

Hybrid Model for PAPR Minimization in OFDM System

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Abstract— *The technology has been growing rapidly in the form of portable wireless devices that can perform multiple functions to cope with the state-of-the-art technology and synchronization. A total device capacity must be increased to accommodate new wireless applications. This can be achieved by leveraging new technologies, with higher data rates. Spectrum pooling has gained immense popularity, with increased demand for frequency range and bandwidth availability constraints. Statistics suggest that much of the spectrum licensed is not used all the time. Because of the transmitter's nonlinearity nature, the large (peak to average power ratio (PAPR)) phenomenon is a drawback in orthogonal frequency division multiplexing (OFDM). Several hybrid approaches have recently been implemented to minimize PAPR's high value, at the expense of increasing the level of computational complexity in the system. In this paper, a new hybrid approach has been introduced in parallel to combine the selective mapping approach (SLM) with the partial transmit sequence (PTS) approach to improve the efficiency of PAPR reduction with lower numerical method complexity. The findings reveal that the OFDM systems with the proposed hybrid approach have better efficiency in terms of PAPR elimination, side-information, and computational complexity compared to current hybrid methods. Also, a hybrid approach proposed output could be maintained without degradation.*

Index Terms: OFDM, PTS, PAPR, SLM

I. INTRODUCTION

Today fourth-generation cellular networking networks have been used in several countries around the world. Also, there are some challenges, such as an explosion of wireless mobile applications and services that cannot even be addressed by (4G), such as spectrum scarcity and higher energy use [1]. Fourth-generation communications are based on (Orthogonal Frequency Multiplexing Division (OFDM)) [2]. The OFDM is used in single-frequency networks such as digital audio broadcasting (DAB), digital video broadcasting (DVB), and indoor wireless systems such as IEEE802.15 [3], IEEE 802.11 [4], IEEE802.16 [5], and 4G-LTE [6]. A special situation is OFDM transmission with multiple carriers. By adding guard bands, this divides a bandwidth into two subcarriers and isolates them. Such carriers overlap, yet due to the presence in the form of the pulse, they are orthogonal. Using the Cyclic Prefix (CP), Inter-Symbol Interference (ISI) can be eliminated. OFDM offers advantages such as fading resistance, easier channel equalization, security, interference, and efficiency in computing. But the good side lobes and the strict timing criteria make bandwidth performance a sadness.

On the other hand, other strategies have been suggested to reduce the high PAPR pattern in the OFDM method, including coding techniques [7], clipping and filtering techniques [8], constellation extension techniques [9], nonlinear compounding transformation schemes [10], and interleaving techniques [11], multiple signal representation (MSR) such as selective level mapping (SLM)[12], the partial transmission scheme (PTS)[13]. The MSR strategies are an appealing alternative because of their excellent efficiency, which can be applied without degradation of the signal [14]. The conventional PTS (C-PTS) scheme between the aforementioned techniques is a well-known deterministic non-signal distortion approach that delivers excellent PAPR reduction efficiency, but is set to increase the difficulty of measurement and involves side details.

SLM and Interleaving are considered to be another multiple signal representation (MSR) technique schemes to provide a lower computational difficulty, The degradation cost in PAPR performance reduction [15]. Several experiments have been conducted in recent years to merge the two forms of MSR approaches and use each method's inherent feature in one deterministic way.

Several methods were presented in the literature to combine PTS with SLM to reduce PAPR-value. By adding the input data sequence to the SLM technique and then forwarding each changed sequence to the PTS technique, Pushkarev [16] implemented a hybrid algorithm focused on the combination of SLM and PTS. Pushkarev method can have stronger PAPR reduction efficiency than C-PTS and SLM strategies, although the computational difficulty is greater than that of the C-PTS system.

K. Singh [17] and A. Mohammed [18] Combined the SLM and PTS approaches with a different method by adding SLM to the input data series and choosing the resulting OFDM signal as the PTS stream. The Singh's approach will accomplish PAPR reduction efficiency better than C-PTS and SLM schemes as the similarity between sub-carriers inside the sub-blocks are reduced, but the level of computational complexity and side knowledge is reduced compared with the C-PTS technique.

Tiwari proposed another tactic in [19] by mixing the SLM and PTS schemes. The method of Tiwari depended first on the application of the SLM technique and then the resulting OFDM signal was transferred to the FFT block before the C-PTS technique was implemented. The Tiwari's method is superior to the PAPR reduction C-PTS process, to the disadvantage of the growing machine and side knowledge sophistication.

Also, Xiaoqiang [20] introduced an algorithm that depends on the combination of interleaving and PTS techniques in which the permutation data sequence corresponding to the optimum time-domain sequence is transferred to the C-PTS technique to further improve PAP efficiency. Xiaoqiang algorithm PAPR reduction efficiency is better than C-PTS. Mathematical formulas and bits of side information, however, are far larger than the C-PTS method.

In this paper, the suggested hybrid scheme (SLM-CSS-PTS) is implemented, where several factors have been measured to develop a realistic, excellent PAPR reduction approach, such as PAPR reduction efficiency, computational complexity, side details, Bit error rate output and Power Spectral Density (PSD). Simulation results and numerical analyses show that the proposed hybrid scheme has better performance compared to current hybrid schemes in terms of PAPR reduction, low computational complexity and low side details. Additionally, the hybrid approach proposed preserves the BER and PSD efficiency without degradation.

