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PERFORMANCE ANALYSIS OF OFDM SYSTEM USING PTS ALGORITHM BASED ON PARTICLE SWARM OPTIMIZATION

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ABSTRACT

Orthogonal Frequency Division Multiplexing (OFDM) is a popular multicarrier modulation innovation in the wireless dispatches that enables high- rapidity data release. The high peak to average power ratio (PAPR) is formed because of numerous subcarriers in an OFDM system for modulated trademark transmission. In this paper, we extend a special technique to reducing the high PAPR in a wireless communication system. The actual path employs that a Partial Transmit Sequence (PTS) method based on Particle Swarm Optimization (PSO). In this paper, we describe OFDM system that uses the traditional PTS path in convergence with PSO. To reduce computing complication, the offered methodology effectively investigates the ideal combination of phase revolution factors[1,2,3]. The experimental effects show off that the intimated scheme significantly reduces computational complication and PAPR.

KEYWORDS: OFDM, PAPR, MCM, PTS, PSO, SNR, BER

1. Introduction

Moment's digital world is filled with wireless technologies that enable the indefectible prosecution of diurnal chores, hence perfecting persons' quality of life. The wide vacuity of wireless technology has redounded in a significant increase in public mindfulness and proficiency with the innovation [1]. This point made an OFDM system largely effective and simple volition for broadband services. To covert the fading in frequency channel into flat fading channel the inter symbol interference (ISI) issue is introduced [2]. These ways include trimming, rendering, direct companding, selective mapping (SLM), and PTS [3]. PTS is a largely successful approach for lowering PAPR. One of the issues with the PTS fashion is the substantial computing cost needed to determine the ideal phase variables. Over all multitudinous styles, the PTS method appears more effective and deformation- free methodology to reduce OFDM system's PAPR [4].

2. OFDM SYSTEM MODEL

In numerous corridors of the world, all telecommunications norms, including those for WLANs, DTT, and DRT, are grounded on the OFDM, an extensively used rectification and manifold innovation [5]. OFDM have the formerly and now been appertained to as MC, Multi-tone, and Fourier transfigure in the literature. In mathematics, two functions are considered orthogonal if integral part of their by- product on top of the named time range is zero [6]. Orthogonal functions might be described as scrupulously detached.
Signal representation is shown below:

$$s(t) = \sum_{k=0}^{M-1} c_n \, e^{j2\Pi f_k t} \quad (1)$$

Here, $f_k = f_0 + k.\Delta f$ (2)

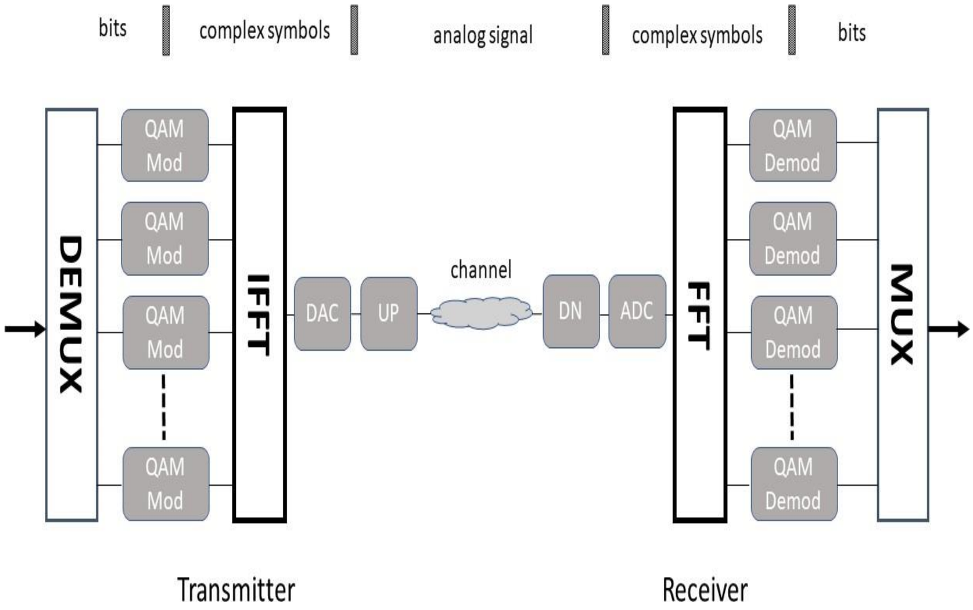

Figure 1: Block Diagram of OFDM system

Figure 1 depicts the abecedarian block illustration of an OFDM system, which includes a transmitter and a receiver. At the transmitter, input conclusion bit sluice enters the system. typically, this input bit sluice is demultiplexed to lower the bit aqueducts which are fed into M-QAM modulators [7]. An equivalent down- motor shifts the frequency of an OFDM signal and returns it to baseband. Before applying to FFT block, ADC converts input signal into digital representation. The initial isolated data sluice is also rebuilt utilizing the multiplexing procedure [8].

