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Abstract

Wireless Sensor Networks (WSNs) are self-organized infrastructure less arrangement of (mobile/static) nodes, used to monitor the system response in terms of the physical conditions of the environment such as temperature, sound, wind, and pollution. However, such networks have numerous challenges such as resource availability, noise, link performance and security. Orthogonal Frequency Division Multiplexing (OFDM) approach gives the optimum solution to increase bandwidth, reduce the energy consumed and improve the link performance of the nodes (router nodes) present in the network. But this approach has certain challenges like timing and synchronization, envelope fluctuations are high, and offset phase. The paper presents, a combinational procedure to condense the fluctuations of enveloping multi-input-multi-output (MIMO) OFDM multi-carrier signals. The presented algorithm is the union of probabilistic model techniques and constellation extension. The proposed scheme attains a considerable drop in peak-to-average power (PAP) to reduce Bit Error Rate (BER) of the link between the nodes, when correlate with conformist approaches and improve the channel performance. The proposed approach is validated using M-lab.

Keywords: Fluctuation, Multi-carrier, MIMO, OFDM, Wireless sensor network.

1. INTRODUCTION

The WirelessSensor Networks (WSNs) are set of spatially isolated and devoted sensors to monitor and record the physical surroundings of the atmosphere and categorize the composed data at a fundamental location. WSNs assess the environmental conditions like sound, temperature, humidity, pollution levels, and wind. WSNs consist of a gateway to grant wireless connectivity support to the wired globe and scattered nodes. The application areas of WSNs are medical management and distant monitoring. In medical management, WSNs create less persistent patient observing. Also, for services such as the streetlights, electricity grid and water municipals, wireless sensors (WSs) present an economical technique to collect system data which decreases the energy consumption and utilize resources efficiently. Due to such applications, WSNs are frequently used to monitor the system response. However, due to its variety of application in the field of communication,wireless sensor networks posses certain challanges such as required huge bandwidth and maintain network connection, when sensor nodes are mobile. Multi-carrier modulation (MCM) satisfies this prerequisite efficiently and is dynamic to reduce the channel disruption.

Multiple-input multiple-output orthogonal frequency division Multiplexing (MIMO-OFDM) is one among important technologies of MCM. Which is applied in numerous applications (e.g. IEEE 802.11, HIPERLAN/2, Digital Video Broadcasting (DVB), Digital Audio Broadcasting (DAB) and 4G mobile communication systems), as the bandwidth of the network channel is being used efficiently .In the proposed method, this technique is used at the intermediate sensor nodes which can act as routers in the sensor network and having multiple inputs and multiple outputs. Because any intermediate node in the network can be act as a router for number of input output end users, as a result the intermediate node (Router Node) will be overloaded and reduce efficiency by dropping number of input data packets at the router node. This loss of packets in turn reduces the order of packets and increases the error rate in the channel connected between end users. So, to overcome this problem a technique is being proposed, which reduces the PAPR and enhance the channel performance. However, there are some challenges and issues bounding MIMO-OFDM systems such as frequency synchronization, timing, high envelope fluctuation and phase offset. These constraints restricted the mobile node battery power and collapse the connection between end users. In the present art of work, a number of approaches have been projected to decrease the envelope variations in multicarrier signals [1-10]. Such techniques comprise clipping **Zhenxing Chen** and **Seog Geun Kang** [3], coding **K. Patterson** [2], tone injection (TI) tone reservation (TR) **J. Tellado** [4], partial transmit sequence (PTS) **Muller,** and **Huber, Tellambura** [7, 8], selective mapping (SM) **Van Eetvelt** et al., **Bauml** et al. [5, 6], and active constellation extension (ACE) **Krongold**, **Jones** [9, 10]. To contrast with every above method **Jiang** and **Wu** [1] demonstrates that probabilistic techniques have lesser PAPR i.e. SLM, TR, PTS and TI. ACE, on the other hand, provides collection in a non-directive way as a result of which minimizes the peak signal power.

