International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-8 Issue-11, September 2019

Energy Efficient Fractional Particle Swarm Optimization Based Power Allocation in MIMO-NOMA System

Shaik Khaleelahmed, Nandhanavanam Venkateswararao

Abstract: *Non-Orthognal Multiple Access (NOMA) is a key technology used for improving the achievable rate in Multiple Input Multiple Output (MIMO) wireless networks of the next generation. In MIMO-NOMA systems the Energy Efficiency (EE) needs to be improved by a Fractional Particle Swarm Optimization Algorithm (FPSO) based on user ordering. To recommend capable energy and power allocation in the platform efficiently, the proposed optimization algorithm prioritizes the users based on satisfying the quality of service (QoS) and maximum power constraints. The FPSO algorithm prioritizes the users in optimal way by using objective function. The simulated results are analyze using the assessment metrics, like Bit Error Rate (BER), achievable rate, energy and spectral power. The performance of the FPSO-based power allocation approach is showing the higher spectral power, energy, achievable rate are 113.1915dB, 19.4898dB, 81.19153Mbps and lower BER of 0.0000152 respectively.*

Keywords *: MIMO-NOMA, Energy Efficiency, Power Allocation, Fractional Particle Swarm Optimization Algorithm, Quality of Service.*

I. INTRODUCTION

In Multiple Input Multiple Output - Non Orthogonal Multiple Access (MIMO-NOMA) systems are used to satisfy the requirements of 5G. The noise cancellation and interference cancellation, power allocation and broader coverage are the growing interest research fields.The MIMO systems are capable to support multiple antennas are used for optimize the data speeds in wireless communications. NOMA is a multiple access technique in non orthogonal domain to enhance the capacity of system and energy efficiency. In MIMO systems with multibeam a centralized mechanism is developed [1]. In 5G networks beam energy enabled in Massive MIMO towards the spatial region for energy transfer [2]. The battery charging and discharging capabilities decides the devices life time. Energy Harvesting (EH) is another way to extend the life time of device and to enhance the energy efficiency by intend the Energy Efficient (EE) mechanism [10].

Next generation wireless systems data rates enhance by using NOMA technique. Successive Interference Cancellation (SIC) carried out by multiplexed the users with same frequency by using NOMA. In MIMO-NOMA uses the less power by more Channel State Information (CSI) than the users with more power with less CSI. Power decreasing order by the received signals guarantees by decoding sequentially in MIMO-NOMA [3]. The compensation of NOMA combines the beamspace of MIMO. In mm wave communication MIMO beamspace is potential access by NOMA. To support the beam Successive Interface Cancellation (CSI) and Intra-beam superposition are coding the users simultaneously. The achievable sum rate is significantly improved in the MIMO-NOMA approach by using the mmWave channel scheme [4]. In this system, SIC complexity reduced in the receivers by users paired into clusters [5]. In [6] exchange the data by usage of antennas to introduced multi pair communication system. To eliminates the inter-pair interference [7] by the approach in the imperfect channel information the energy efficiency and spectral efficiency does not consider . optimum energy efficiency is determine by the factors circuit power and noise power. In [8] payload power allocation and joint pilot approach in the multiple access system trouble of error propagation is decrease. Layered transmission approach [9] in MIMO-NOMA system sum rate is increased. In [2], detailed the challenges faced by existing techniques.

The power allocation is derived to form the closed form expression.In [4], to break the limit of the beamspace the beamspace MIMO and the NOMA are integrated. In the ultra dense network the pairing of the clustering and the user are not considered in the beamspace. In [5], transmit power level and the channel gain difference of the user is defines the user energy efficiency.The power allocation and optimal time computing is not focused for resource allocation [10].

This paper proposes fractional particle swarm optimization (FPSO) power allocation model to increase the Energy Efficiency (EE). Users are optimally selected by the FPSO, so that to gain the higher EE in the antennas the users are effectively allocated. The higher fitness measure indicates that the users are effectively allocated and the fitness estimation is done based on the energy efficiency. The contribution of the paper based on the optimally selected users such that the energy efficient power allocation is done by priority-based scheduling in the MIMO-NOMA to adopting FPSO.

Manuscript published on 30 September 2019.
*Correspondence Author(s)
Shaik Khaleelahmed*, ECE department, VR Siddhartha Engineering College, Acharya Ngarjuna University, Andhra Pradesh, India. Email: khaleelto786@gmail.com
Nandhanavanam Venkateswararao, ECE department, Bapatla Engineering College, Acharya Ngarjuna University, Andhra Pradesh, India.. Email: nvrao68@gmail.com

This paper is organized as in section 1 introduction is described . System model of the power allocation approach in Section 2. In section 3 the proposed FPSO algorithm for the power allocation is described. The results and discussions and finally in Section 4, In section 5 conclusion is given.

