$$

N= Sub-carriers number

N_{IIFT} =N IFFTs operation

U=independent phase sequence

PAPR0= threshold value

α= oversampling factor]^T

3) DCT-SLM

The aim behind the scheme comprising a mixing of two appropriate methods. It combines the DCT and also the SLM technique. At the transmitting end, firstly the stream of data is going to get transformed by matrix of DCT and later on this data which has undergone transformation will processed by SLM block. If it's passes through IFFT block ,the data block passes by managing the DCT matrix then all the coefficients autocorrelation of IFFT input got reduced, and hence the lessened PAPR is obtained.

Here the data passes through the unit of SLM and then will work with DCT unit. Here considering the case if DCT matrix is used after SLM then it further do the lessening of PAPR of signal. The O/P signal of PAPR will be reduced. The block of transmitter is showed below.

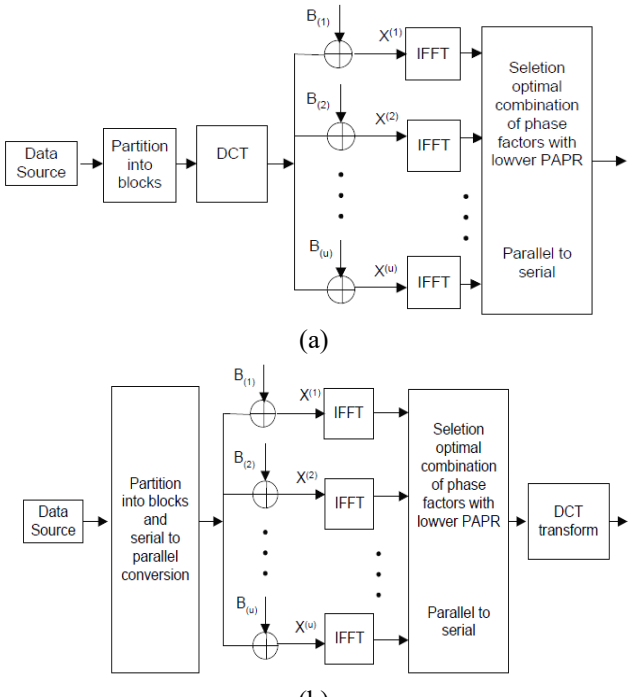


Figure 3: Block of DCT-SLM scheme

4. Interleaver Block

If the data frames which are transmitted shows the more correlation level then they possess more PAPR which can be reduced, and thereby achieving if their large correlation patterns will get broke. Therefore block of fixed permutations known as interleaving are used just to break the strongly related correlated patterns. Hence (k-1) blocks of interleavers getting used in transmitting end and these interleavers will therefore generate (k-1) combinations of frames of input data. The value of minimum PAPR will be chosen for transmission. The uniqueness of a corresponding interleaver requires to be passed at reception as a part of side information. The method is simplified with the implementation when done comparison with PTS or other schemes. Suppose the K computations of PAPR are performed simultaneously then the delay related to processing will get reduced hence uses for more speed of data communication.

For the spectrum monitoring purpose Interleaved resembles a very feasible option. Since in OFDM , the spaces are kept between the subcarriers equally and hence the frequency locations of all the SC can be determined if we capture one subcarrier. Interleaving is playing an important rule just to combat the noise bursts problem and fading occurring in error correction systems .If frame of data is interleaved then all the peaks related with the OFDM signals are getting compressed. Whenever interleaver is operating on a particular block comprising of symbols N and if the permutations are to be performed then block of data of X = $[X_0, X_1, \ldots\ldots X_{N-1}]^T$ becomes $X'=[X_{\pi(0)}, X_{\pi(1)} \ldots\ldots X_{\pi(N-1)}]^T$ where {n}={$\pi(n)$} belongs to 1-1 mapping and value of $\pi(n) \epsilon \{0,1, \ldots\ldots N-1\}$.If the multiple symbols are generated then the IDFT value needs calculation in individual sense for each different permuations.Afterwards the min PAPR value will be chosen for transmission. Given below is the block showing the interleaved OFDM transmitter. In this block of data is keeping with the (M-1) OFDM signals in comparison and therefore (M-1) Interleavers and M IDFT block are needed. More over in this process transmission of [log_2 M] amount of SI bearing bits are sent to reception point thereby helps in recovering the data at reception point thereby helping to know the receiver that which interleaver is used having least PAPR value for transmission purpose. At pt. of receiving the receiver will therefore calculates the FFT of the receiving signal and deinterleaving is applied.. Here the PAPR is considering two factors which are number of interleavers used (M-1) and interleaving design.