The goal of this paper is to combine Approximate Gradient Project (AGP) and PTS techniques to reduce BER caused by the channel in comparison with the conventional approaches. The remainder of the paper consists of related work being discussed in Section II. Section III presents the background and motivation, the proposed approach is presented in section IV, simulation results of the presented approach are revealed in part V and the conclusion of the paper is specified in part VI.

2. RELATED WORK

Umesh and **Kadam** [11] proposed an algorithm in which the authors try to enhance the performance of the OFDM system using BPSK modulation technique. However, this approach increases the complexity and enhances the delay, which in-turn reduces the throughput. **Singh** and **Gupta** [12] proposed a review of channel estimation in OFDM, in which the authors show the employment of OFDM as a modulation scheme or multiplexing method and it will turn into capable technology designed for next generation in wireless technology. **Oxving** et al. [13] presented an approach to improve the SL0 algorithm, however, it increases the computational time to get better performance in comparison with the conventional methods. **Patel** and **Sipa** [14] proposed a model to improve the BER for OFDM systems using digital modulation techniques. However, the authors assumed that at higher SNR the gain will improve, which increases the energy per bit times the number of bits per symbol. **Mohana** et. al. [15] proposed a MIMO-OFDM model by choosing multiple antennas to reduce the noise and enhance the BER. But the use of multiple antennas increases the probability of noise incorporation which decreases the system performance. **Pratima** and **Soni** [16] proposed an approach to analyzing the BER of digital modulation techniques such as QAM, BPSK, and QPSK. **Zimran** and **Boon** [17] proposed a wavelet OFDM V-BLAST MIMO modulation technique for wireless sensor networks to reduce BER and PAPR of the system. **Chen** and **Seog** [18] presented a three dimensional OFDM technique using a better version of partial transmit sequence to reduce PAPR in WSNs for transmission in the physical layer. **Leila** et al. [19] discussed a MIMO OFDM technique for a wireless network and reduction in PAPR is obtained by space-time block-coded systems. In this method filtration and clipping gives better performance.

A. MIMO- OFDM System

A MIMO-OFDM signal can be symbolized as 'M' self-governing subcarriers to follow orthogonal with each other with T_s as the orthogonal symbol period and having frequency of $\frac{1}{T_s}$. The broadcasted signal envelop of OFDM is presented as:

$$p[t] = \frac{1}{\sqrt{M}} \sum_{k=0}^{M-1} C_k \, e^{j2\pi kt/M} \qquad 0 \leq t \leq M-1 \qquad (1)$$

The transmitted information present here is in the type of the constellation which directly depends on the type of mapping employed (i.e. BPSK, QPSK, and QAM). In these mapping techniques, the fluctuations created in envelopes having very high peak signal value in the band. This enhances PAP ratio (PAPR) [1] of OFDM and can be expressed as:

$$PAPR[P[t]] = \frac{max_{0 \leq t \leq M-1} \left[|P[t]|^2 \right]}{E[|P(t)|^2]} \qquad (2)$$

Where, $E[|P(\mathrm{t})|^2]$ represents the expected operator.

B. REDUCTION METHODS OF PAPR

This section presents the probabilistic and constellation expansion methods.

1. PROBABILISTIC APPROACH

The term probabilistic means disarrangement in multi carrier communique. This scenario initially presents the data input which is jumbled and then optimized with appropriate phases to obtain the least PAPR series. Here two main methods, PTS and SLM of probabilistic methods are discussed.

A. SELECTIVE MAPPING

The selective mapping method is proposed in **Van Eetvelt** et al., [5] and **Bauml** et al. [6]. In this method the sequence is divided into a numerious part, latter each part is then multiplied by disparate phase range. The sequence having the least PAP is selected from all partitions. The OFDM series then can be given as$X[p]=[X[0],[1],\ldots,X[Z-1]]$ is distributed into V block with a size similar to that of $X[p]$.