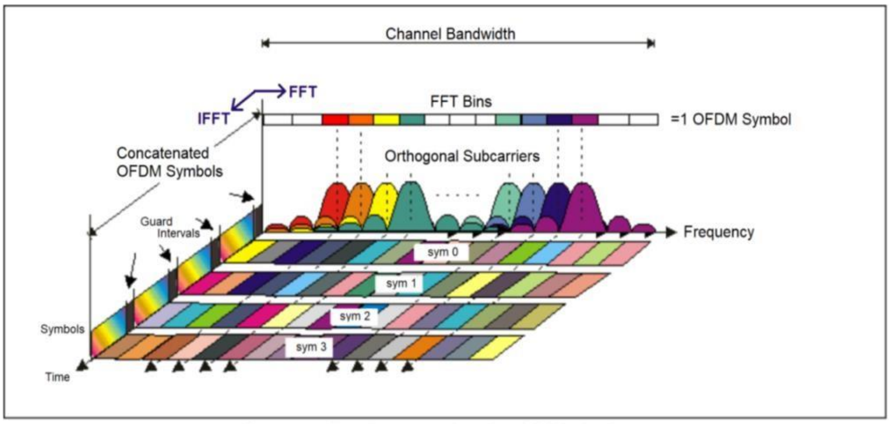

Figure 2: Integrated concept of frequency and time domains of the OFDM signal

Figure 2 depicts a time and frequency sphere imaging of OFDM signal. Each hallmark in the illustration represents a set of OFDM subcarriers that are transmitted via the channel. Digital OFDM signal is generated with transmitting conclusion of digital reform mark S_k along IFFT block [9]. OFDM signal of separate- time transmitted, formulated with M carrier waves, can be described along n slices, as shown off below:

$$s_n = \frac{1}{\sqrt{M}} \sum_{k=0}^{M-1} S_k \, e^{\frac{j2\Pi kn}{M}} \; ; 0 \le n \le M-1 \qquad (3)$$

The PAPR of the signal is defined as the ratio of the maximum power to average power is given as:

$$PAPR = \frac{Max|s_n|^2}{E[|s_n|^2]} \qquad (4)$$

$$PAPR_{dB} = 10 \log_{10} \frac{Max|s_n|^2}{E[|s_n|^2]} \qquad (5)$$

The complementary cumulative distribution function (CCDF) is frequently used to evaluate the PAPR minimization method's efficiency. The CCDF is defined as "the probability of an OFDM signal's PAPR exceeding a threshold level. "ρ"

$$CCDF = P(PAPR > \rho) = 1 - [1 - e^{-\rho}]^M \qquad (6)$$

1. PTS TECHNIQUE BASED ON PSO

The PTS (Partial Transmit Sequence) technique divides the input conclusion into several sub sequences. IFFT is applied to each sub-block independently and multiplied with complex phase factor $p^n = e^{i\theta_m}$. Figure 4 is a schematic diagram of an OFDM transmitter that uses the PTS approach [10]. The input data stream, indicated as S, is divided into N unique subblocks, known as S_n. The goal is to find the phase factors p^n that minimise the PAPR of the time-domain signals [11-12].

$$s = \sum_{n=1}^{N} p^n \, s_n \qquad (7)$$

$$s = \sum_{n=1}^{N} p^n \; IFFT[S_n] \qquad (8)$$

$$s = \sum_{n=1}^{N} \widetilde{p^n} \, x_n \qquad (9)$$

The below expression shows how to select phase factors to reduce PAPR:

$$[\widetilde{p^1}, \; \widetilde{p^2}, \ldots, \widetilde{p^n}] = \arg min \, [max|\sum_{n=1}^{N} p^n s_n|] \quad (10)$$

The below expression represents the PAPR reduction of the time-domain signal:

$$s = \sum_{n=1}^{N} \widetilde{p^n} \, s_n \qquad (11)$$

To get the optimum collection of phase vectors, search 4^N sets of phase factors with the permissible range of p = {±1, ±j}. As the sub-blocks increases the search complexity also becomes higher.