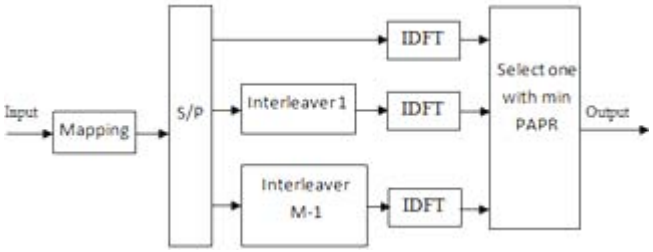


Figure 4: Basic block of an Interleaver

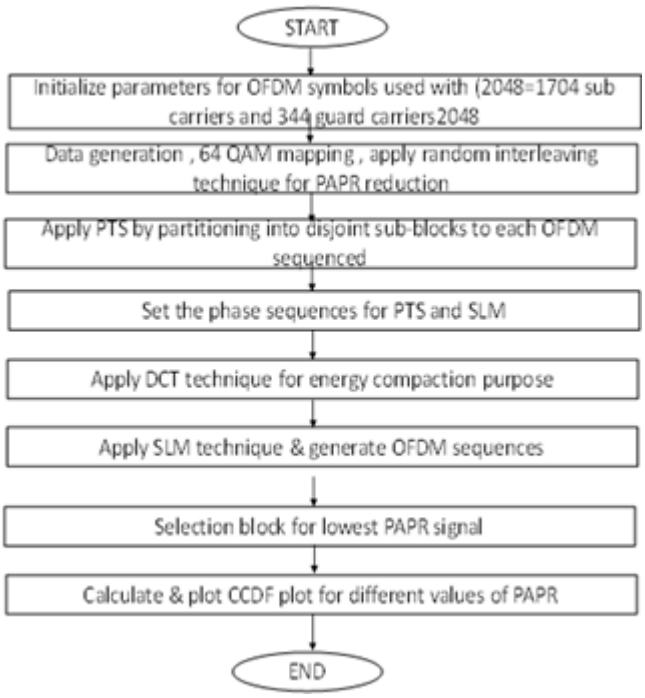
5. Implementation

Table 1: Parameter values and techniques

Parameters	Values and techniques
No of subcarriers used	2048 (1704 used carriers and 344 guard carriers)
IFFT size	512
Modulation scheme	64 QAM
Oversampling factor	6
Guard type	Zero padding
Phase factors in SLM &PTS	1,-1,j,-j
DCT matrix	1D
Partitioning scheme	Interleaved partitioning
Interleaver	Random interleaver
No of iterations for PTS	4
Random OFDM symbols generated	100000

There are certain parameters used for lessening PAPR are under gist and given above. The sub carriers used are 2048.Out of 2048 sub carriers 1704 are the actual SC and remaining 344 are the guard carriers. The IFFT size taken as 512.Modulation of system is done with the 64 QAM and the size of word is taken as 6.The window size is taken as 0.Here the ZP is used as a cyclic prefix. Here the factors for rotation used are 1,-1,j,-j for the SLM technique. The phases used for PTS belongs in the interval $(0,2\pi)$. Interleaved partitioning scheme is adopted for the partitioning of sub blocks in the PTS method. The (CCDF) of the PAPR for the signal transmitted are plotted after each method reducing PAPR used.