Each of these break-up blocks is multiplied by phase series$H^V=[H_0^V, H_1^V,\ldots,H_{N-1}^V]^T$, which is having the same length as the basic OFDM series. This creates fresh tailored series represented as$X[p]^V=[\{X^V[0],X^V[1],\ldots,X^V[Z-1]]^T$. The Inverse Discrete Fourier transform (IDFT) of each block categorizations can be figured as:

$$x^V[n] = \left[x^V[0], x^V[1], \ldots, x^V[Z-1]\right]^T \quad (3)$$

From all blocks, the block with lowly peak power from (3) is selected for broadcasting i.$\bar{x_l} = x^V$.The selective series of phase are broadcasted and the same information is received for recuperating the original ODFM series, called as the side information.

$$\breve{V} = argmin_{V=1,2,..,v}\left(max_{n=0,1,\ldots,Z-1}|x^V[n]|\right) \quad (4)$$

B. SEQUENCE OF PARTIAL TRANSMIT

Muller and **Huber** [7] and **Tellambura** [8] proposed the PTS technique in which they present an effective way for phase factor calculation. The series which is OFDM mapped is divide into V dislodge sub-blocks$X[P]=[X^0,X^1,\ldots X^{V-1}]^T$, which are repeatedly placed. The Vacant positions of sub-blocks having similar size at zero padding called as a partial sequence. These blocks are changed into the time domain and the information about phases is collected from particular sub-block. The new phase vectors the can be given as $g^V = e^{j\varphi V}$,V=1,2,…,U. The PAPR is minimised by choosing the appropriate value of phase vector and can be the represented as:

$$\bar{x_l}[t] = \sum_{v=1}^{U} g^V x^V \quad (5)$$

Here the lowly PAPR, value getting from (5) is broadcasted along with the phase information to receive the fundamental OFDM sequence.

$$[\check{p}^1, \ldots, \check{p}^U] = argmin_{[p^1,\ldots p^U]}\left(max_{n=0,1,\ldots,Z-1} \left|\sum_{v=1}^{U} p^u\, y^u[t]\right|\right) \qquad (6)$$

However, it is difficult in probabilistic technique to choose the criterion of phase vectors. As a result, the complexityof thesub-blocks increases.

2. QPSK ACE

The author **Jones** [10] proposed ACE in which the convex problem is reduced and minimizes the PAPR. where IA- imaginary axes and RA-real axes.

This approach necessitates processing of both frequency and time domain signals. The key theory of this method is to move the points of surface constellation towards external of the fundamental constellation to generate substitute symbol of the same representation. Figure 1 represents the equivalent expansion of each point for QPSK. Krongold and Jones presented two ACE algorithms namely projection onto convex sets (POCS) and approximate gradient project (AGP) **Krongold** and **Jones** [9, 10].

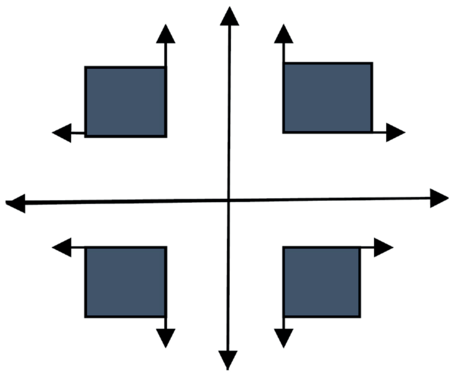


Fig. 1 QPSK Extension of Constellation in ACE Method

A.ROJECT ONTO CONVEX SETS (POCS)

POCS approach has dual convex sets to verify the absolute constellation point and internal point. This algorithm executes clipping at a preset level, however having constant phase as given in modulated series, hence can be given as:

$$\bar{x_l}[t] = \begin{Bmatrix} x[t] |x[t]| < M \\ Me^{j\theta[t]} |x[t]| \geq M \end{Bmatrix} \qquad (7)$$

where $x[t]$=$|x[t]|e^{j\varphi[t]}$

The $\bar{x_l}[t]$ of (5) is transformed into $X[P]$, to impose every constellation expansion constraihnt by reinstating the entire inside points to their fundmental values. This process continues till the PAPR is minimized. However, this approach has a severe problem of sluggish meeting and also has difficulty to select suitable clipping point.