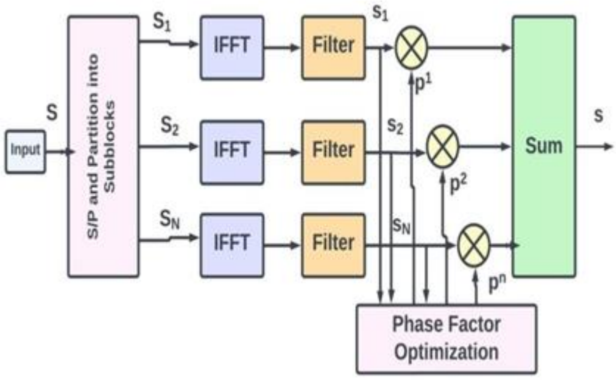

Figure 3: PTS technique for minimizing PAPR of OFDM

Particle Swarm Optimization (PSO) is a speculative optimization path grounded on mass motion and particle position of swarm. In PSO, gregarious commerce is exercised to manipulate a variety of difficulties. The fashion being bandied is generally appertained to as the original variant of PSO [13].

Let Lj = (lj1, lj2,..., ljN) is location of the jth patch, Pj = (pj1, pj2,..., pjN) is the stylish place (pbest) derived with the jth patch and the stylish point found along all patches with the gbest index is shown. Vj = (ϑj1, ϑj2,.., ϑjN) is used to indicate the jth patch's velocity (V). By using Eq. (12) and (13), patches pass.

$$v_{jb}(k+1) = \omega\, v_{jb}(k) + Q_1 + Q_2 \qquad (12)$$

Here, $Q_1 = a_1 r_{1b}(k)\left[p_{jb}(k) - l_{jb}(k)\right]$, *and* $Q_2 = a_2 r_{2b}(k)\left[p_{jb}(k) - l_{jb}(k)\right]$

$$l_{jb}(k+1) = l_{jb}(k) + v_{jb}(k+1) \qquad (13)$$

Here, k shows intake repetitions and b shows natural numbers from 1-N; ω determines inertia weight.

$$\omega = Iteration\ Number / Max.Iteration \qquad (14)$$

The portions a_1 and a_2 indicate how soon every flyspeck proposal its single and global optimum positions. $r_1 and r_2$ are two similarly dispense unsystematically numbers in the scope of 0 to 1 [14-15]. To calculate the new particle velocity, use Eq. (12). Preceding velocity is used to determine fashionable velocity. After computing its velocity, the particle moves to its new place using Eq. (13). The particles fitness was assessed using below formula:

