Performance Analysis of a Combined PTS Partitioning Scheme for PAPR Reduction in OFDM Signals under Different Modulation Techniques

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Abstract—Orthogonal frequency division multiplexing (OFDM) is known as one of the promising broadband techniques in wireless communications. One of the major drawbacks of OFDM is its high peak-to-average power ratio (PAPR) due to the overlay process of all subcarrier signals. This leads to distortion problems at the receiver. Partial Transmit Sequence (PTS) technique is one of the most popular to reduce the PAPR in OFDM systems without any distortion. The crucial step in any PTS system is partitioning of the OFDM frame into disjoint sub-blocks. Adjacent partitioning PTS (AP-PTS) is an easy partitioning scheme achieving attractive PAPR reduction performance in a trade-off between cost and performance. This paper offers performance analysis of an enhanced PTS technique based on the combination of two kinds of sub-block partitioning methods (adjacent with interleaved) for PAPR reduction in OFDM signals. It also investigates into implementation of Finite Radon Transform (FRAT) as a modulation technique for data mapping and provides comparative analysis of the performance of FRAT with the traditional data mapping techniques such as phase shift keying (PSK) and quadrature amplitude modulation (QAM). The effects of PTS partition length variability of disjoint sub-blocks on AP based PTS systems were also determined in order to perform the comparative analysis. (AP-PTS) scheme was applied for both fixed length and variable length partitioning for modulation techniques mentioned above. Simulation results show that the enhanced PTS technique outperforms reduction in PAPR against the adjacent with fixed and variable length, which (AP-PTS) is known to perform better than the interleaved partitioning for all the scenarios of mapping, and show that the traditional mapping for any types of techniques (PSK or QAM) with various partitioning scenarios had a better PAPR reduction performance compared to FRAT data mapping.

Keyword-Orthogonal frequency division multiplexing (OFDM), Peak-to-average power ratio (PAPR), Partial transmit sequences (PTS), Sub-block partitioning, Finite Radon Transform (FRAT)

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) is a transmission technique which involves a blend of modulation and multiplexing. A high data rate stream splits into a number of low data rate streams which are modulated onto different orthogonal carriers [1]. OFDM is very attractive which used in digital communications; it ensures superior transmission rates with spectrum efficiency. The frequency spacing between the carriers and the orthogonality to each other is established through the use of Fast Fourier transform (FFT). Immunity against multi-path dispersion is high, by requiring a large number of subcarriers [2]. Newly, OFDM is mainly used in digital audio broadcasting (DAB), digital video broadcasting terrestrial (DVB-T), mobile multimedia access communication (MMAC), IEEE802.11a, IEEE802.16 and IEEE 802.20 [3, 4].

However, one major drawback of the OFDM system is the high peak-to-average power ratio (PAPR) due to its multicarrier nature. The larger PAPR signal would cause high out-of-band radiation and degradation of bit error rate (BER) performance when the OFDM signal is passed through a radio frequency power amplifier [5, 6]. Recently, to reduce the PAPR at the transmitter, many methods have been used in the literature [7, 8], such as clipping [9], clipping and filtering [10], coding [11], selective mapping (SLM) [12], companding methods [13], tone reservation (TR) [14], tone injection (TI) [15], active constellation extension (ACE) [16], partial transmit sequences (PTS) [17]. Each of these methods has a diverse cost for bit error rate (BER) and the reduced PAPR. Among these, the PTS method [18, 19], is one of the more appealing and a distortionless scheme for PAPR reduction in OFDM systems. In the PTS method, the input data of N symbols are partitioned into M disjoint sub-blocks. The subcarriers in each sub-block weight by a phase factor. The phase factors are selected such that the PAPR of the combined signal is reduced. Also, PTS method works with an arbitrary number of subcarriers and any modulation technique [2]. In this paper, we present performance analysis of an enhanced PTS technique that combined two sub-block partitioning schemes adjacent with interleaved to reduce the PAPR. Also, we implemented Finite Radon Transform (FRAT), which is originally used for image processing as a modulation technique for data mapping, as done by Ibraheem Zeyid T., et al [20]. A comparative analysis of the performance of FRAT with the traditional data mapping techniques such as (PSK and QAM) is also presented.

Both adjacent for (fixed and variable) length and interleaved PTS methods are implemented and tested for the sake of comprehensiveness in the analysis. The rest of the paper is organized as follows: In Section II, we present an overview of an OFDM system, ordinary PTS technique, and FRAT. Section III presents the sub-block partitioning schemes. In section IV, we elaborate on the enhanced PTS scheme for reducing PAPR of an OFDM signal. In section V, we analyse the simulation results. Finally, Section VI gives the conclusion.