II. PAPR BASED ON OFDM

In practical applications, the high PAPR value in multi-carrier systems based on orthogonal transmissions, such as OFDM, is classified as the major disadvantage these systems face. The ratio of the maximum transmitted signal peak power divided by the mean signal power can be defined as PAPR [22]. Fig.1 displays a condensed OFDM device diagram in which one of the modulation families maps the input data sequence first, and then parallel shift to the IFFT node. IFFT modifies the baseband input sequence by the orthogonality of the subcarriers and transforms the frequency domain output sequence to the time domain. The cyclic prefix (CP) is applied to the signal before transmission, such that the OFDM signal may be interpreted as

$$x(n) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X(k) e^{j2\pi k \frac{n}{N}}, \quad 0 \leq n \leq N-1 \quad (1)$$

where $X(k)$ the input data sequence, and (N) is the sub-carrier numbers. On the receiver side also, all transmitter operations performed are reversed. In OFDM system, the signal output consists of the summation as a sinusoidal form of several different modulated subcarriers. Because of the design of the IFFT array, the instantaneous peak strength of certain sinusoid signal subcarriers may be combined to become far greater than the average signal capacity; providing such subcarrier phases are identical [23]. PAPR in decibel (dB) could be formulated in mathematical terms as [24]

$$\text{PAPR (dB)} = 10 \log_{10} \frac{\max |x(n)|^2}{E\{|x(n)|^2\}}, \quad (2)$$

where $E\{.\}$ represents the mean value of the signal. Furthermore, a popular method for determining PAPR output is the CCDF (Complementary Cumulative Distribution Function) [25]. The CCDF based on PAPR denotes the probability that the PAPR value exceeds a certain OFDM symbol threshold (PAPR₀)

$$\Pr(\text{PAPR} > \text{PAPR}_0) = 1 - (1 - \exp(-\text{PAPR}_0))^{NL}, \quad (3)$$

(L) is Oversampling Factor. The OFDM baseband signal continuous-time (nearly) could be achieved by implementing L-time over-sampling of the distinct OFDM signal to collect those signal peaks that do not occur while measuring the PAPR value. The oversampling process is done by adding (L-1) N zeros between the subcarriers. The sampling of the discrete baseband signal with $L > 4$ is also necessary to improve the precision of the PAPR value [26].

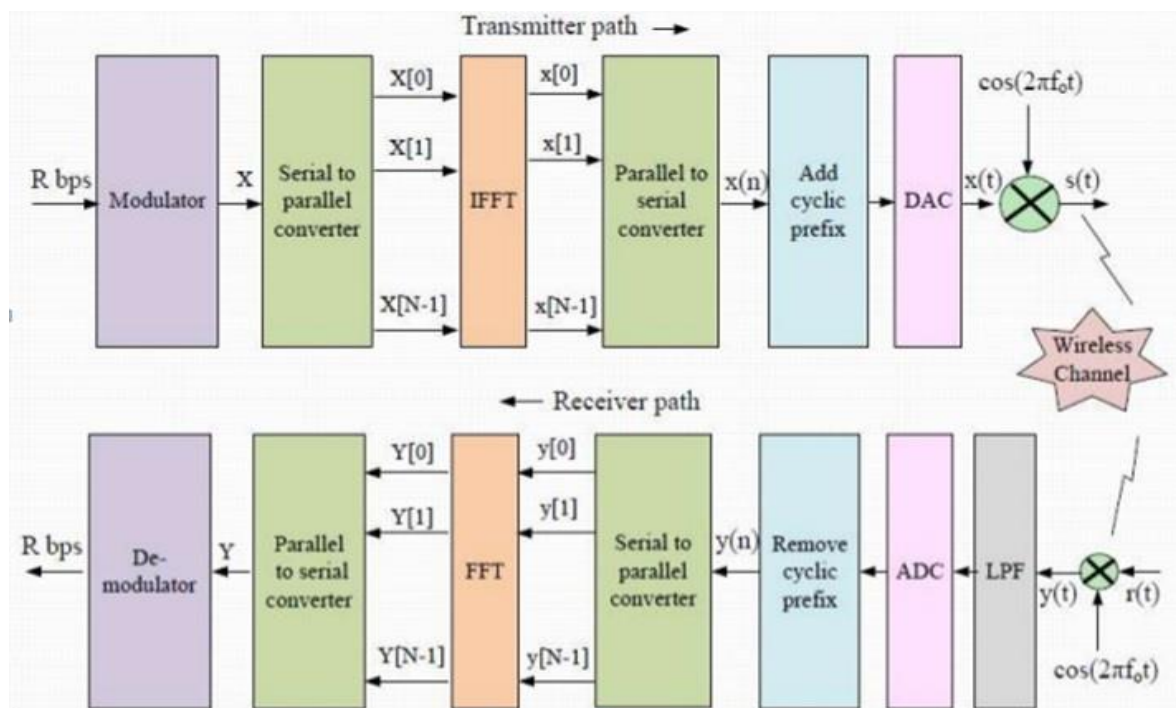


FIG. 1: BLOCK DIAGRAM FOR OFDM [23].