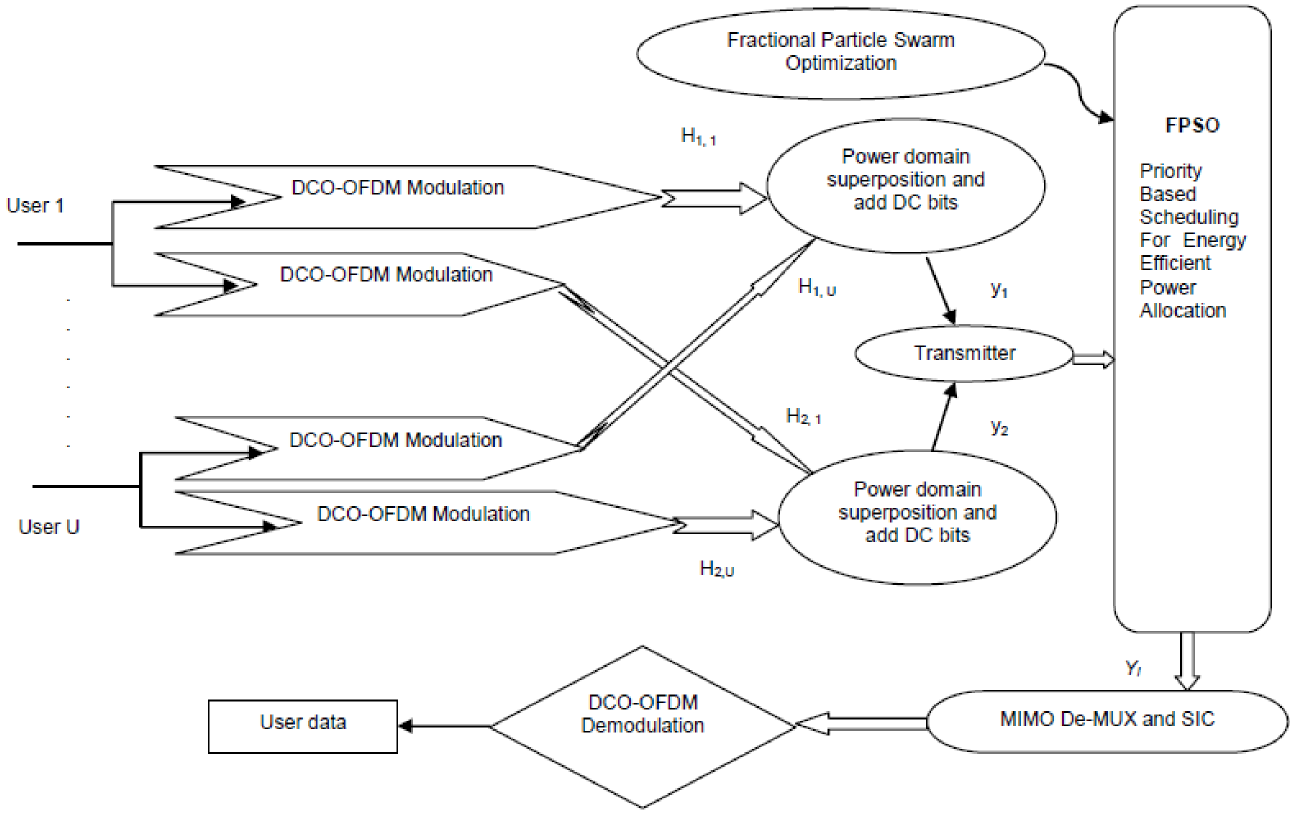

Fig 1. Block diagram of the Fractional Particle Swarm Optimization Algorithm based power allocation in MIMO-NOMA system

II. SYSTEM MODEL AND PROBLEM FORMULATION

A. System Model

Let us consider the multi user downlink MIMO system using the Base Station (BS) connected with M number of antennas, which transfer the information to the number of receivers associated with X number of antennas. Let M be the number of users and the channel matrix of BS for the x^{th} user, $\left[x \in \{1,...,M\}\right]$ is expressed as $A_x \in B^{X \times M}$, which is a quasi static independent. In Figure 1, MIMO-NOMA system uses a DCO-OFDM modulation. The addition of DC bias and the superposition of the power is performed to the input signal of the user, It is represented as,

$$y_k(i) = \sum_{i=1}^{U} \sqrt{\beta_{k,l}(i)} H_{k,l} + J_{dc} \tag{1}$$

where the channel function of k^{th} transmitter and l^{th} user is represented by $H_{k,l}$. $\beta_{k,l}$ is point out by the power of k^{th} transmitter and l^{th} user. Individual transmitter DC bias is given by J_{dc} .address.

B. Problem Formulation

For the effective system, the power with higher EE and the maximum fitness defines the optimal allocation power. In an effective way the allocation of the users indicates the higher fitness measure. Based on the energy efficiency the fitness of the solution is determined it is formulated in [12] as,

$$\max_{\gamma_{x,k}} \ \eta \text{, such that } E_{x,k} \geq E_{x,k}^{\min},\ x \in (1,...,M) \tag{2}$$

$$\sum_{x=1}^{M} \sum_{k=1}^{S} \alpha_{x,k} \leq 1 \tag{3}$$

where, the above equation reprasents minimum rate requirements and the minimum transmit power. The energy efficiency η for the system is represented as,

$$\eta = \frac{E^{mean}}{X_c + X_d} \tag{4}$$

where, $E^{mean} = \sum_{x=1}^{M} \sum_{k=1}^{S} \alpha_{x,k}$ denotes the sum rate.