II. PAPR IN OFDM SYSTEM AND PTS SCHEME

A. PAPR in OFDM System

The complex baseband signal in the OFDM modulation technique $\mathrm{x_n}$ with N subcarriers is given by

$$\mathrm{x(n)} = \frac{1}{\sqrt{\mathrm{N}}}\sum_{\mathrm{k=0}}^{\mathrm{N-1}} \mathrm{X(k)}\, \mathrm{e}^{\left(\frac{\mathrm{j}2\pi \mathrm{kn}}{\mathrm{N}}\right)} \quad , \quad 0 \le \mathrm{n} \le \mathrm{N}-1 \tag{1}$$

where $\mathrm{X_k}$ is denotes the input data symbols at k-th subcarrier modulated by QAM or PSK.

The PAPR of the transmitted signal $\mathrm{x_n}$ in Eq. (1) is defined as the ratio of its maximum power divided by its average power, which can be expressed as [21]

$$\mathrm{PAPR} = \frac{\max|\mathrm{x(t)}|^2}{\mathrm{E}[|\mathrm{x(t)}|^2]} \tag{2}$$

where E[22] denotes the average power.

In order to evaluate any PAPR reduction performance, OFDM system uses the complementary cumulative distribution function (CCDF). The CCDF of PAPR denotes the probability that the PAPR of a data block exceeds a given threshold PAPR0. CCDF is defined as [23]

$$\mathrm{CCDF(PAPR_0)} = \mathrm{P_r}\,(\mathrm{PAPR} > \mathrm{PAPR_0}) \tag{3}$$

B. PTS Scheme

The PTS method's main mentality is shown in Fig. 1, the frequency-domain signal of data block X is partitioned into M disjoint sub-blocks of equal size, denoted as $\mathrm{X_m}$, where $\mathrm{m} = 1, 2, \dots\dots, \mathrm{M}$, where each sub-block's length is still N. Therefore, is expressed as

$$\mathrm{X} = \sum_{\mathrm{m=1}}^{\mathrm{M}} \mathrm{X_m} \tag{4}$$

Next, Inverse Discrete Fourier Transform (IDFT) is used to transform sub-block partitioning from frequency domain to the time domain, which can represent as

$$\mathrm{x_m} = \sum_{\mathrm{m=1}}^{\mathrm{M}} \mathrm{IDFT}\,\{\,\mathrm{X_m}\,\} \tag{5}$$

Then all subcarriers for each sub-block $\mathrm{x_m}$ are multiplied by phase weighting factors and combined together to produce a group of candidates. The candidate to achieve the lowest PAPR is selected for transmission. Thus, the time domain signal after the combination is given by

$$\mathrm{x} = \sum_{\mathrm{m=1}}^{\mathrm{m}} \mathrm{b_m x_m} \tag{6}$$

In general, PTS sub-block partition schemes can be classified into three categories; interleaved, adjacent, and pseudorandom [24]. Out of these partitioning schemes, pseudorandom sub-block partitioning PTS (PRP-PTS) has the best for PAPR reduction performance. Adjacent partitioning PTS (AP-PTS) scheme used in comparison is attractive method because of its low computational complexity, and offers performance in PAPR reduction very close to PRP-PTS [25].

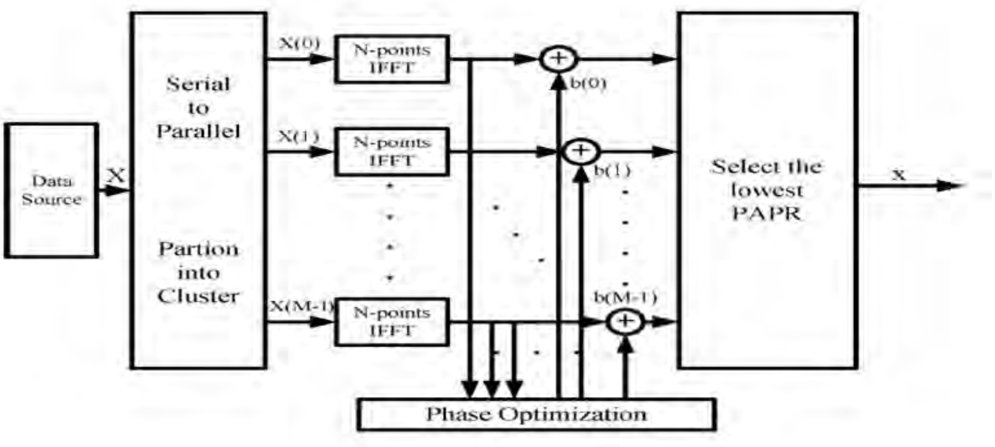

Fig.1. Block diagram of the PTS Scheme

C. *Finite Radon Transform (FRAT)*

As mentioned in [20], FRAT is one of the discrete types of the Radon transform that used later as a new data mapping in OFDM systems. This transformation is defined for 2-dimensional signals. This transformation is defined here in 2-dimensional binary data matrix (A). The FRAT of a two dimensional square matrix A, with a condition that the size of the matrix, denoted by p, should be prime can be obtained first by taking the 2D-FFT of A [26, 27]

$$F(r,s)=\sum_{m=0}^{p-1}\sum_{n=0}^{p-1}A(m,n)\ e^{-j\left(\frac{2\pi}{p}\right)rm}e^{-j\left(\frac{2\pi}{p}\right)ns} \tag{7}$$