B.APPROXIMATE GRADIENT PROJECT

In this approach,sudden rise is used to reduce the maximum value in AGP algorithm. This method is devised by choosing the signal which is clipped i.e.n_{clip}, can be represented as:

$$\bar{x_l}[m] = x^c[m] + n_{clip}[m] \quad (8)$$

where,

$$n_{clip}[m] = \begin{cases} 0, & |x[m]| \le S \\ (S - |x^c[m]|)e^{j\theta[m]} & |x[m]| > S \end{cases} \quad (9)$$

So, the new OFDM series can be achieved as:

$$x^{b+1} = x^b + \mu n_{ext} \quad (10)$$

where b- iteration number, µ-gradient factor, and
n_{ext}- time sequence which is extended.

All the above methods required improvement in BER. In this paper, a new algorithm has been presented to optimize the BER in wireless sensor network, by optimising the channel loss constraints. The proposed technique is the combination of probabilistic scheme and constellation expansion, used to reduce PAPR and improve the channel performance.

4. PROPOSED TECHNIQUE

Consider the wireless sensor network as given in figure 2.

'N_1, N_2... N_8' are the sensor nodes and 'R_N' is the intermediate or the router node as it will act as a router in the network. Two sensor nodes can connect directly if they fall within the sensing range, however if the two nodes do not lie within the sensing range they got the connectivity through an intermediate node (Router) and the network is called multi hop network. So number of input and output users can use same node as a router node and such type of network is called as MIMO sensor network. In such cases, the router nodes are susceptible to the channel noise which increases BER.

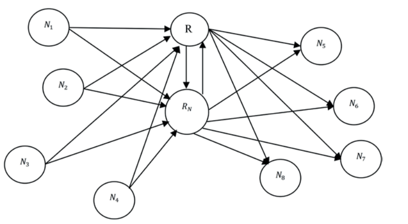


Fig. (2) Sensor Network

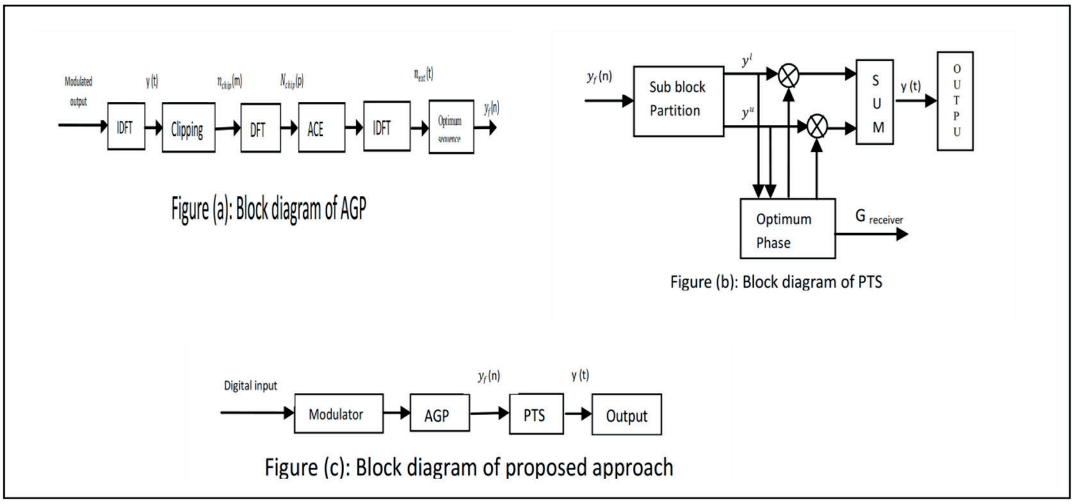


Fig. (3) PAPR Reduction Approach

In this paper, a method is being developed to optimize the BER in comparison with the existing algorithms. The parameters such as calculation complexity and BER **Jiang** and **Wu**, **Lim** et al., **Patidar** et al. [1, 20-22] should be improved to diminish PAPR. The individual presentation of AGP-PTS technique is enhance, such that it produces less PAPR when compared to other conventional algorithms.