The flow chart used for implementation is as follows:



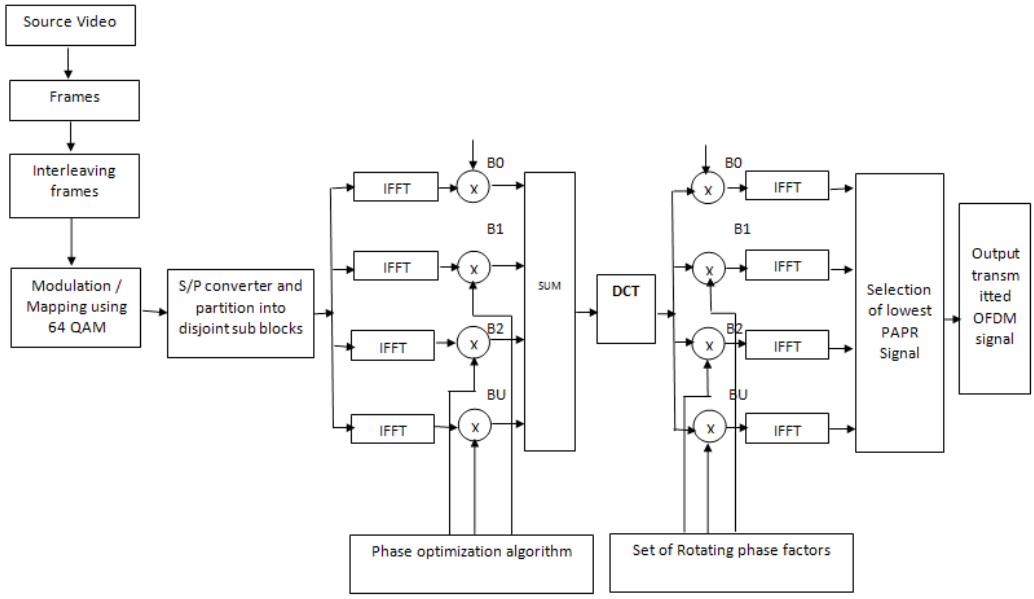


Figure 5: Basic block of the Proposed System

A system which is proposed is made by combination of hybrid techniques including DCT,PTS and SLM algorithm as shown below. In the model initially the encoded data will be applied for interleaving purpose and later on to other stages. Here video data is choosed as a source comprising of a 3D quantity. Firstly a video which is transmitted undergone conversion into frames or images which is 2 D quantity and then decimal to binary conversion will be taken place. Now these frames are fed to encoder block where these input bits will be modulated by 64 QAM modulation and hence converted into complex symbols.

Now the frames will be given to the interleaver block .Here random interleaving is done just to reshuffle the sequence of frames. Random interleaving will merely do permutations on all lines of the I/P bit stream in a random fashion. The effect related to random shuffling will make the correlation in all symbols. Random interleaver rearranges all elements of I/P vector using permutations in random sense. Here frames are considered therefore the column vector will be an input vector. When we sent a signal it requires some power for sending the bits. Supposing we have 8 bits to send then the power required is in increasing order from 1 to 8, therefore when we calculate the average PAPR we will have something a value around 4.5 so to save power the interleaver is sending the bits in random order like 2 6 4 7 8 1 and so on, by doing this the average PAPR value decreases. Figure 5. 1 Block diagram of proposed system

Figure 6: Interleaver Processs

As drawn above the interleaver has randomized the bits sequence for reducing the PAPR content in the system. Once it got passed by an interleaver it goes to the S/P converter block which mainly converts the serial input into parallel input, as given as the block the bits are now sent as arrays of x[i] where I = 0 to n.

After passing through the S/P converter block the data input again send to the PTS block. Here the iterations number are considered as 4 i.e. count of sub blocks are chosen as 4.We can consider more no of sub blocks partition but the value remains same and hence IFFT requirement will be more and time consumed for functioning will be more. The values of OFDM sub blocks will be calculated just by considering the optimization algorithm, such that it is given below:

$$b_u{}^1 \ldots\ldots\ldots b_u{}^v = arg\ min_{[b_u{}^1 \ldots\ldots\ldots b_u{}^v]} \left(\frac{Max_{n\epsilon[0,N]} \left| \sum_{v=1}^{V} b_u{}^v x_n{}^{(u,v)} \right|^2}{E\{ \left| \sum_{v=1}^{V} b_u{}^v x_n{}^{(u,v)} \right|^2 \}}\right) \quad (9)$$

where $x_{(n)}{}^{(u,v)}$ denotes n no of subcarriers in the V sub block of U PTS block.
$b_u{}^v$ represents the rotational factors which are actually applied to all the V subblocks in U PTS blocks where U and V will $1 \leq u \leq U, 1 \leq v \leq V$.