After that, a component of the matrix F has been re-distributed according to the optimum ordering algorithm given in [23]. Therefore, the dimensions of the resultant matrix will be $p\times(p+1)$ and will be denoted by the symbol F_{opt}. Fig. 2, shows the optimal ordering of the matrix of Fourier coefficients for matrix dimension p=7.

$$\begin{bmatrix} f1 & f8 & f15 & f22 & f29 & f36 & f43 \\ f2 & f9 & f16 & f23 & f30 & f37 & f44 \\ f3 & f10 & f17 & f24 & f31 & f38 & f45 \\ f4 & f11 & f18 & f25 & f32 & f39 & f46 \\ f5 & f12 & f19 & f26 & f33 & f40 & f47 \\ f6 & f13 & f20 & f27 & f34 & f41 & f48 \\ f7 & f14 & f21 & f28 & f35 & f42 & f49 \end{bmatrix},\ F_{opt}=\begin{bmatrix} f1 & f1 & f1 & f1 & f1 & f1 & f1 & f1 \\ f2 & f10 & f9 & f16 & f8 & f21 & f14 & f13 \\ f3 & f19 & f17 & f31 & f15 & f34 & f20 & f18 \\ f4 & f28 & f25 & f46 & f22 & f47 & f26 & f23 \\ f5 & f30 & f33 & f12 & f29 & f11 & f32 & f35 \\ f6 & f39 & f41 & f27 & f36 & f24 & f38 & f40 \\ f7 & f48 & f49 & f42 & f43 & f37 & f44 & f45 \end{bmatrix}$$

Fig.2. Optimal ordering of FRAT coefficients for matrix size: p =7

Finally, the FRAT can be obtained by taking the 1D-IFFT for each column of the matrix F_{opt}.

$$r_i=\mathrm{Re}\left\{\frac{1}{p}\sum_{m=0}^{p-1}f(i)e^{j\left(\frac{2\pi}{p}\right)km}\right\} \tag{8}$$

Now, the matrix with the r_i columns represents the FRAT of A

$$R=\begin{bmatrix} r_{0,0} & r_{0,1} & \cdots & \cdots & r_{0,p} \\ r_{1,0} & r_{1,1} & \cdots & \cdots & r_{1,p} \\ \vdots & \vdots & & & \vdots \\ \vdots & \vdots & & & \vdots \\ r_{p-1,0} & r_{p-1,1} & \cdots & \cdots & r_{p-1,p} \end{bmatrix} \tag{9}$$

A modification is made on R which is the matrix of FRAT coefficients, for the purpose of raising the bit per Hertz of the mapping before resizing the mapped data and that's by constructing the complex $\overline{\mathrm{R}}$ matrix from the real matrix R according to

$$\bar{r}_{l,m} = r_{i,j} + i r_{i,j+1}, 0 \le (i,j) \le p \tag{10}$$

where, $\bar{\mathrm{r}}_{\mathrm{l,m}}$ refers to the elements of the matrix $\overline{\mathrm{R}}$, and $\mathrm{r}_{\mathrm{i,j}}$ refers to the elements of the matrix R.

The recovered vector can be obtained by reversing the above procedure, i.e. by taking the matrix resizing, retrieve a real matrix, taking the 1-D FFT, retrieving the original Fourier coefficients ordering, taking the 2-D IFFT and finally resizing the 2-D matrix to 1-D matrix. Fig. 3 shows the main procedure of taking the FRAT and IFRAT.