III. PAPR REDUCTION TECHNIQUES

PAPR reduction involves several methods and this depends on varying factors like reduction capability, increased transmission signal strength, computational complexity, data rate loss, peak reduction carrier, BER increase, spectral efficiency. PAPR reduction methods were suggested to minimize the high PAPR [27] as often as practicable. Several of these methods: clipped and filtered, Tone Injection, Partial Transmit Sequence, coding, compounding, Tone Reservation, Selected Mapping (SLM), etc.

Two techniques will be discussed in this articles.:

A. Partial Transmit Sequence (PTS):

Muller introduced the partial transmission sequence technique in 1997 to improve the performance of PAPR reduction in the OFDM system [28]. In Fig.2, Partial Transmission Sequence (PTS) is a un-distortion system that divides the input information block into several disorganized sub-blocks and executes IFFT. Such sub-block outputs of the IFFT are scrambled or weighted by a set of rotational determinants that are summed up to create specific candidate signals. In the end, the lowest PAPR signal for transmission is chosen [29]. As long as a PTS has to be applied, the uncertainty that is a significant

parameter in the transmitter must be taken into account because it increases exponentially with the quantity of the subsequence. For this purpose, the rotation of the vector should be limited to a set with a finite number of elements PTS, which is hindered by a high computational complexity [30] resulting from a thorough search of candidate signals and additionally allows data concerning rotation factors to be sent as side information to the receiver.

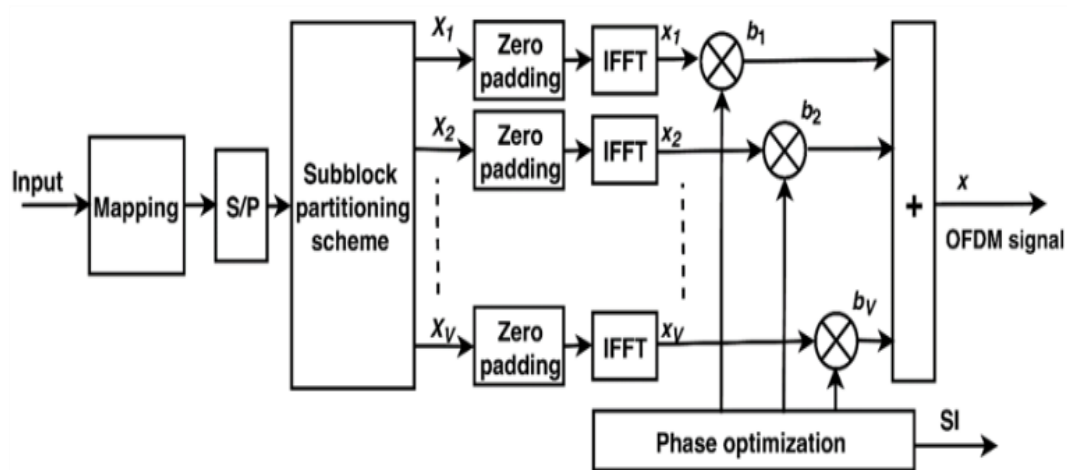


FIG. 2: PTS BLOCK DIAGRAM.

The advantage of PTS: has low complexity and Introduces less distortion.

Drawbacks of PTS: BER performance degrades, side information is required and involve complex transmitter quantities of the vector.

B. Selected Mapping (SLM):

In 1995, Bauml suggested the selective mapping technique to reduce the value of PAPR within the OFDM system [31]. SLM 's simple concept is to create alternate U transmission sequences seeded from the same data source and then pick the transmitted signal with the lowest PAPR. The idea stems from the assumption that as the PAPR is calculated from the sequence of data vectors transmitted, X^u can alter the PAPR properties after the IFFT by multiplying the data vectors by some random step. A set of U markedly distinct, pseudo random fixed vectors is generated

$$P^u = [P_{u,0}, P_{u,1}, \dots, P_{u,N-1}] \text{ , where } (u) = [1, 2, \dots, U]$$

mathematically,

The data, X^u , are multiplied subcarrier wise with each one of the U vectors, $P^{(u)}$, resulting in a set of U different possible transmit symbols, $X^{(u)}$ as depicted in

$$X^u = [X_0 P_{u,0}, X_1 P_{u,1}, \dots, X_{N-1} P_{u,N-1}]$$

Next, all U possible transmit vectors are transferred to the time domain via the IFFT, $x^{(u)} = \text{IFFT}\{X^{(u)}\}$, and the transmit symbol with the lowest PAPR, X^U , is chosen for transmission. A SLM transmitter block structure is depicted in Fig 3.