$$fitness(s) = \frac{1}{PAPR(s)} \qquad (15)$$

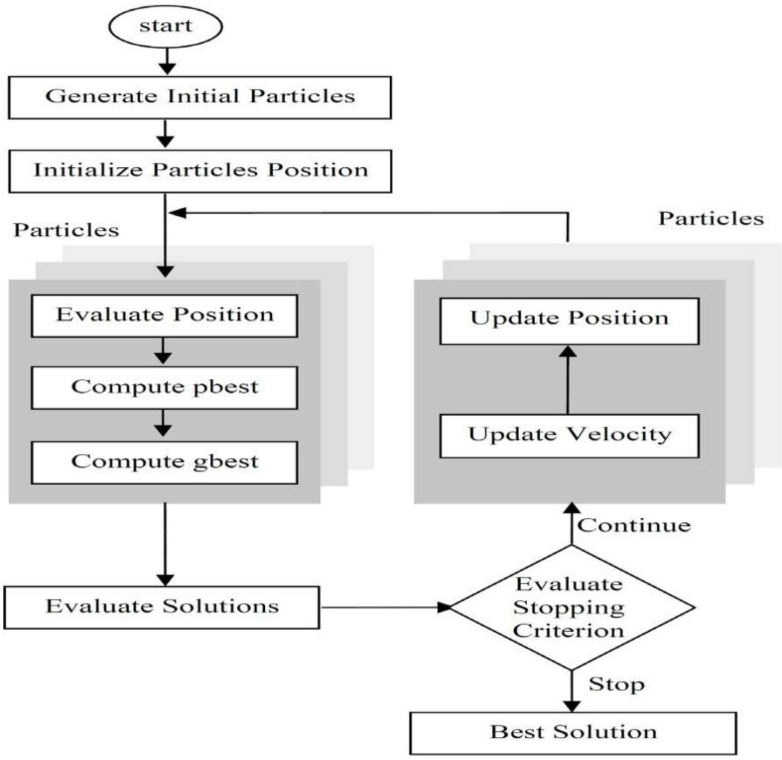

Figure 4: Flow Chart for PTS technique based on PSO

4. RESULTS

To decrease PAPR of OFDM system using PTS technique based on PSO numerous simulations have been performed. MATLAB Software R2018a was used to analyze the performance of PAPR with different simulation parameters.

Table-1: Simulation Parameters

Parameters	Value
No. of symbols	1e4
No. of subcarriers	512
Modulation Technique	QPSK
No. of sub-blocks	2,4,8,16
No. of particles per generation	10
Partition	adjacency partition
Overall sample rate	4
Iteration numbers	[1 4 8 10 20 30]
Maximum iteration number	30
Learning factors	a1 = 2; a2 = 2
Maximum velocity	$V_{max} = 0.2$
Min. inertia weight vector	$w_{min} = 0.4$
Max. inertia weight vector	$w_{max} = 0.9$
Channel	AWGN
Threshold value	6.7

Figure 5 shows the CCDF of the PAPR analysis of OFDM signal grounded on PTS method escorted by different sub-block counts. According to Figure 6, for CCDF = 10^{-4}, the PAPR of the system without PTS is 11.9 dB, for N = 2, 4, 8, 16 the respective PAPR values are 11.2dB, 10.2dB, 8.8dB, 8.12dB. The figure shows that as the number of sub-blocks increases, the PAPR value of OFDM system decreases.

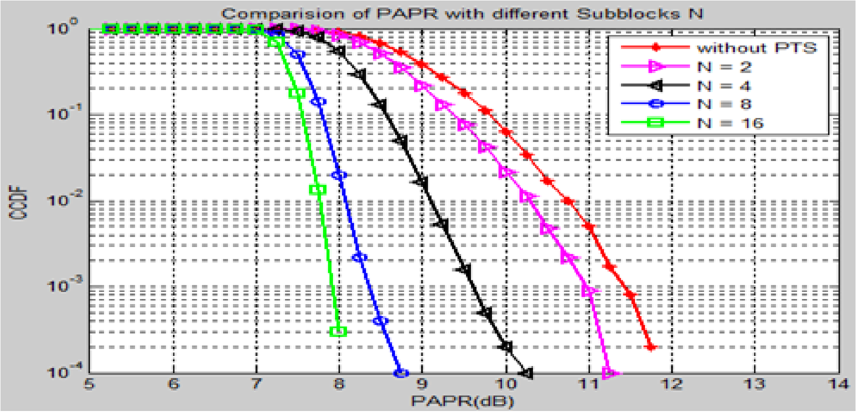

Figure 5: Comparison of PAPR with different sub-blocks

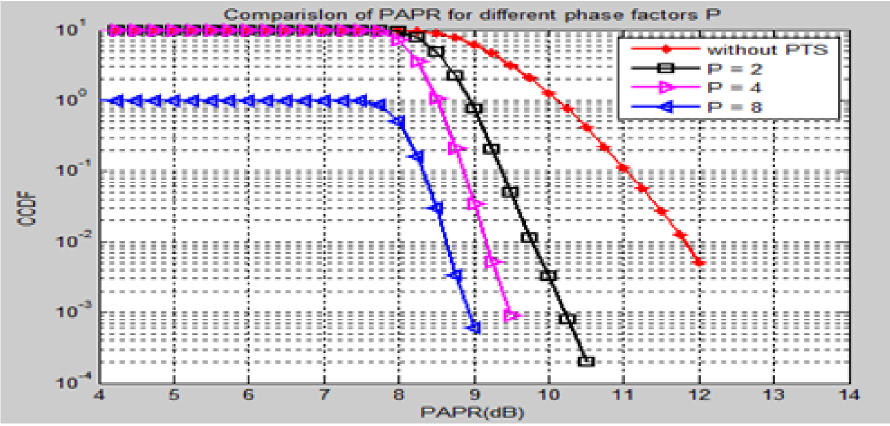

Figure 6: Comparison of PAPR for different phase factors

Figure 6 shows the PAPR comparison with different phase factors. The phase factors are chosen from the wider order of 2, 4, or 8. It's proved that lesser freedom in picking weighting rudiments for the combining phase leads to fresh decrement. The PAPR minimization performance improves as the number of phase weighting variables grows still, because to the several duplications, processing time improves.