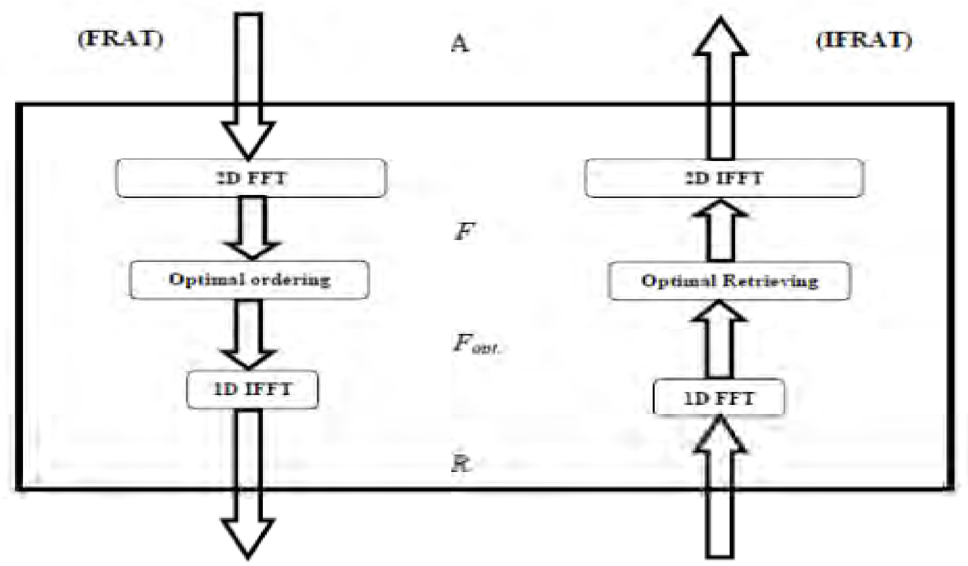

Fig. 3.Block diagram of the FRAT and inverse FRAT

III.SUB-BLOCK PARTITIONING ON PTS METHODS FOR PAPR REDUCTION

1. *Adjacent Partitioning PTS (AP-PTS)*

In this section, we simulated the PTS scheme with an adjacent method for variable and fixed length of sub-blocks partitioning. Mathematical frameworks of these two different adjacent methods can explain by [28].

A. *Adjacent Partitioning with Variable length (VL-AP)*

In this method, the input data OFDM symbol was first partitioned into M disjoint with equal variable sub-block size. Each sub-block has IFFT was computed. The output of IFFT in each sub-block was a phase rotated by the rotation factors and combined to achieve PAPR as low as possible. The transmitted signal in this scheme can be represented by,

$$\tilde{x}(n) = \sum_{i=0}^{M-1} x_i^{(r_i)}(n) \tag{11}$$

where $\mathrm{x}_\mathrm{i}^{\mathrm{r_i}}(\mathrm{n})$ is the phase rotated of the time domain signal for partition $\mathrm{P_i}$ with length $\mathrm{L_i}$. As mentioned, first variable length partitions are generated as follows.

$$\mathrm{X} = \left[\acute{\mathrm{P}}_0\ \acute{\mathrm{P}}_1 \acute{\mathrm{P}}_2 \ldots\ldots\ \acute{\mathrm{P}}_{\mathrm{M}-1}\right] \tag{12}$$

$$\mathrm{P}_0 = [\qquad \acute{\mathrm{P}}_0 \qquad , 00000 \ldots\ldots 0] \tag{13a}$$

$$\mathrm{P}_1 = [00000 \ldots\ldots 0, \quad \acute{\mathrm{P}}_1, \quad 00000 \ldots\ldots 0] \tag{13b}$$

$$\ldots\ \ldots\ \ldots\ \ldots\ \ldots.\ \ldots.\ \ldots.\ \ldots.\ \ldots\ \ldots.\ \ldots..$$

$$\mathrm{P}_{\mathrm{M}-1} = [00000 \ldots\ldots 0, \quad \acute{\mathrm{P}}_{\mathrm{M}-1}] \tag{13c}$$

Then the time domain signal is obtained by taking IFFT of these partitions as showed by Eq. (14).

$$\mathrm{x_i(n)} = \mathrm{IFFT(P_i)}, \mathrm{i} = 0,1,2,\ldots\ldots,\mathrm{M}-1 \tag{14}$$

Phase rotated $\mathrm{x}_\mathrm{i}^{\mathrm{r_i}}(\mathrm{n})$ of the time domain signals are obtained simply through multiplication by phase factors,$\varphi(\mathrm{r_i}) = \mathrm{e}^{\mathrm{j}\theta_\mathrm{i}}$ as in Eq. (15) whereθ_i are the rotation angles.

$$x_i^{(r_i)}(n) = \varphi(r_i)x_i(n) \quad (15)$$

B. Adjacent Partitioning scheme with Fixed Length

We repeated the procedure in step (a) with fixed length size of sub-blocks partitioning for the same input data OFDM symbol.

2. Interleaved Partitioning PTS (IP-PTS)

In interleaved partitioning, the N subcarrier is first divided into M groups with each group having $L = N/M$ contiguous subcarriers. Then the i-th interleaved partition is formed by assigning i-th subcarrier of each group to the i-th interleaved partition. The partitions can be represented by the following equations [28],

$$P_0 = \left[\, P_0^{(1)}0\,..0P_0^{(2)}0\,.....0P_0^{(M)}00..0\right] \quad (16a)$$

$$P_1 = \left[\, 0P_1^{(1)}0\,..00P_1^{(2)}0\,.....00P_1^{(M)}0..0\right] \quad (16b)$$

……… … …. …. …. …. … …. …..