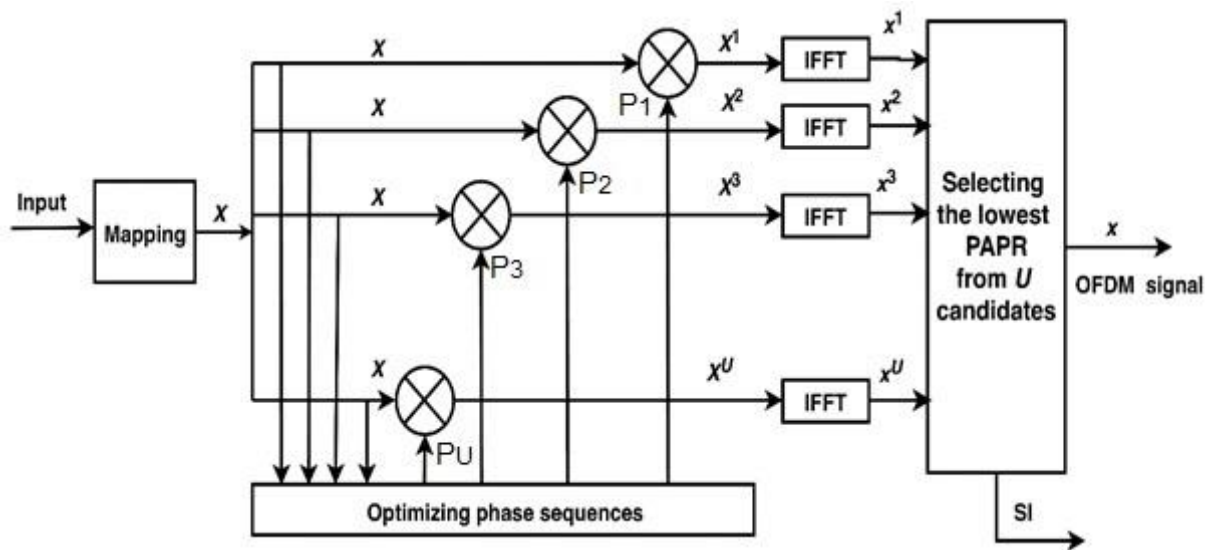


FIG. 3. SLM BLOCK DIAGRAM

Side information is also an essential problem with SLM as it is appropriate to notify the recipient which vector $P^{(u)}$ was used. $\log_2(U)$ bits are required to send this data to increase redundancy. Since the loss of this information (in a fading channel) means that the full lack of transmit symbol channel coding is necessary, redundancy is further enhanced in order to ensure proper data recovery at the receiver.

The advantage of SLM is: Number of carriers separated, it does not introduce any distortion, while the disadvantages of SLM are: Degrades efficiency at BER, there is a need for side data.

IV. PROPOSED METHOD

A new approach to combine the SLM method and the CSS-PTS method is proposed, so it can be termed the SLM-CSS-PTS method. This method aims to reduce the PAPR value and the complexity of the computation better than the C-PTS technique. The procedure for reducing the PAPR value in the SLM method is to generate (U) phase rotation vectors (PRV), $P^u = [P_{u,0}, P_{u,1}, \dots, P_{u,N-1}]$, where (u) = $[1, 2, \dots, U]$, and (N) is the length of the data sequence [34]. Moreover, the original data sequence, $X = [X_0, X_1, \dots, X_{N-1}]$, is copied according to a combined number of PRVs [33]. Next, U -PRVs multiply the data sequence component-wise to generate the new independent sequences [34],

$$X^u = [X_0 P_{u,0}, X_1 P_{u,1}, \dots, X_{N-1} P_{u,N-1}]. \quad (4)$$

After that, the independent sequences are transferred to the IFFT bank to produce a range of candidate signals, then the candidate signal that achieves the lowest PAPR value is selected with the optimal PRV index for transmission [21].

$$x^u = \text{IFFT}(X^u) \quad , \quad u = 1, 2, \dots, U. \quad (5)$$

In the CSS-PTS method, the procedure for reducing the PAPR value starts after obtaining the time-domain sub-block sequences $\{x_v | v = 1, 2, \dots, V\}$, in which the g th candidate sequence, $1 \leq g \leq G$, is generated by cyclically shifted some sub-block sequences and combined them [35]. The OFDM signal can thus be written as

$$x = \sum_{v=1}^V x_v^g, \quad 1 \leq g \leq G, \tag{6}$$

where x_v^g is the cyclically shifting version of x_v by some of the integer shift numbers? This is [36],

$$x_v^g = \text{circular}(x_v, q_v^g) = [x_v(q_v^g), x_v(q_v^g + 1), \dots, x_v(N + 1), x_v(0), \dots, x_v(q_v^g - 1)] \tag{7}$$

where $q_v^g, 1 \leq v \leq V$, is the shift number. Also, the set of shift numbers in the g th candidate sequence is denoted by $H^g = [q_1^g, q_2^g, \dots, q_V^g]$. Hence, the CSS-PTS method needs to construct G -shift number sets, $H = [H^1, H^2, \dots, H^G]$, To generate the OFDM signals needed for the candidate [32]. Among the candidate sequences, the candidate with the minimum PAPR is selected with the correct optimum shift number for transmission to the receiver. In the (SLM-CSS-PTS) method, the reduction protocol for PAPR is to combine the SLM method with the CSS-PTS method in parallel, where each method is used to process half the input data sequences and both halves are again combined before transmitting to the receiver. Fig.4 shows the SLM-CSS-PTS method, where the sequence of input data is divided into two equal parts A and B,

