Digital Chaos Encryption-Based Sub-Block Partition by a Hybrid PTS Approach and PAPR Reduction Using HSOSS Algorithm

Mrinmoy Sarkar, Asok Kumar, and Bansibadan Maji

Abstract Decreasing the peak-to-average power ratio (PAPR) is a great challenge for data communication using OFDM. Here is introduced a new hybrid optimized partial transmit sequence (PTS) for minimizing the PAPR, where data encryption is done with 4D DFT-based hyper-chaotic sequence. An innovative hybrid seagul optimization and salp swarm (HSOSS) optimization are proposed here to produce a phase weight factor for the PTS. Several sizes of the subcarrier are investigating the new approaches performance. The proposed model is implemented in MATLAB platform and performances are calculated with factors like bit error rate (BER) with respect to signal-to-noise ratio(SNR), PAPR complementary cumulative distribution function (CCDF) in regard to SNR, and the finally, based on the computation time, final results are compared.

Keywords OFDM · PAPR · PTS · HSOSS · CCDF · SNR

1 Introduction

In wireless communication system, OFDM is considered as an effective technology for the high-speed data rate. Worldwide interoperability for microwave access IEEE.802.16 [1], wireless local area network (WLAN) IEEE.802.11 [2], and digital video broadcasting (DVB) are the several communication frameworks based on the OFDM systems known as transmission data technology. The elevated PAPR is the key

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difficulty of the OFDM systems, and the high power amplifiers (HPAs) are occurred by high PAPR multicarrier signal [3].

PAPR is calculated per OFDM symbol, which is used for enumerating envelope fluctuations. The amount of CCDF minimization measured the capability of PAPR reduction [4]. One of the well-known PAPR minimization approaches is named PTS approach. The time-domain (T.D), modulation (IFFT), and frequency-domain (F.D) are the three aspects used to review the various ordinary and modified-PTS schemes. In distinct sub-blocks, the addition of power of time domain is also known as cost function, which is generated to reduce the complexity in PTS [5].

The improved DFT-based and chaotic chirp matrix approaches [6] are proposed to simultaneously achieve security performance and PAPR reduction. Moreover, orthogonal-phase (Q) and chaotic self-phase (I) encryption approach are also proposed to realize scheme encryption using linking symbols in the time and frequency domain [7]. PTS, trellis-assisted constellation subset selection (TACSS) and non-linear commanding transforming, active constellation extension (ACE) [8], selected mapping, peak windowing, tone injection, coding, filtering and clipping, and clipping are the various solutions introduced to eliminate the high PAPR issue in OFDM. PTS is the most efficient and attractive scheme among these schemes, because, which has high PAPR reduction without signal distortion. With several evolutionary algorithms for optimization named genetic algorithm (GA), particle swarm optimization (PSO), and artificial bee colony (ABC) [9].

2 Related Works

Arun Kumar and Manisha Gupta [10] have suggested a PTS and SLM PAPR minimization for FBMC. An elementary successive optimization approach was introduced for implementing the proposed model, which enhance the performance and the difficulty of design was less.

The combination of PTS and Gaussian pulse-based TR approaches was introduced by M. Vijayalakshmi and K. Ramalinga Reddy for reducing the PAPR [11].

A new PTS scheme based on multi-population cultural algorithm adopting knowledge migration (MCAKM) has been introduced by Tarik Hadj Ali and Abdelkrim Hamza for best phase rotation factors search [12].

A proficient PTS scheme based on particle swarm optimization (PSO) was introduced by Mehdi HosseinzadehAghdama and Abbas Ali Sharifi for minimizing the PAPR [13]. The modulated signals in OFDM were transmitted by a huge amount of subcarriers, which have maximum PAPR.

Minimum-complexity side data-free new PTS approach was proposed by Samriti Kalia and Alok Joshi to diminish PAPR in OFDM Systems [14]. A new PTS approach without side information and with reduced complexity was proposed here.

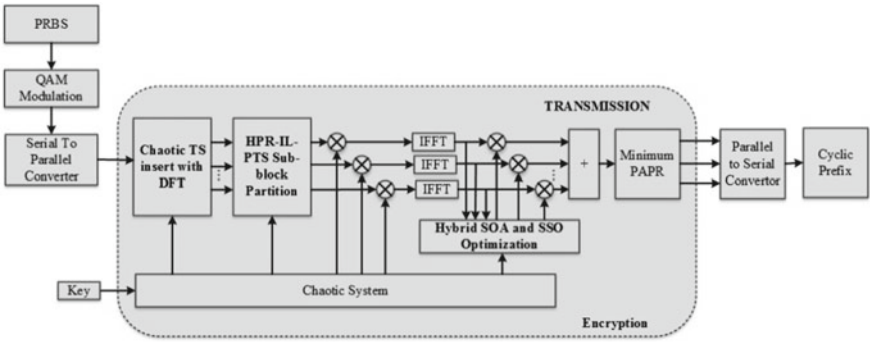

Fig. 1 Schematic block diagram

3 Proposed Methodology: A 4D Hyper-Chaotic-Based Hybrid Optimized PTS for PAPR Reduction

In this research, data encryption is taken by the 4D digital hyper-chaos, and then a new hybrid sub-block part ion is taken by the PR-IL-PTS approach and finally, the phase weighting factors are optimized by HSOSS algorithm for PAPR minimization. Hence, the data transmission in OFDM system is securely transmitted and the minimization of PAPR is also achieved.