$$P_L = \left[\, 00..0P_L^{(1)}0\,..0P_L^{(2)}0\,.....0P_L^{(M)}\right] \quad (16c)$$

where, P_i^j is the j-th element of the i-th interleaved partitioning. In the above this method, the remaining steps to generate a transmitted signal are similar to those of AP-PTS method, after partitioned an input symbol sequence of N sub-carriers into M disjoint sub-blocks with equal size. The sub-blocks partitioning are converted into the time domain by using IFFT operation. The output of all these IFFT results was rotated by a set of rotating phase factors and finally combined to achieve the minimum PAPR. The mathematical process is represented by

[IFFT]

$$x_0(n) = IFFT(P_0) \quad (17a)$$

$$x_1(n) = IFFT(P_1) \quad (17b)$$

$$x_{M-1}(n) = IFFT(P_{M-1}) \quad (17c)$$

[Rotation]

$$x_0^{(r_0)}(n) = x_0(n) \quad (18a)$$

$$x_1^{(r_1)}(n) = x_1(n) \quad (18b)$$

$$x_{M-1}^{(r_{M-1})}(n) = x_{M-1}(n) \quad (18c)$$

[Transmitted Signal]

$$\tilde{x}(n) = \sum_{i=0}^{M-1} x_i^{(r_i)}(n) \quad (19)$$

IV. ENHANCED PTS METHOD

The enhanced PTS method can be found in our earlier paper Ibraheem Zeyid T., et al. in [28]. The enhanced PTS approach reduces PAPR during the improved combination of partitioning. In this method to break down the long correlation patterns, a fixed permutation (adjacent and interleaved) sub-block partitioning schemes are employed, which are provided in the section below.

This enhanced method is similar to other sub-blocks partitioning, which it begins through the frequency domain data frame as an input into v adjacent blocks. Then, the blocks are divided into sub-blocks of size s. Finally, blocked interleaved partitions P_i are constructed by appointment the sub-blocks into the partitions, as follows

$$P_i\binom{q}{r} = Sb_{ri}(q) \quad (20)$$

where, $P_i\binom{q}{r}$ represents the q-th element of the sub-block r within the partition P_i and $Sb_{ri}(q)$ represents the q-th element of the sub-block i within the block r of the original data. A blocked interleaved partition consists of a sub-block from each of the v blocks. Each sub-block has a size of s, and thus, the partition size is $s.v$.

Now, in the enhanced PTS approach, each of the blocked interleaved partitions contains $s.v$ elements. The IDFT of each partition is then obtained independently. The output of the IDFT in each of the partitions P_i is given by

$$x_n^{(i)} = \sum_{q=0}^{s-1}\sum_{r=0}^{v-1} P_i\binom{q}{r} e^{j2\pi(rl+is+q)n/N} \quad (21)$$

where $x_n^{(i)}$ represents n-th sample in the PTS sequence corresponding to the partition P_i, N is the total number of subcarriers, and l is the number of blocks $(l = N/v)$. Moreover, r is the sub-block index within the partition and q is the index within the sub-block.

The PTS sequences $x_n^{(i)}$ are phase rotated with a rotation factor w_i, while the first sequence $x_n^{(0)}$ is kept constant, that is, w_0=1. The phase factors w_i are given by the exponentials

$$w_i = e^{j\varphi_i} \qquad i = 0,1, \dots \dots (z-1) \tag{22}$$

where, φ_i are randomly selected numbers within the range $0 \leq \varphi_i \leq 2\pi$, z is the number of block interleaved partition. Subsequently, rotated sequences $\tilde{x}_n^{(i)} = w_i . x_n^{(i)}$ are then combined to generate a transmission signal candidate $\tilde{x}_n$ that contains the same information within a phase factor.

$$\tilde{x}_n = \sum_{i=0}^{v-1} \tilde{x}_n^{(i)} \tag{23}$$

This process is repeated with a different set of phase rotation values. With each repetition, the PAPR of the candidate transmitted signal is computed. The candidate OFDM symbol with the lowest PAPR is transmitted.

V. SIMULATION RESULT

In this section, we present numerical simulation to evaluate and compare the performance of our enhanced PTS method with the conventional PTS sub-blocks partition schemes (interleaved and adjacent) for fixed length is carried out through simulation compared to the variable length adjacent PTS (VL-AP), when the numbers of subcarriers N=64, number of sub-blocks M=8, and different types of modulation techniques including QPSK, 8PSK, 16QAM, and 64QAM that compared with another type of modulation namely, Finite Radon Transform (FRAT). In order to generate CCDF of the PAPR, 2000 OFDM blocks are generated randomly. The performance will be analyzed using MATLAB version 7.8 for the simulation and the computation of CCDF.