$$X = [XA, XB], \tag{8}$$

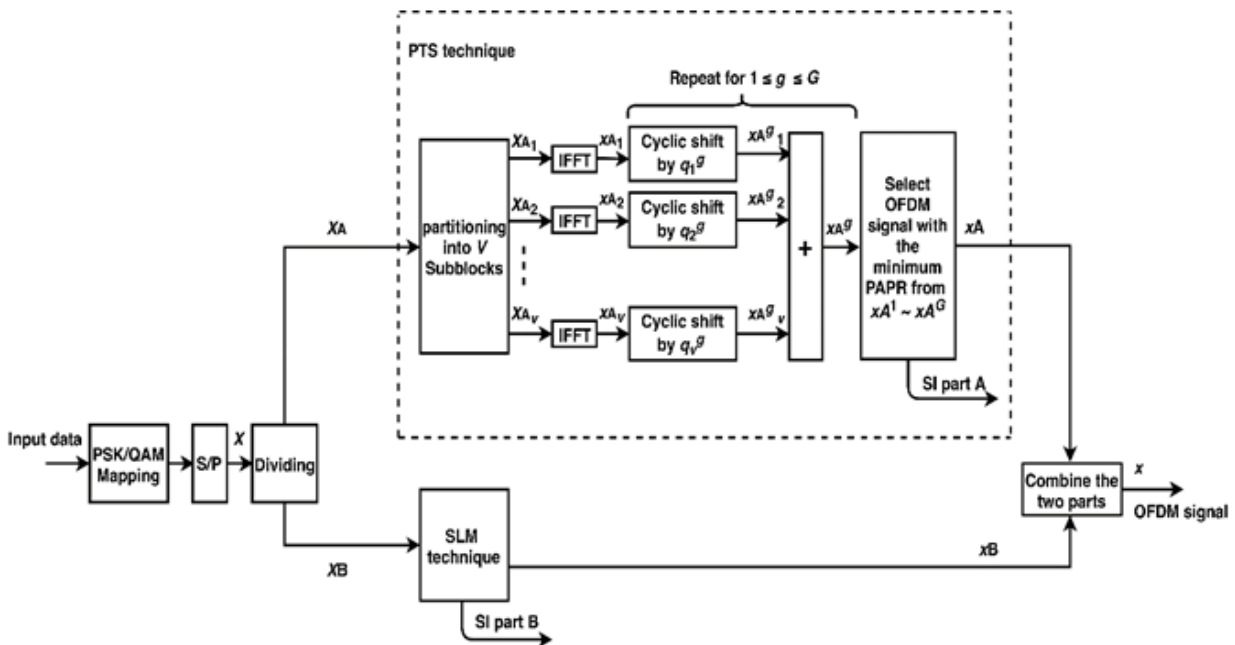


FIG 4. BLOCK DIAGRAM OF (SLM-CSS-PTS) METHOD.

Thus,

$$XA = [X_0, X_1, X_2, \dots, X_{(N/2)-1}], \quad (9)$$

, and

$$XB = [X_{N/2}, X_{(N/2)+1}, X_{(N/2)+2}, \dots, X_{N-1}]. \quad (10)$$

After that, the data of part A undergoes the PTS technique, while the data of part B undergoes the SLM technique. Next, the first part employs the CSS-PTS procedure to reduce its PAPR, Where, instead of phase rotation variables, the cyclic shift technique is used to optimize the transformed sub-blocks to produce the optimal signal of Part A,

$$xA = \sum_{v=1}^V \left\{ \text{circular}(xA_v^g) \mid g = 1, 2, \dots, G \right\}, \quad (11)$$

where (V) is a totally sub-block number, and (G) is the total number of signals for the candidate. On the other hand, part B utilizes the SLM procedure to diminish its PAPR, where the SLM technique produces the optimum signal of part B,

$$xB = \text{IFFT}(XB^u) \quad , \quad u = 1, 2, \dots, U. \quad (12)$$

Finally, the optimal signals of both parts A and B are combined to produce the entire transmitting signal transmitted to the receiver with each part's side information,

$$x = [xA, xB] \quad (13)$$

Because both SLM and PTS techniques are employed to reduce the PAPR value, The PAPR reduction efficiency of the SLM-CSS-PTS method will be improved and the subcarriers will be more independent. Besides, the SLM-SC-PTS method's computational complexity is the sum of the complexity of SLM and PTS. Also, CSS-PTS mathematical calculations in the time domain will be complex addition and multiplication operations by using H shift number sets. Hence, the number of the complex addition operations ($C_{\text{add}}^{\text{SLM-CSS-PTS}}$) and multiplication operations ($C_{\text{mult}}^{\text{SLM-CSS-PTS}}$) of the SLM-CSS-PTS method can be formulated as

$$C_{\text{add}}^{\text{SLM-CSS-PTS}} = (U + V) \left[\frac{N}{2} \log_2 \frac{N}{2} \right] + \left[\frac{N}{2} \times H \times (V - 1) \right], \quad (14)$$

$$C_{\text{mult}}^{\text{SLM-CSS-PTS}} = [UN] + \left[(U + V) \left(\frac{N}{4} \log_2 \frac{N}{2} \right) \right] + \left[\frac{N}{2} (H + (H - 1) \times (V - 1)) \right]. \quad (15)$$

Besides, the SLM-CSS-PTS side information bit number is the sum of the SLM side information and the CSS-PTS side information,

$$SI^{\text{SLM-CSS-PTS}} = \log_2 U + \log_2 H. \quad (16)$$

V. SIMULATION RESULTS AND DISCUSSION

It is suggested to use the low computational difficulty level of the SLM methodology and the superior PAPR reduction performance of the CSS-PTS approach in one system, the SLM-CSS-PTS process. In this section, the OFDM system evaluates the PAPR and BER, PSD, side details, and computational complexity outputs of SLM-CSS-PTS. In Table (1) The parameter values in the literature for testing the SLM-CSS-PTS scheme related to the other OFDM approaches.