Figure (3) represents the individual block diagrams of AGP, PTS and proposed approach. The various steps involved in the proposed approach (refer figure c) are as follows:

(1) Obtain an OFDM output that is the domain of frequency from the modulator, represented as$X[p]$.

Switch this signal into thedomain of time y$[t]$by employing IDFT

(2) Execute AGP on the signal y[t] by considering $c = 0$ as initial iterationand the highest value is set to c_{max}.

(3) The clipping level say M is applied on x$[t]$ and conserve similar phase as in fundamental OFDM signal.

$$\bar{x}[t] = \begin{cases} x^c[t] |x^c[t]| < M \\ Me^{j\varphi[t]} |x^c[t]| \geq M \end{cases} \quad (11)$$

where, $x^i\,[t] = |x^c\,[t]|e^{j\varphi}[t]$

(4) Acquire clipped signal portion of (11)

$$n_{clip}[t] = x\,[t] - x^c\,[\mathrm{t}] \quad (12)$$

(5) Now n_{clip} is converted to frequency domain value which is termed as M_{clip}.

(6) Locate route of constellation point as per ACE constraints. Which reinstate every internal constellation position to fundamental location and directs the external points to the exterior part of the gathering as shown in Figure 1.

(7) Use IDFT to get a completely new constellation i.e. n_{ext}.

(8) Choose appropriate gradient factor δ and calculate fresh series represented as:

$$x^{b+1}[t] = x^{c}[n] + \mu n_{ext}[t] \qquad (13)$$

(9) Execute and confirm procedure on $x^{b+1}[t]$.

(10) The increment of 'b' value by '1' i.e. 'b+1' and obtaining y_f [n] final value.

(11) PTS is pertained to $y_f[n]$. Separate the series into V dislodge of the same size sub-block.

(12) A set is created for phase vector $h = [h^1, h^2, \ldots, h^v]$ and multiplied with the fractional seriesy $_f[n] = [x^1, x^2, \ldots, x^v]$.

(13) Execute andverify procedure of series i.e. N=4^(v-1)for least PAPR signal to fundamental signal.

$$\hat{y}[t] = \sum_{u=1}^{v}[h^{v} * y^{v}[t]] \qquad (14)$$

(14) Choose least PAPR series as given in (14)

$$G_{reciver} = \underset{[h^1,\cdots,h^v]}{\arg\min}\left(\underset{t=0,1,\cdots,N-1}{\max}|\hat{y}[t]|\right) \qquad (15)$$

(15) Organize other information for the recipient to identify the subsequent phase series by as given in (14).