Interleaved partitioning scheme is chosen for separating sub blocks .All the V sub blocks will get multiplied with complex phase sequences given by phase factor as $w_v = e^{j\emptyset m}$, where M value given by = 1,2,3,....V and $\emptyset = [0,2\pi]$. After the IFFT operation the PTS block will produce an O/P signal x^u as given by

$$x^u = \sum_{v=1}^{V} b_u{}^v \; x^{(u,v)} \text{ where } 1 \leq u \leq U, \quad (10)$$

and $x^{(u,v)}$ denotes domain of time representations of the V sub blocks or IFFT has been taken .
Now selection of all the factors related to phase needs optimization just to lessen the PAPR is given in equation below and also the signal among all the U signals is selected having the min. PAPR value as given by,

$$u = \arg min_{0 \leq u \leq U-1} \left(\frac{Max_{n\epsilon[0,N]} \{ |x_{(n)}{}^v| \hat{} 2 \}}{E\{ |x_{(n)}{}^v|^2 \}}\right) \quad (11)$$

Here the alternatives which are to be produced by the conventional hybrid technique represents the no of PTS blocks as given by,

$$I = I_{PTS} \leq I_{PTS\ max} \quad (12)$$

Consisting of number of superpositions (candidates) in every PTS block as given by

$$I_{CH} = U_{Total}\, I_{PTS} \leq UW^{(V-1)} \quad (13)$$

Since SLM and PTS are used in an combined manner and hence the SI number given by

$$SI = [log_2(U) + log_2(I_{PTS})\ bits \quad (14)$$

which shows the side information

The main role performed by IFFT is to change the domain of frequency to time .After passing through the PTS block now signal will passes through DCT block .DCT is a coding technique for transformation which considers that pixels in one image shows a more level of coincidence with the neighboring pixels of that particular image. Similarly when considering a transmission of video all the pixels which are near to each other of consecutive frames shows more level of correlation. Now the values of pixels from respective are exploited easily with correlation. Here the motto of DCT is to transform the spatial(correlated data) into uncorrelated data coefficients).Since DCT has property of compaction of energy and hence the efficacy of this transformation scheme is directly linked by showing ability of packing the data input in less as much coefficients as possible. This is possible by discarding some coefficients showing relatively small amplitudes without adding some part of distortion in context of visual aspects in the reconstructed received image.

DCT tries to extends the conceptually N point original sequence of data to 2N point by just considering the extension mirror of N point sequence. In DCT both the ends of data shows continuous nature and hence lower order value components will become dominated after doing transformation with DCT. This transform was given by scientist named as Ahmed et al.DCT is a Fourier transform where main aim is to lessen the autocorrelation in the signal which is an input thereby helps in reducing in PAPR problem to some point and hence no requirement of sending SI at the receiver.

In thesis DCT is applied after PTS block. The precoding on each symbol will be obtained by DCT matrix. The main intention of the DCT coding matrix is to convert the domain of time signal to the newly transformed domain .Since DCT is showing the orthogonality nature and hence known as linear transform which needs implementation using Butterfly structure.DCT is working on numbers which are real and is a real transform in which the whole data undergoes multiplication with a cosine function. The M M DCT matrix P is shown below.The DCT matrix contains rows and columns and they satisfies orthogonality thereby helps in reducing PAPR value.

$$P_{ij} = \begin{cases} \frac{1}{\sqrt{M}} \; i = 0, 0 \leq j \leq M-1 \\ \sqrt{\frac{2}{M}} \cos\left[\frac{(2j+1)i\pi}{2M}\right] \; 1 \leq i \leq M-1, 0 \leq j \leq M-1 \end{cases} \quad (5.8)$$

where i and j representing rows and columns entries, resp. For a 1 M vector X , Y shows its DCT. Hence it is obtained as Y = PX and P is known DCT matrix.

Now the DCT signal passes through the SLM block ,since DCT-SLM is adopted and hence the amount of auto correlation will get reduced. Since the DCT is adopted first before SLM then the autocorrelation among the digitally modulated OFDM bits will get reduced thereby lessen the PAPR effect because of property of compaction .

In SLM block the DCT signal gets divided into 4 disjoint sequences and hence after multiplication with the phases and done with the IFFT operation the signal with the less amount of PAPR undergoes selection. Then the signal which is selected having lowest PAPR value will passes through AWGN channel.