The overall schematic model of proposed PTS approach is demonstrated in Fig. 1, A pseudo-random binary sequence (PRBS) is given to the serial to parallel (S/P) converter after the QAM modulation. The converted sequences are given to the chaotic TS with DFT for the security purpose, which is given to the sub-block partition by HPR-IL-PTS. Inverse Fast Fourier Transformation is performed on the partitioned signals, and then each signal is multiplied with weight factors generated with HSOSS algorithm. Now the minimum PAPR signal is proceeded. Then the signals are converted parallel to serial stream and guard bands are provided with cyclic prefix.

4 Implementation: Results and Discussion

The correlation parameters are used to produce better performance in PAPR minimization. The performances are demonstrated in terms of CCDF, BER, CCDF in terms of number of subcarriers, CCDF as regards sub-blocks, PAPR reduction with respect to number of iterations, CCDF in terms of sub-block partition methods, and total generation cost and time complexity. The proposed model is compared with existing PAPR reduction methods such as original OFDM, PTS, GWO-PTS, HWOMFO and it shows the proposed scheme outcomes are maximum compared to others. Data encryption is done by the 4D chaotic hyper TS and the sub-blocks are

partitioned effectively by HPR-IL-PTS approach and it compared with original PR-PTS and IL-PTS and the phase weighting factors are obtained by HSOSS algorithm. The BER performance in OFDM with respect to SNR in dB is shown in Fig. 2; it shows that the proposed model achieved less error rate. The main goal of this research is to obtain very less BER and PAPR reduction. This figure shows that the proposed model achieves best performance than the other existing approaches. At SNR = 4.3 dB, then, the BER value of the proposed model is 10^{-8}, but the actual OFDM has 10^{-1}.

Figure 3 demonstrates the CCDF in terms of SNR in dB; it shows the comparison of CCDF of proposed approach with existing approaches. The proposed scheme HSOSS is compared with existing models such as original OFDM, PTS, GWO-PTS, and HWOMFO. The proposed model achieves low CCDF at SNR = 4 dB, this performance is better compared to that of actual OFDM. For the proposed model, the SNR = 4 dB, then the CCDF value is 10^{-17}.

Figure 4, here the proposed model compared with existing HWOMFO and PS-GWO. It is the convergence diagram; it gives convergence rate of PAPR with respect to the number of iterations. Compared to PS-GWO, the proposed model achieves

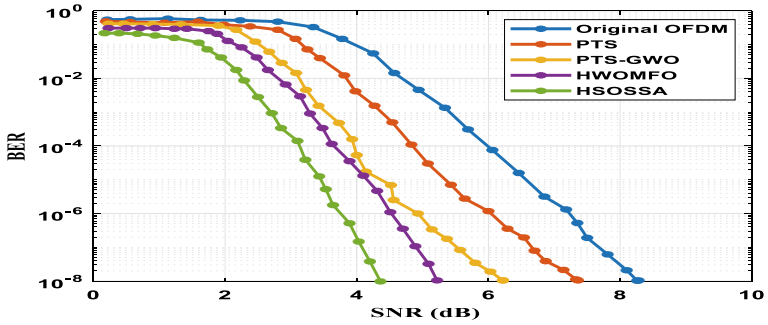

Fig. 2 BER with respect to SNR in dB

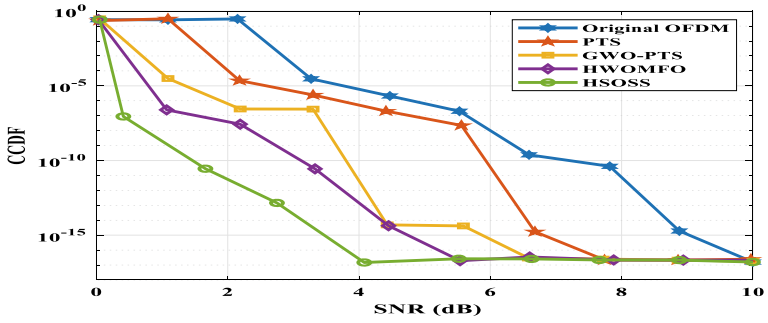

Fig. 3 CCDF versus SNR Performance in dB

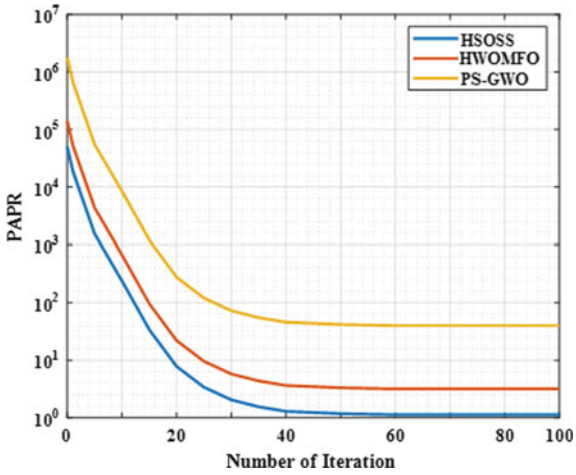

Fig. 4 PAPR reduction with respect to number of iterations

easily convergence rate. The proposed (HSOSS) model gets converge rate at the twentieth iteration, but PS-GWO gets converge at thirtieth iteration.