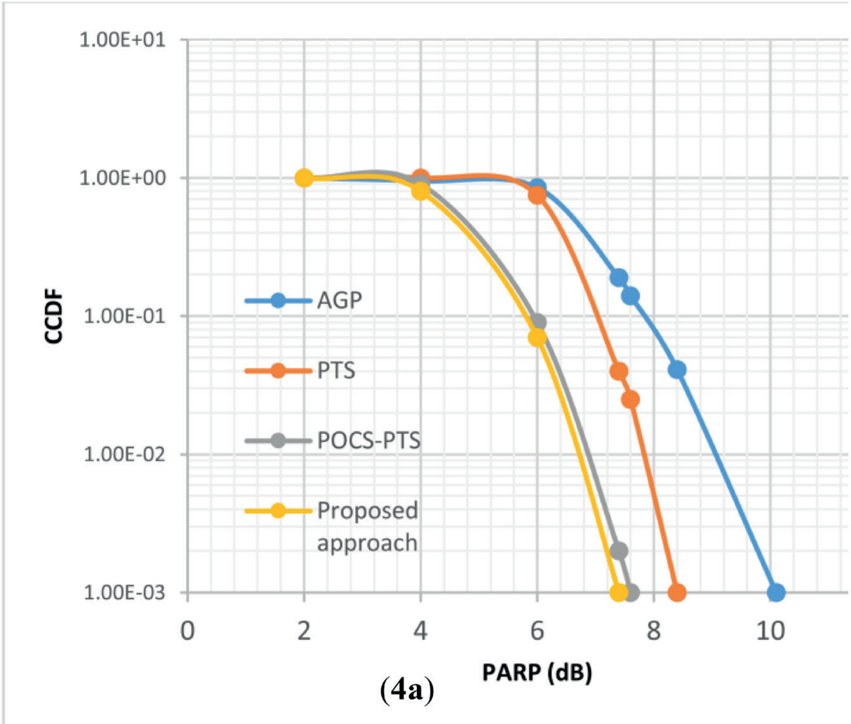
A. Computational Complexity

The complications of the presented approach are calculated by a number of addition and multiplications used or required. The PAPR minimization designs have composite nature of calculation. In probability models, such type of complex analysis is consists of 'N' sub-carriers, 'U' sub-block and 'n' bit information which is equal tolog_2 N.The complication of PTS and SLM in context of the multiplications for OFDM signal is given as **Umesh** and **Kadam** [11], $V\times M\times[(t/2)+1]$ with numeral value$V\times M\times t$ and $V\times M\times t/2$ with numeral value $(N+4\times V+2)\times M\times t$. Here, N represents the number of series as given in 14th step. So, when U is boosted PAPR decreases, there is an increment in the complexity. As a result, the constellation extension approach executes a number of iterations (c) to unite. Hence, AGP requires c complex multiplications and $c\times\{4\times M+M\times t\}$ complex additions which is greater than POCS with complex multiplications $c\times M\times t/2$ and complex addition $c\times M\times t$.

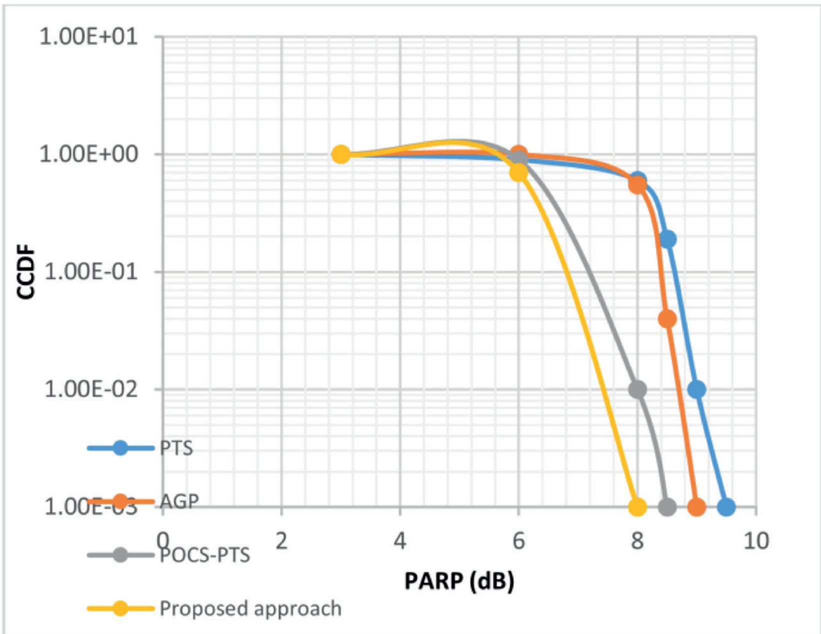
The presented approachrecommends fewer numbers of complex additions, compared to PTS as no IFFT operation is required between AGP and PTS blocks instead a number of complex multiplications are required. Consequently, in this approach, the number of complex additions and multiplications are modi$\times\left\{2\times M+\frac{M\times t}{2}\right\}$:$M+M\times t\}+\{N+4\times V+2\}$ and $I\times\{2\times M+(M\times t)/2\}+V$ respectively to reduce complexity in multiplication.