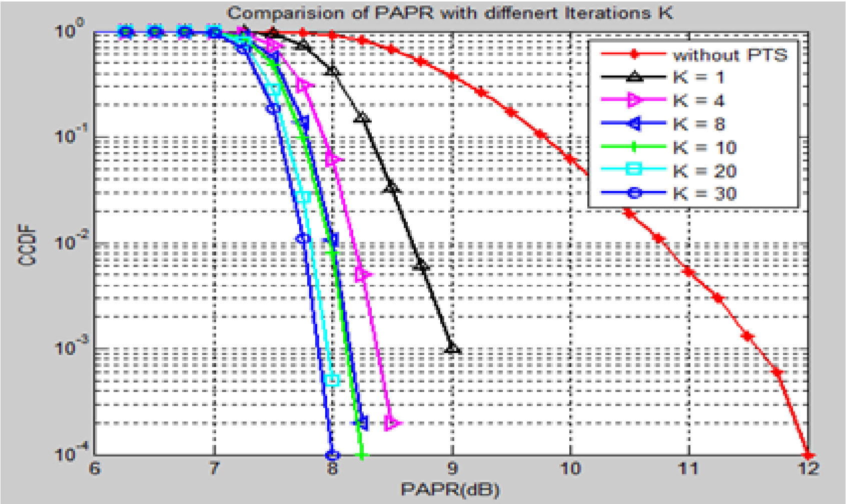

Figure 7: Comparison of PAPR using different iteration factors

Figure 7 exposes a few replicated findings from the CCDF of the PAPR study for the OFDM system across a number of iterations. Every generation has seen an improvement in the PAPR's CCDF. However, the degree of improvement is limited when K is more than 40. The computational complexity increases with K. Increases in K improve PAPR efficiency.

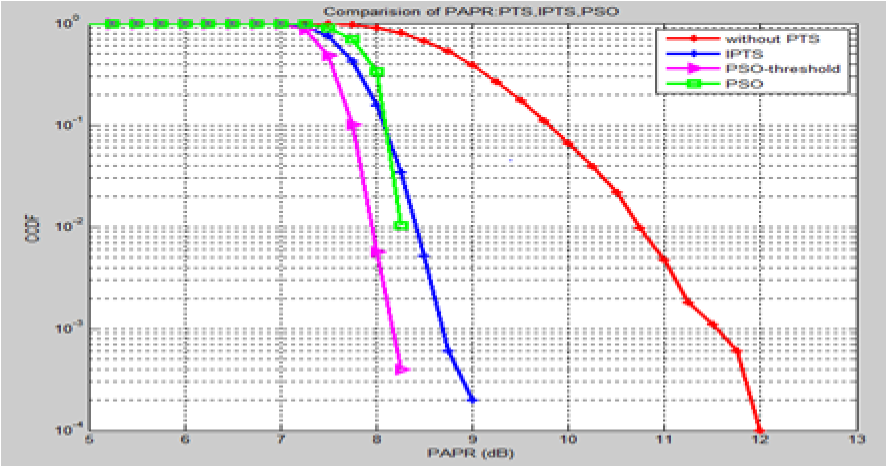

Figure 8: Comparison of PAPR without PTS, IPTS, PSO-threshold, PSO

Figure 8 shows the suggested PSO for the PTS system, as well as a CCDF contrast of IPTS and PSO. If CCDF = 10^{-3}, then PAPR of OFDM without PTS is11.62 dB, while IPTS and the suggested fashion have