CCDF versus SNR performance for different subcarriers is shown in Fig. 5. The subcarriers taken from 16 to 256 and the proposed scheme's CCDF value are shown by every subcarriers.

Figure 6 shows the CCDF performance in terms of PAPR for different sub-blocks at initial condition. The sub-block partitions are done by the hybrid PR-IL-PTS part ion approach. Blocks are divided by 2, 4, 6, and 8 sub-blocks; compared with original OFDM, the sub-block partition approach has better CCDF performance. The PAPR value is 3.8 dB, and then the CCDF is 10^{-6}.

Comparison of CCDF performance of proposed algorithm with respect to SNR is demonstrated in Fig. 7. Here, the proposed sub-block partition approach is compared with existing partition approach PR-PTS and IL-PTS. The proposed sub-block partition method archives very less CCDF compared to other two approaches.

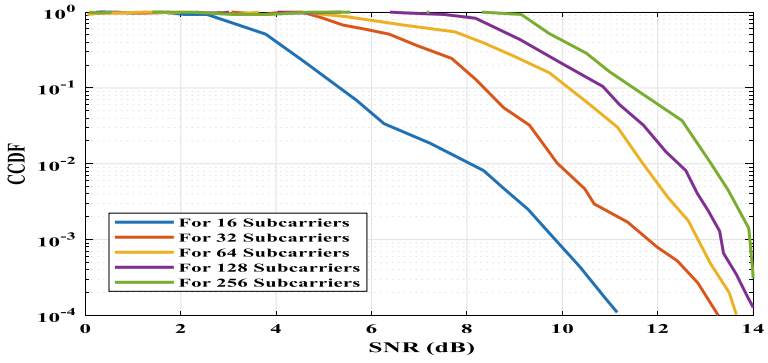

Fig. 5 CCDF of PAPR performance with respect to SNR for different subcarriers

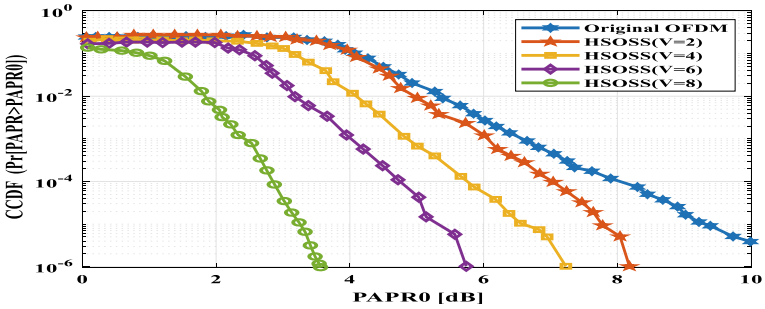

Fig. 6 CCDF performance in terms of PAPR for different sub-blocks at initial condition

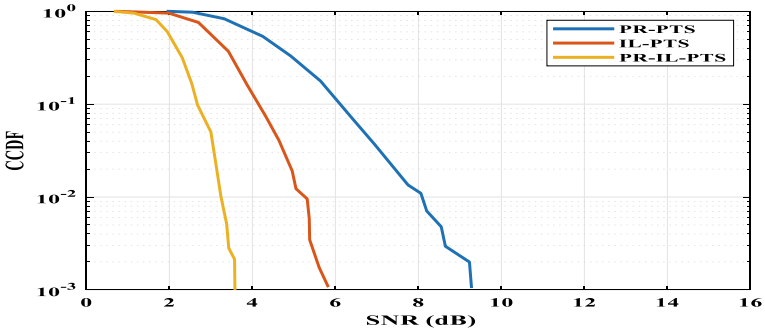

Fig. 7 CCDF with respect to SNR for sub-block partition approaches

5 Conclusion

The new hybrid optimized PTS approach is introduced in this research for decreasing BER and PAPR in OFDM. The sub-blocks are partitioned efficiently by HPR-IL-PTS approach, which achieves the maximum performance. The optimal phase weighting factors are obtained by a new hybrid SOSS algorithm, which proceed the scheme with low PAPR. The encoded signals are modulated using QAM modulation. Next, the signals are encrypted by 4D hyper-chaotic sequences. The chaotic TS is inserted with DFT for the encryption. Then, the encrypted signals are efficiently partitioned. The new hybrid optimized PTS approach is introduced in this research to diminish the PAPR and BER in OFDM. The sub-blocks are partitioned efficiently by HPR-IL-PTS approach, which achieves the maximum performance. After the partitions, the IFFT is used over the modulated signal, and the cyclic prefix is inserted here. In the receiver side, the reverse process of transmission takes place.

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