5. RESULTS

This part of the paper gives simulation results of existing and proposed approach. In the simulation experiment, 10,000.



(4a)

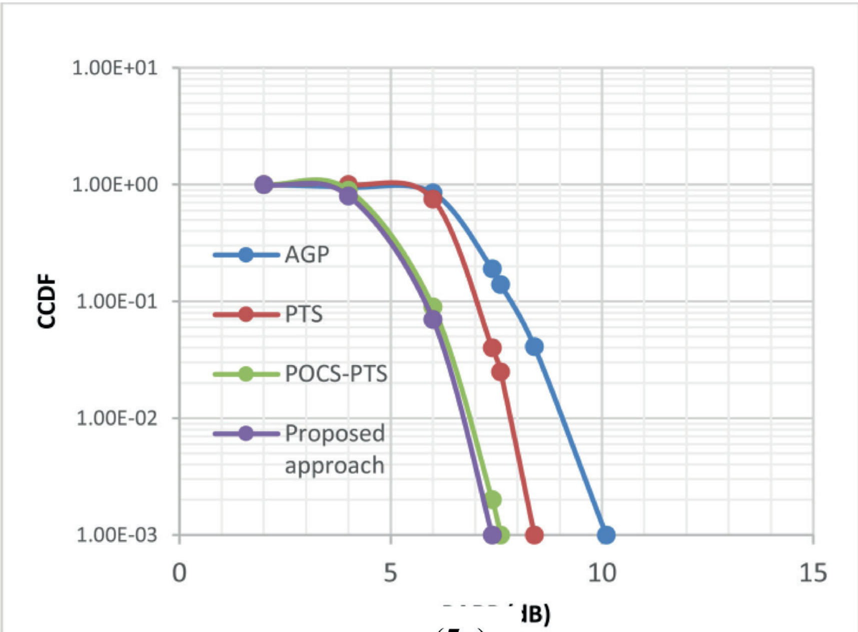


(4b)

Fig. (4): PAPR Comparison (a) N= 128 (b) N = 1024

OFDM frames between N=128 and 1024 subcarrier are designed for QPSK modulation. The given set up i.e. SLM and PTS bifurcate series into ‘4’ sub-blocks.

From Fig.4 (a) it is observed that the proposed approach decreases PAPR by one dB and 0.2 dB as contrasted to PTS and POCS-PTS approach respectively 0.0024 Complementary Cumulative Distribution Function (CCDF). In addition, the proposed approach also decreases the PAPR with increment in the number of subcarriers (N=1024). From Fig. 4 (b) it has also been observed there is an enhancement of 2 dB in the conventional approaches i.e. PTS and AGP.



(5a)