Less PAPR value is desired at transmitter and hence all the operations will be done at the transmitting end. After getting passed from channel at the module of reception all the reverse operations will be performed like IDCT and deinterleaver is used . At sending time the signal bits were

made random and then those randomized signals are gain transferred to the serial series of the signal.

This system found to best than other system bcoz of the adding interleaver. In the old systems i.e. without the interleaver, we linearly send the signal and hence the power required will also increase linearly and when the average PAPR is calculated of such system its high. But if the Interleaver is added then we send a signal randomly and hence the power usage is not linear and is automatically low and the avg PAPR is low comparatively then the old systems.

6. Results

MATLAB simulation is done and comparison of results is obtained on basis of PAPR value, BER and corresponding CCDF in conventional system, system using only DCT and the system which is proposed in which hybrid techniques are adopted like SLM,PTS and DCT .Here three different videos of three different sizes are considered and value of PAPR, BER FOM and the corresponding CCDF is calculated by considering the no. of frames and the SNR in relation to the parameter of channel for systems. The no of frames and SNR of AWGN might be altered by altering different values. The channel used is AWGN channel. After implementation it is seen that the Peak to Avg power ratio is considerably less for system which is implemented and BER degradation is not more when the no. of frames are increased when done comparison with the systems which uses DCT and also conventional system as DCT is having the higher energy compaction property.

6.1 Simulated Results for Normal OFDM system

The given below figure shows when no scheme is applied. Here the video which is considered is of 153 Kb in which 203 frames are processed and channel SNR channel as 30.Graph is plotted by considering the frames and SNR of channel as an input. Both these quantities can be altered for tests purpose. It was seen that the value is around 14.42 db which is very high.BER performance is also low. Despite of the increasing range of PAPR , the merit of figure is high and it goes on increasing with the increased frame .CCDF is also plotted as it is seen that the PAPR exceeds the certain threshold level.

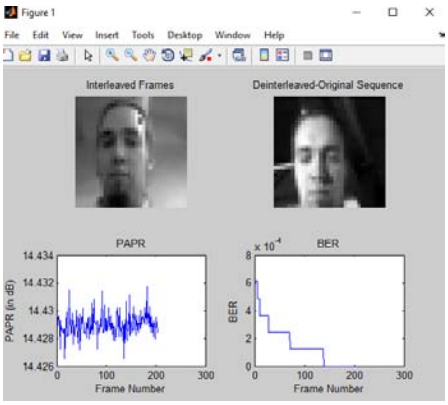


Figure 1: PAPR Vs. No of frames of conventional system

Here the figure shows the sent and received signal frames, and it also depicts the CCDF curve plotted against PAPR value.

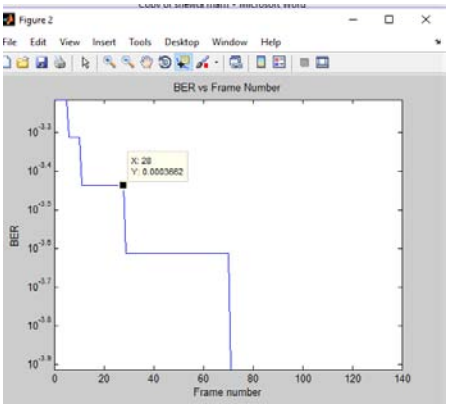


Figure 2: BER Vs. Frame number of OFDM system

Here above it is shown BER reduction as the no. of frames increases. Hence its necessary to apply PAPR reduction scheme.

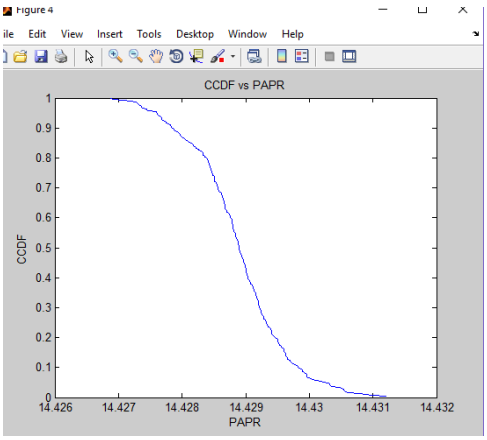


Figure 3: CCDF Vs PAPR

Here the figure above depicts the CCDF Vs PAPR of conventional system using 64 QAM modulation technique with IFFT size of 512.