Fig. 4 show the performance of fixed length traditional PTS schemes and variable length adjacent scheme PTS (VL-AP) by using FRAT as a mapping technique which is compared with the ordinary QPSK modulation technique based OFDM system. At CCDF=10^{-3}, it can seen that the $PAPR_0$ of original OFDM (signal without PTS) under FRAT mapping was 9.9 dB, original OFDM (signal without PTS) in QPSK modulation was 9.8 dB, (VL-AP) in FRAT mapping was 8.4 dB, interleaved partitioning (IP) with QPSK modulation was 7.6 dB, (VL-AP) in QPSK modulation was 7.3 dB, adjacent partitioning fixed length (AP) was 7.2 dB, and enhanced method with QPSK modulation was 6.8, respectively. Therefore, the enhanced method with QPSK modulation reduced PAPR by 3.1 dB, AP with QPSK modulation by 2.7 dB, VL-AP with QPSK modulation by 2.6 dB, IP with QPSK modulation by 2.3 dB, VL-AP with FRAT by 1.5 dB, and original OFDM with QPSK modulation by 0.1 dB from the original signal under FRAT mapping technique. Ordinary modulation QPSK for enhanced method and traditional PST with fixed and variable length sub-blocks partitioning is better in PAPR reduction performance than the FRAT mapping technique.

In Fig. 5, the original OFDM signal for 8PSK modulation obtains much 1.5 dB of PAPR reductions than the original OFDM signal under FRAT mapping when CCDF=10^{-3}. The enhanced PTS method for 8PSk modulation compared with (AP, VL-AP, and IP) in 8PSK modulation, and (VL-AP) with FRAT reduced PAPR by 0.5 dB, 0.7 dB, 0.9, and 2 dB, respectively.

Fig. 6 presents the PAPR reduction performance of FRAT and 16QAM modulation based on an OFDM system when CCDF=10^{-3}. The enhanced PTS method with 16QAM modulation scheme can obtain PAPR reduction about 0.6 dB, 0.7 dB, 0.9 dB, 1.7 dB, 3.7 dB, and 4 dB better than AP-PTS, VL-AP, IP in ordinary 16QAM modulation, VL-AP with FRAT, original OFDM with 16QAM modulation, and original OFDM with FRAT, respectively. In this figure, the ordinary 16QAM modulation gives PAPR reduction performance better than FRAT based on OFDM at the same CCDF.

Also, in Fig. 7, the performance of the enhanced algorithm is analyzed, to compare the performance of PAPR reduction of the ordinary PTS schemes for fixed and variable length by using ordinary 64QAM against FRAT based on OFDM when. At CCDF=10^{-3}, it can see that the enhanced method with 64QAM modulation reduced PAPR by around 4.1 dB, AP with 64QAM modulation by 3.8, VL-AP with 64QAM modulation by 3.8, IP with 64QAM modulation by 3.5 dB, VL-AP with FRAT by 3 dB, and original OFDM with 64QAM modulation by 0.7 dB from the original signal in FRAT. It can be observed that the PAPR reduction for the enhanced PTS method compared to ordinary PTS schemes with (fixed and variable) when using ordinary mapping for any types of techniques (PSK or QAM) against FRAT data mapping is listed in Table I.

Finally, it can be observed that the enhanced PTS method can achieve the best PAPR reduction performance as the traditional PTS schemes. Therefore, PAPR reduction performance for any type of ordinary modulation techniques is better than FART modulation.

TABLE I
Numerical simulation of comparison enhanced PTS technique and ordinary PTS for different types of modulation

Modulation	**CCDF**	**PAPR of Enhanced PTS (dB)**	**PAPR of fixed AP-PTS (dB)**	**PAPR of VL-AP PTS (dB)**	**PAPR of IP-PTS (dB)**	**PAPR of VL-AP PTS (dB) in FRAT**	**PAPR of original OFDM (dB)**	**PAPR of original OFDM (dB) in FRAT**
QPSK	10^{-3}	6.8	7.2	7.3	7.6	8.4	9.8	9.9
8PSK	10^{-3}	6.4	6.9	7.1	7.3	8.4	10.3	11.8
16QAM	10^{-3}	6.1	6.7	6.8	7	7.8	9.8	10.1
64QAM	10^{-3}	6.5	6.8	7.1	7.4	7.8	10	10.3