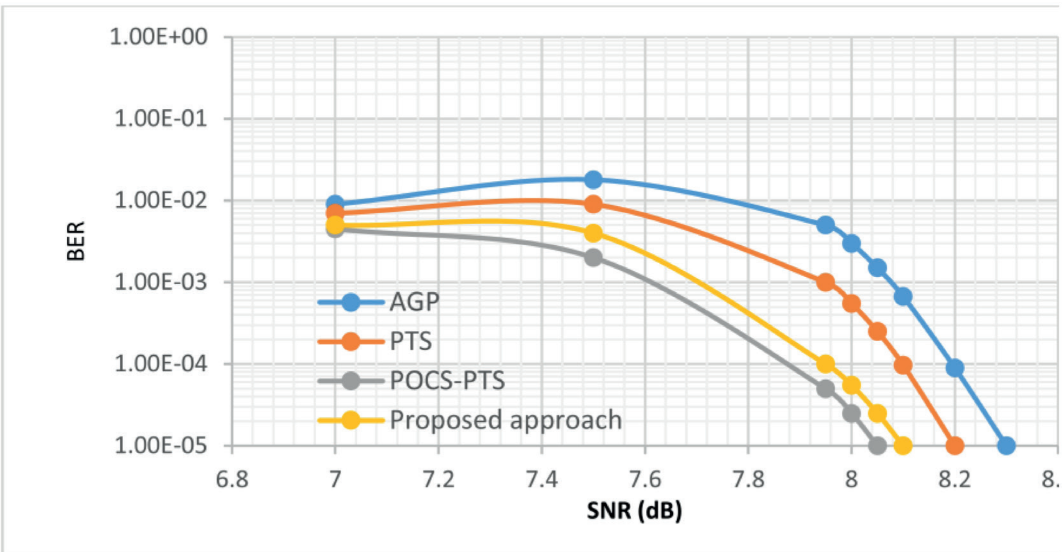


Fig. (5) BER Performance (a) N = 128 (b) N= 1024

Figure 5 (a) and figure 5 (b) demonstrates that in the occurrence of noise (AWGN), the presented scheme sustains at similar BER. Furthermore, for 1024 sub-carriers the BER presentation is found to be enhanced 8dB than the existing approaches signal-to-noise ratio (SNR).

The computational complexity of existing and presented approaches is recapitulated in Patidar et al. [21]. Despite the fact that POCS-PTS illustrates minimum complications between combinational approaches, however, it shows high PAPR than proposed approach. It has been observed from Patidar et al. [21], when N=128, the presented approach suggests an improvement of 58% in composite multiplications when compared to PTS approach, however it consumes 92% fewer composite additions. For N=1024, it illustrates increment in the composite multiplication and decrement in the compound addition at 40% and 93% correspondingly. As a result, the growth in compound multiplication in the presented approach is overcome by the fall in compound addition as contrasted to PTS approach.

CONCLUSION

This paper presents different combinational approaches for PAPR reduction. The presented approach gives better results by reducing the PAPR, BER, effectively improves the link performance and reduces the channel noise, in comparison with the existing approaches. Furthermore, for a huge number of subcarriers, the PAPR reduces further and at the same time improves BER. The presented approach reduces the PAPR considerably (i.e. 1dB). However, the improvement (i.e. 58%) in computational complexity because of compound multiplications is being roughly compensated during the large reduction (i.e. 92%) in compound additions. Hence can be used to reduce in WSN at channel level to reduce interference and can enhance the performance of the network model in terms of BER and noise

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طريقة تقليل (PAPR) بإستخدام حامل الموجات المتعددة (OFDM) الذكية التشكل في شبكات المجسات اللاسلكية

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الملخص:

شبكات الاستشعار اللاسلكية (WSNs) هي بنية تحتية ذاتية التنظيم (متحركة أو ثابتة)، تستخدملمراقبة المعلومات الراجعة من الحساسات المكونة لشبكة أي نظام خاص لأي من معايير الظروف الفيزيائية للبيئة مثل: درجة الحرارة والصوت والرياح والتلوث. غير أن ، هذه الشبكات لديها العديد من التحديات مثل توفر الموارد والضوضاء وأداء القنوات والأمان. حيث توفر مقاربة تعدد الإرسال بتقسيم التردد (OFDM) أفضل حل لزيادة عرض النطاق الترددي وتقليل الطاقة المستهلكة وتحسين أداء العقدة (عقدة جهاز التوجيه) الموجودة في الشبكة. ولكن هذهالمقاربة لديها بعض التحديات مثل التوقيت والتزامن ، تقلبات المغلفات العالية ، وتداخل المرحلة. في هذه الورقة ، يقترح أسلوب تقويمي لتكثيف تقلبات إشارات متعددة المدخلات (MIMO) متعددة الموجة الحاملة OFDM. يستخدم الأسلوب المقدم خوارزمية تتمثل في اتحاد تقنيات النموذج الاحتمالية وتمديد الكوكبة.يحقق المخطط المقترح انخفاضًا كبيرًا في قوة الذروة إلى متوسط (PAP) لتقليل معدل أخطاء البتات (BER) للوصلة بين العقد ، مقارنةً بالمخططات التقليدية وتحسين أداء القناة. هذا وسيتم التحقق من فاعلية وأداء المنهج المقترح باستخدام M-lab.