The AWGN channel block used in an ofdm system [37] [38] [39] applies Gaussian white noise to an individual or complex input signal. This block introduces real Gaussian noise when the input signal is low, and generates a true output signal. This block introduces complex Gaussian noise when the input signal is complex, and generates a complex output signal.

TABLE 1. SIMULATION OF THE SLM-CSS-PTS PARAMETERS IN OFDM.

Simulation Parameters	Values
(N): NO. of sub-carriers	1024,2048
(M): NO. of the constellation	(64)
(L): NO. of Oversampling	(4)
(V): NO. of sub-blocks	(4)
(W): NO. of phase factors	($\{\pm 1\}, \{\pm 1, \pm j\}$)
NO. of sub-frames	(1000)
(r): Roll-off factor	(0.6)
Modulation type	M -QAM
Determine value (α) – Xiaoqiang method	(0.5)
Number of phase rotation vectors (PRV) – SLM method	(24)
Channel model	AWGN

A. PAPR 'S RESULTS FOR SLM-CSS-PTS.

The modeling takes place in the OFDM system whenever the number of the subcarrier is 2048 and the constellation order $M = 64$. The SLM-CSS-PTS algorithm performs other methods concerning reductions in PAPR performance. As seen in *Fig.5*, when CCDF OF SLM-CSS-PTS, PR-PTS, SLM, K. Singh's method, Xiaoqiang 's method, Tiwari's method, and OFDM's original value. Besides, the SLM-CSS-PTS BER output is close to that of the original OFDM signal, as seen in *Fig.6*. This is because the SLM-CSS-PTS procedure is a form of MSR methodology, where the SLM-CSS-PTS approach has no signal distortions. Also we can see comparison of the number of complex multiplications for suggested method and other methods in *Fig.7*.

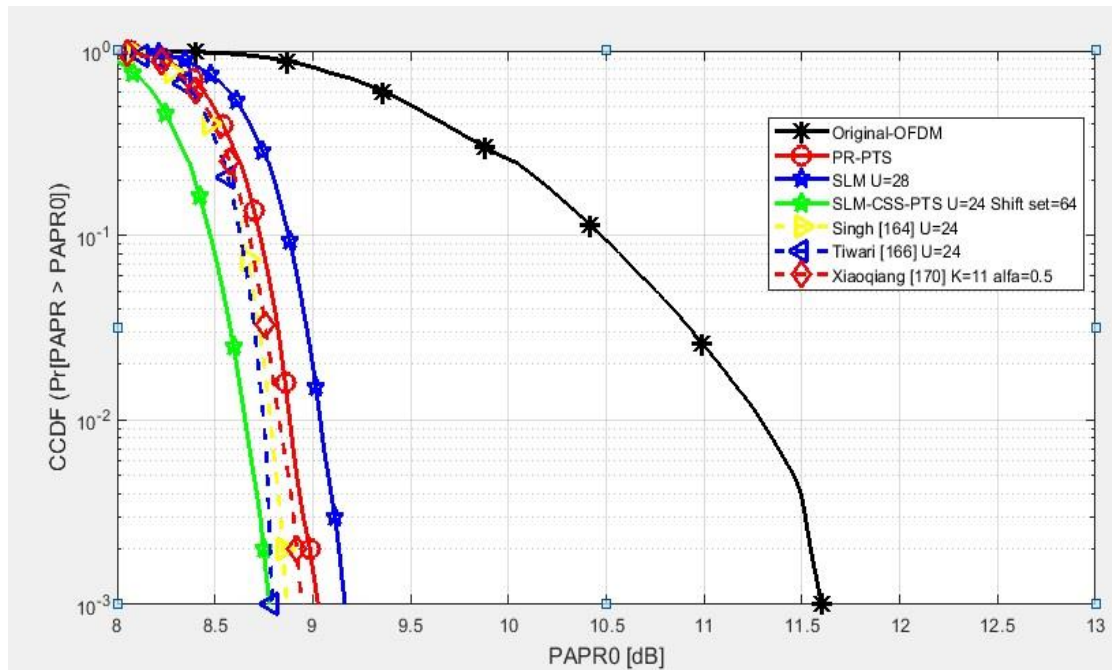


FIG 5. CCDF COMPARISON PAPR FOR THE PROPOSED METHOD WITH THE OTHER METHODS, NO. OF SUBCARRIER = 2048, M = 64.

B. Computational Complexity of SLM-CSS-PTS Compared With Other methods

The difficulty of the calculation here reflects the sum of complicated contributions in the frequency and time domains and complicated multiplications. In this section, the SLM-CSS-PTS system's mathematical estimation is conducted and compared with PR-PTS and some similar methods discussed in the literature. Table (2) details complex add-on and multiplication equations in the sources for PR-PTS, SLM-CSS-PTS, and several of the integrated processes.

Table (3) shows the number of complex adding and multiplication processes for the various methods in Table (2). The results indicate that SLM-CSS-PTS is the lowest computational complexity among methods combined.