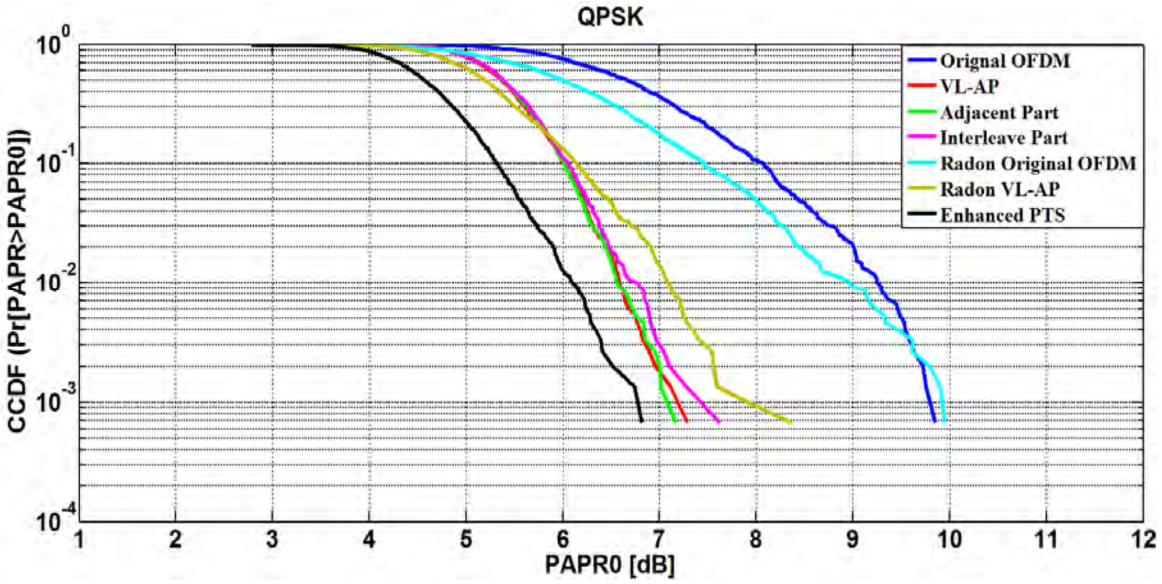

Fig.4. Comparison of PAPR reduction performance of the enhanced PTS method with the ordinary PTS schemes with fixed and variable partition lengths for QPSK modulation and FRAT

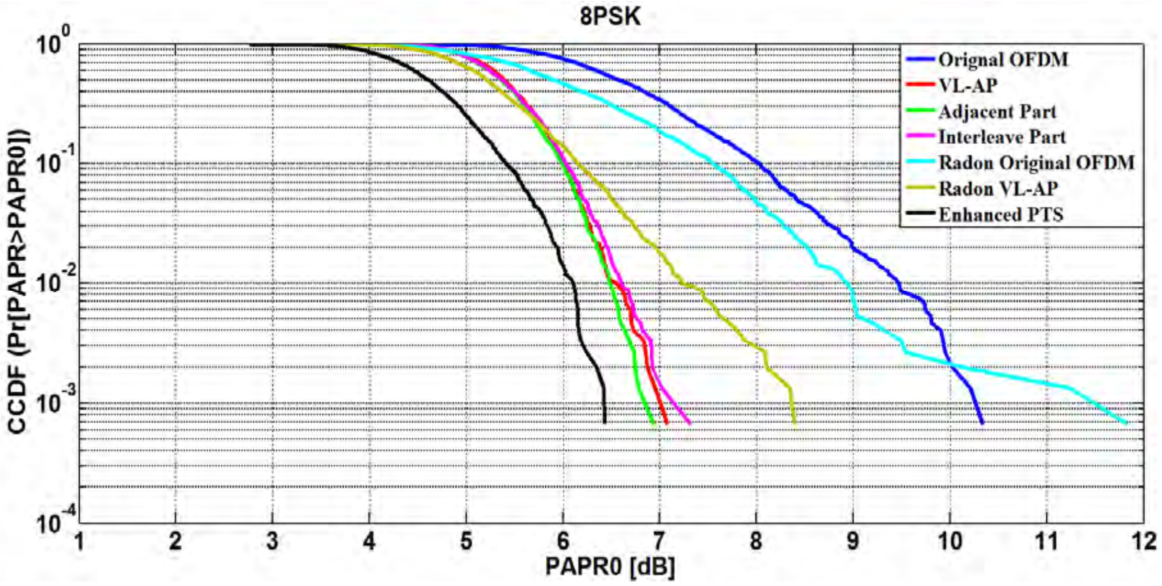

Fig.5. Comparison of PAPR reduction performance of the enhanced PTS method with the ordinary PTS schemes with fixed and variable partition lengths for 8PSK modulation and FRAT