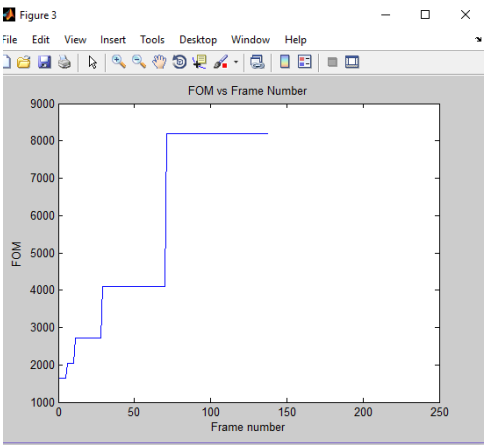


Figure 4: FOM of the system

Above it depicts the figure of merit of the system.

5.2 Simulated results for the system using DCT

The given figures shown below when DCT is considered. The video size is of 153Kb and the frames are 203.The SNR is 30. The time for simulation purpose is 3.6845 mins. The size of an image is 32 .It is obtained that the PAPR is found to be 10.2418 db. At the end the plotting of graph is done for CCDF against Peak to Avg. Ratio .The CCDF stays o 10.17db .Here reduction of almost 5db as done comparison with the conventional system.

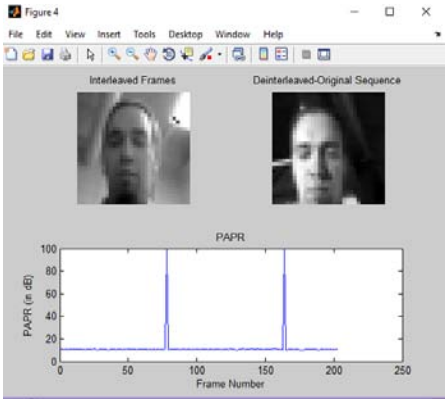


Figure 5: PAPR performance of MC system using DCT

Here the figure above is depicting that the PAPR value has dropped down to 10.13 db if reduction technique using DCT is applied.

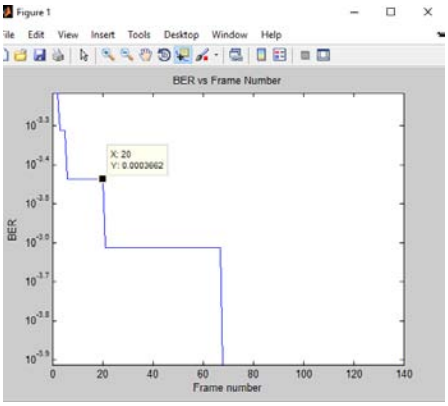


Figure 6: Performance curve related to BER Vs Frame number

Here above the curve is showing in relation to BER vs. Frame numbers.

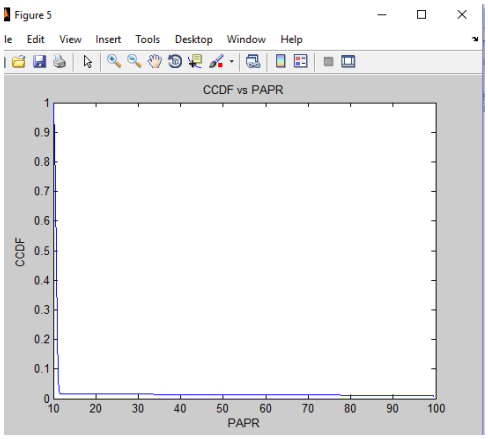


Figure 7: CCDF vs PAPR of MC system using DCT.

In the above figure it is depicting that CCDF is exceeding the threshold level.

5.3 Simulated results using Hybrid combination of reduction techniques:

Here the video size is of 153Kb and the frames are 203.The SNR is 30. The no. of frames and SNR can be altered .The simulation time is 4.6845 mins. The image size is as 32 .It is observed that value of PAPR comes around 5.214db.Atlast the graph is plotted for CCDF Vs PAPR .The CCDF stays on the level of 5.214db .Similarly Error Rate performance is good as the no. of frames arises. The FOM increased with the increased no. of frames FOM is the SNR the O/P end to the SNR at the I/P end.