Table (4) offers a comparison of the computational complexity reduction ratio (CCRR) results between the SLM-CSS-PTS approach and the other relevant approaches. The numerical complexity, degree of the SLM-CSS-PTS approach is higher than other combined techniques. For example, when $N = 1024$, the complex addition operations of SLM-CSS-PTS have been reduced by 4.31%, 52.15%, 52.96%, 53.94%, 0%, 31.05%, and 31.05% compared with PR-PTS, K. Singh and Tiwari, respectively. Besides, the complex multiplication operations of SLM-CSS-PTS have been reduced by 37.2%, 68.69%, 57.97%, 58.38%, 13.56%, 45.81%, and 45.81% compared with the PR-PTS, K. Singh and Tiwari, respectively. Consequently, in contrast to other hybrid methods, the SLM-CSS-PTS solution is known to be an efficient tool for optimizing PAPR reduction performance at low computational complexity.

TABLE 2. PR-PTS COMPLEXITY EQUATION, SLM-CSS-PTS, AND SOME OF THE METHODS PREVIOUSLY COMBINED IN THE LITERATURE.

Technique	C_{mult}	C_{add}
SLM	$[2UN] + \left[\frac{UN}{2} \log_2 N \right]$	$[UN \log_2 N]$
PR-PTS	$\left[\frac{VN}{2} \log_2 N \right] + [W^{V-1} \times N \times (V+1)]$	$[VN \log_2 N] + [W^{V-1} \times N \times (V-1)]$
SLM-CSS-PTS	$[UN] + \left[(U+V) \left(\frac{N}{4} \log_2 \frac{N}{2} \right) \right] + \left[\frac{N}{2} (H + (H-1) \times (V-1)) \right]$	$(U+V) \left[\frac{N}{2} \log_2 \frac{N}{2} \right] + \left[\frac{N}{2} \times H \times (V-1) \right]$
Tiwari[19]	$[2UN] + \left[(U+V+1) \left(\frac{N}{2} \log_2 N \right) \right] + [W^{V-1} \times N \times (V+1)]$	$(U+V+1)[N \log_2 N] + [W^{V-1} \times N \times (V-1)]$
K. Singh[17]	$[2UN] + \left[(U+V) \left(\frac{N}{2} \log_2 N \right) \right] + [W^{V-1} \times N \times (V+1)]$	$(U+V)[N \log_2 N] + [W^{V-1} \times N \times (V-1)]$
Xiaoqiang [20]	$[KN] + \left[(K+V) \left(\frac{N}{2} \log_2 N \right) \right] + [W^{V-1} \times N \times (V+1)]$	$(K+V)[N \log_2 N] + [W^{V-1} \times N \times (V-1)]$

TABLE 3. SLM-CSS-PTS COMPUTATIONAL COMPLEXITY, AND THE VARIOUS COMBINED LITERATURE METHODS.

N	PR-PTS		SLM		K. Singh [17]		Tiwari [19]		Xiaoqiang [20]		SLM-CSS-PTS	
	(C _{add})	(C _{mult})	(C _{add})	(C _{mult})	(C _{add})	(C _{mult})	(C _{add})	(C _{mult})	(C _{add})	(C _{mult})	(C _{add})	(C _{mult})
64	13824	21248	9216	7680	23040	28928	23424	29120	15744	22528	10624	11872
1024	237568	348160	245760	172032	483328	520192	493568	525312	329728	403456	227328	218624
2048	483328	700416	540672	368640	1024000	1069056	1046528	1080320	708608	833536	483328	451584

Table 4. CCRR BETWEEN THE SLM-CSS-PTS APPROACH AND SOME OF THE COMBINED APPROACHES IN THE LITERATURE.

N	CCRR SLM-CSS-PTS & PR-PTS %		CCRR SLM-CSS-PTS & Pushkarev %		CCRR SLM-CSS-PTS & K. Singh %		CCRR SLM-CSS-PTS & Tiwari %	
	(CCRR ⁺)	(CCRR [×])	(CCRR ⁺)	(CCRR [×])	(CCRR ⁺)	(CCRR [×])	(CCRR ⁺)	(CCRR [×])
64	23.14	44.12	61.57	72.14	53.88	58.96	54.64	59.23
1024	4.31	37.2	52.15	68.69	52.96	57.97	53.94	58.38
2048	0	35.52	50	67.85	52.8	57.75	53.81	58.19