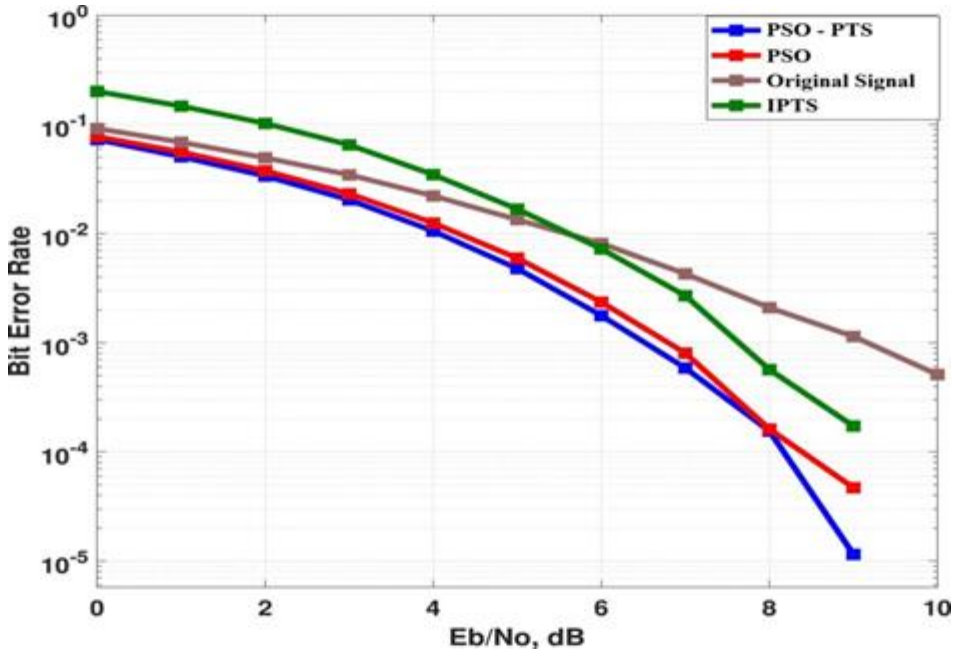

Figure 9: Performance of BER and SNR

PAPR values of 8.7 dB and 8.25 dB. The PSO-PTS strategy's BER performance is contrasted with various techniques in Figure 9. SNR of the original signal is 8.9dB, and its CCDF is 10^{-3}. SNRs of IPTS, PSO, and PSO-PTS are 7.3dB, 6.8dB, and 6.2dB, in that order. The OFDM systems Spectral Efficiency (SE) is shown in Figure 10. The SE values of IPTS, PSO, PSO-PTS, original signal, and SNR are 0.7, 1, 1.4, and 2, respectively, at 20 dB SNR. The spectral efficiency is enhanced by the PSO-PTS.

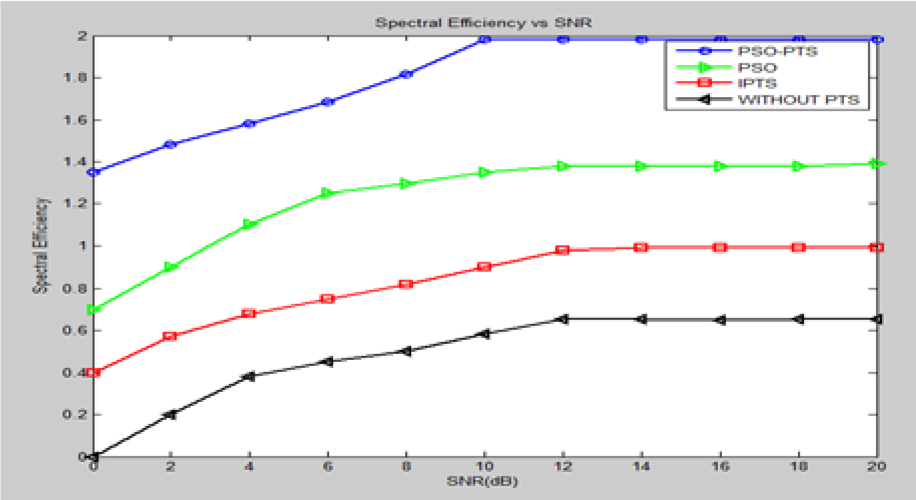

Figure 10: Spectral Efficiency vs SNR

5. Conclusion

In this paper, interpretation of PTS fashion was delved to decrease the PAPR in OFDM system. The PTS's patch gyration procurators were dissembled via a total hunt. The composition in this article, a PSO procedure is assumed to determine the stylish patch procurators for a PTS fashion in order to decrease PAPR more snappily. Hypothetical effects disclose the proffered program outperforms before evolutionary calculation ways by lowering the PAPR when assimilated to other styles. The proposed system is effective because it provides a good PAPR reduction, upgraded range effectiveness, bettered BER interpretation, and low computing complication.

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