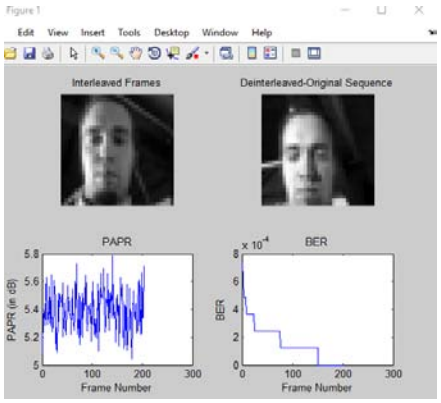


Figure 8: Performance related to PAPR using PTS,SLM and DCT techniques.

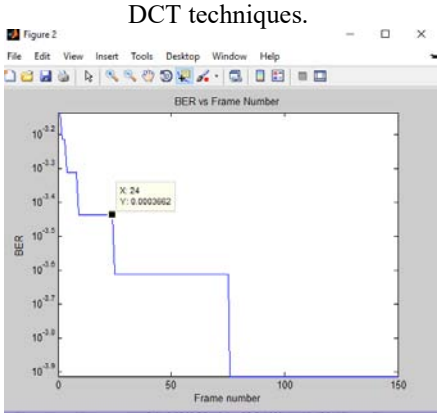


Figure 9: BER curve plotted against PAPR.

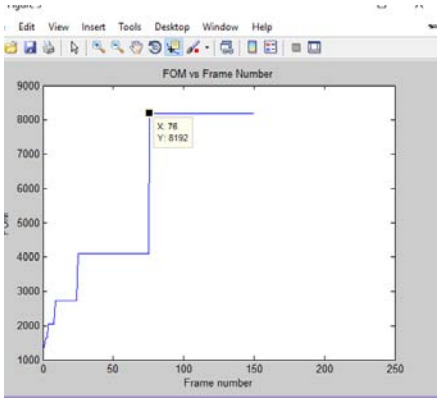


Figure 10: FOM of the system

When no PAPR reduction technique is applied then the FOM of the frames is very low. But when it is applied the end FOM value is then nearly the start FOM value.

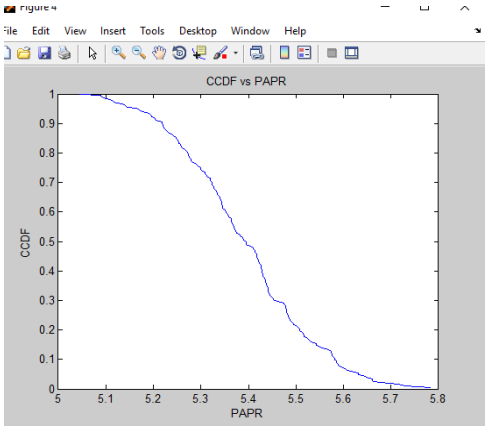


Figure 11: CCDF Vs. PAPR of the system using PTS,DCT &SLM technique

It has been seen from the above graph as that the value of PAPR is lowest in all the three systems and hence will be free from error.

Comparative analysis showing reduction related to PAPR & BER.

NO.OF FRAMES	NORMAL OFDM PAPR(db)	OFDM WITH DCT PAPR(db)	OFDM WITH PTS,DCT and SLM PAPR(db)
203	14.4281	10.9704	5.1765
328	14.4282	10.7539	5.0807
257	14.4284	10.5444	5.1051

NO.OF FRAMES	NORMAL OFDM BER	OFDM WITH DCT BER	OFDM WITH DCT,PTS and SLM BER
203	0.0251	0.0251	0.0282
328	0.0280	0.0281	0.0279
257	0.0276	0.0276	0.0275

7. Conclusion

Since in all the MC communication ,OFDM has been choosen bcoz of high data rate of transmission , but it is having high drawback regarding PAPR value. Hence to mitigate that problem a hybrid technique is proposed which combines PTS,DCT and SLM along with interleaver. However its very difficult to come to conclusion that which technique in individual sense is the most attractive technique and hence all the technique are combined .These techniques are help in reducing a lot of value of PAPR and no data loss. There are certain factors which decides the computational complexity including BER and FOM along with CCDF to decide appropriate PAPR technique.

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