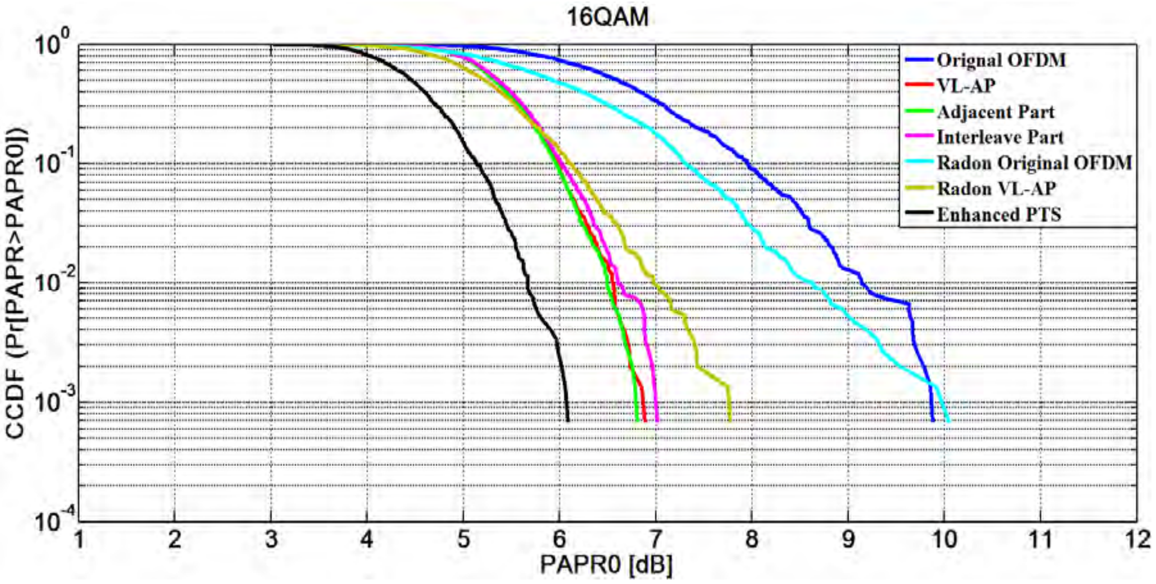

Fig.6. Comparison of PAPR reduction performance of the enhanced PTS method with the ordinary PTS schemes with fixed and variable partition lengths for 16QAM modulation and FRAT

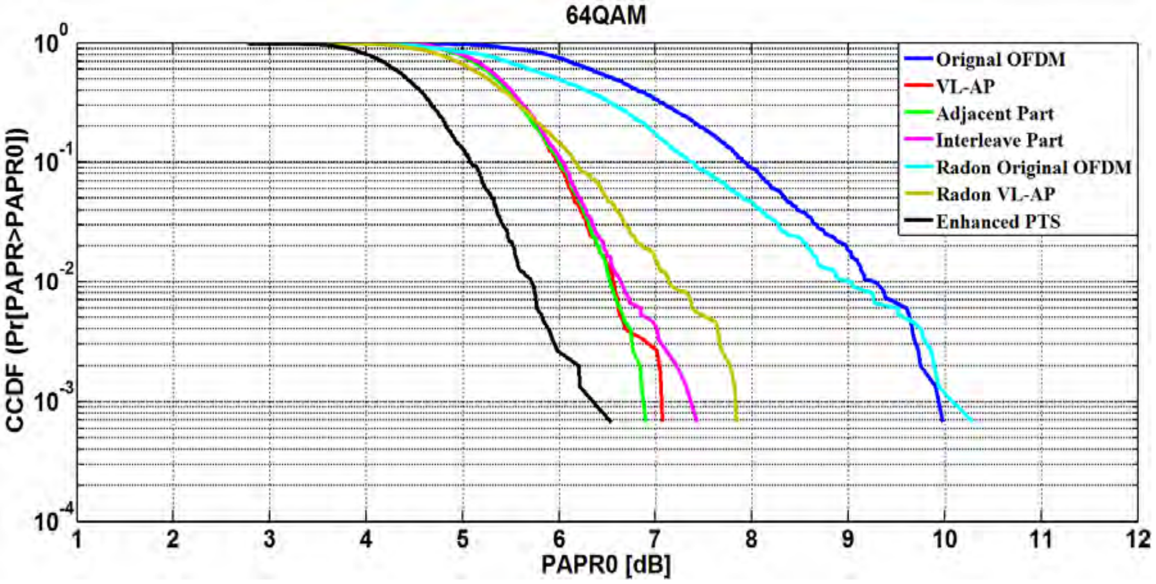

Fig.7. Comparison of PAPR reduction performance of the enhanced PTS method with the ordinary PTS schemes with fixed and variable partition lengths for 64QAM modulation and FRAT

VI. CONCLUSION

In this paper, we offer performance analysis of an enhanced PTS technique that combined two sub-block partition schemes (adjacent with interleaved) to reduce the PAPR in OFDM signals, and implemented Finite Radon Transform (FRAT), which is originally used for image processing as a modulation technique for data mapping. A comparative analysis of the performance of FRAT with the ordinary data mapping techniques such as (PSK and QAM) is also presented. For the sake of comprehensiveness in the analysis, we investigate and analyse the effects both adjacent partitioning (with fixed and variable lengths) and interleaved partitioning in PTS schemes. Simulation results show that the enhanced PTS technique outperforms, in PAPR reduction, the adjacent partitioning scheme (with fixed and variable lengths) which is known to perform better than the interleaved partitioning for all the scenarios of mapping. The results also show that the ordinary mapping for any types of techniques (PSK or QAM) with different partitioning scenarios had better PAPR reduction performance compared to FRAT data mapping. Also, FRAT-OFDM incurs a computational complexity because of the usage of two dimensional FFT in the data mapping and in the sub-carrier modulation. Therefore, sub-blocks partitioning PTS with fixed and variable length in ordinary modulation techniques have better performance compared to FRAT.

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