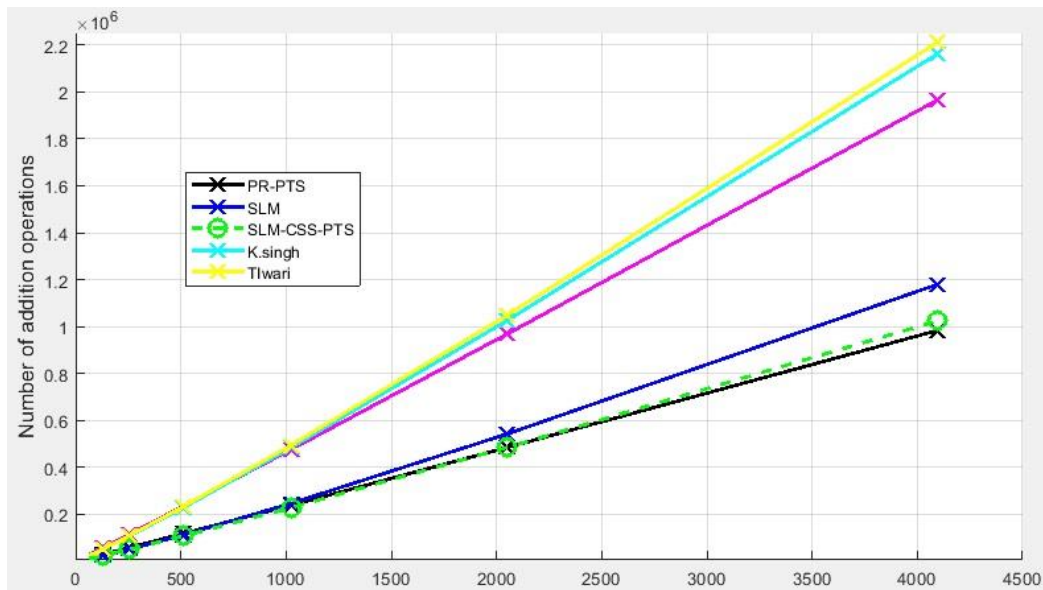


FIG 6. COMPARIDION OF COMPLEX ADDITION NUMBERS FOR DIFFERENT METHODS IN (TABLE 3).

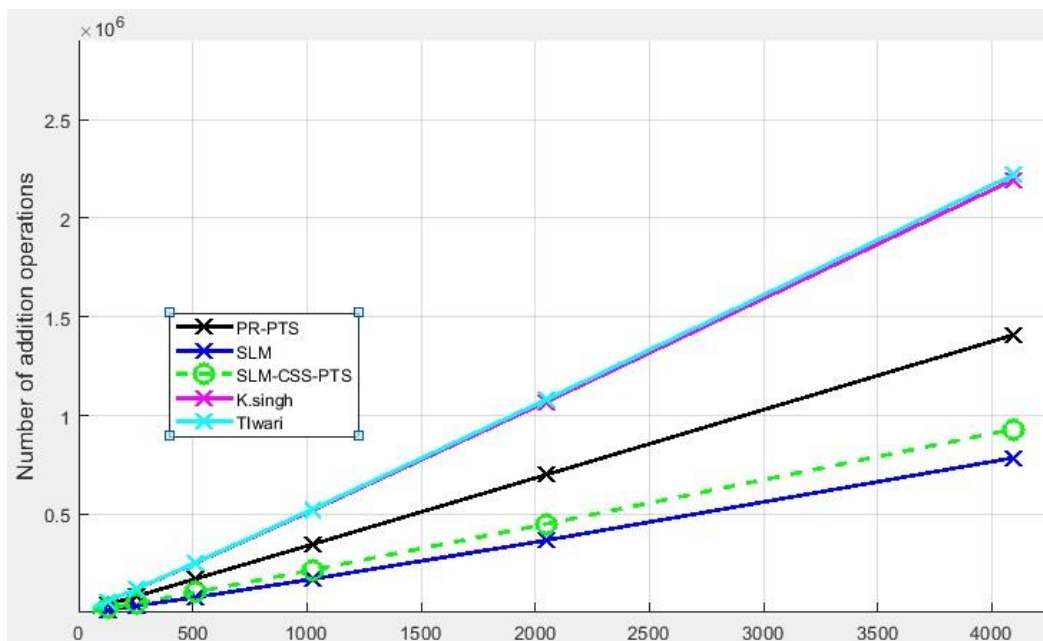


FIG.7. COMPARIDION OF THE NUMBER OF COMPLEX MULTIPLICATIONS FOR DIFFERENT ALGORITHMS IN (TABLE3).

Table 5, on the other hand, lists the side information bits needed for the various methods in this paragraph, where the SI bits of the SLM-CSS-PTS scheme can be calculated by (16). 11 bits for the method of K. Singh, the method of Tiwari 11bits. The SLM-CSS-PTS thus have more side-information bits than the PR-PTS method, given that the suggested method is better than PR-PTS in terms of PAPR output reduction and computational complexity level.

In comparison, the suggested approach has a smaller or an equivalent number of side data bits compared to the other blended methods.

Table (5).SIDE INFORMATION ABOUT SLM-CSS-PTS AND SOME OF THE LITERATURE'S COMBINED METHODS.

V = 4, W = 4, H = 64, U = 24					
Method	PR-PTS	SLM	SLM-CSS-PTS	K. Singh	Tiwari
SI	6	5	11	11	11

VI. CONCLUSION

This research developed a hybrid multiple signal representation (MSR) approaches to reduce the high PAPR sequence in OFDM with low transmitter signal complexity. The suggested hybrid solution incorporates the SLM framework and the CSS-PTS solution in tandem, the SLM methodology has strong low-complexity output reduction PAPR and the CSS-PTS approach has excellent medium-complexity PAPR cost reduction. Simulations and numerical calculations were carried out to evaluate the hybrid method proposed for the reduction of PAPR power, computational complexity, and side details. It's been shown that the hybrid proposed method could enhance PAPR reduction performance, greater than the PTS method, and the current hybrid approach without deterioration. Meanwhile, the suggested hybrid approach is lower in computational complexity than the PTS method and presents hybrid methods. In comparison, the number of side information bits of the new system is less than currently in use hybrid methods. Accordingly, it is concluded that the proposed SLM-CSS-PTS approach is ideal to reduce the high PAPR pattern in the low computational complexity OFDM system.

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