The factors, like fixed circuit power consumption, X_d and the flexible transmit power, denoted as, X_c the teo factors constitutes the total power consumption. The term X_c is denoted as,

$$X_c = X_{\max} \sum_{x=1}^{M} \sum_{k=1}^{S} \alpha_{x,k} \tag{5}$$

The objective function relies on increasing the energy efficiency η, thus the user possess the minimum rate.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

III. PROPOSED MODEL OF ENERGY EFFICIENT POWER ALLOCATION USING FRACTIONAL PARTICLE SWARM OPTIMIZATION ALGORITHM

The proposed FPSO power scheduling method is better performance when compare to the power assign by the sequential ascending order in one by one arrangement existing methods. Optimization algorithm are used for user priority in power scheduling. Concerning the power requirement and quality of service prioritizes the users is carried out by FPSO. Users order in ascending order is followed by the existing method uses Maximum Energy Efficien (Max-EE),Normalized Gain Difference Power Allocation (NGDPA), and Gain Ratio Power Allocation(GRPA). Generally, The optimal channel gain of the individual users power allocation in the MIMO-NOMA systems is employed in the GRPA method. The method NGDPA differs from GRPA by calculate in the difference of channel gain between two users and the absolute value of optimal channel gain is calculated in Max-EE. Therefore, based on the channel gains the existing methods are arranged in the ascending order

The main aim in the MIMO-NOMA system is to increase the Energy Efficiency of system by using proposed FPSO power allocation approach. When MIMO and NOMA both are integrated to enhance the gain in the power allocation and energy efficiency. MIMO-NOMA system FPSO-based power allocation is shown in the block diagram of Figure 1. The algorithmic steps for energy efficient power allocation involved in the priority-based scheduling is given below section.

A. Fractional Particle Swarm Optimization Algorithm (FPSO)

The main goal of the FPSO optimizer is to selects the users appropriately for the power allocation in the global optimum solution. FPSO is a swarm intelligence algorithm inspired from the behavior of paricles and their interaction. The benchmark functions to perform effective optimization in FPSO by determine the global optima for the unimodal and multi-modal.

B. Solution Encoding

The result are signify in an effective manner by using solution encoding in the FPSO algorithm. The number of users in this approach is similar to the size of the solution, and the optimal selection of users is carried out by FPSO, so that to gain the higher EE is based on the the users are allocated in the antennas. In the MIMO-NOMA system to enable the high EE the effective channels are obtained by using the high power. Let, be the number of users or solution, which ranges from 1 to x.

C. Algorithmic steps of the FPSO algorithm

In the FPSO [14] approach, FPSO explores the most capable region of the search space by moving the particle immediately in the initial iteration and then, the swarm moves simultaniously to the next iteration. Thus, it improves the fitness of the swarm and also, provides the best solution. The steps involved in the FPSO algorithm are discussed below:

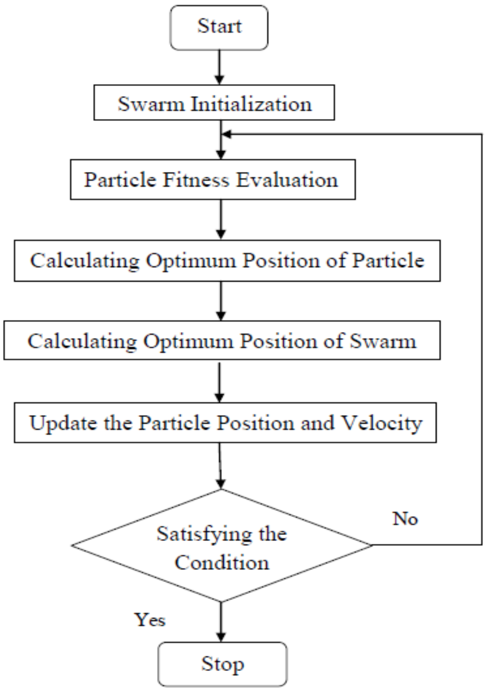

Fig 2. Flow Chart of Fractional Particle Swarm Optimization Algorithm

Step 1: Initializing the swarm population: The particle population in the search space is initialized and represented below,

$$z=[z_u]\;;1\le u\le m \tag{6}$$

where, z_u denotes the position of the particle in the u^{th} dimension. In this approach, the user are represented by particle and particle population represented in the transmitters is nothing but the number of users corresponding to particular transmitter.

Step 2: Fitness Evaluation of particle: To solve the maximization problem the particle fitness is evaluated using the objective function in (2). These constraints are projected to meeting the maximum power requirements and QoS of the user.

Step 3: Compute the optimal position of the particle: The particle tracks the most favorable position of the swarm by evaluating the particle fitness in the population.

Step 4: Update the particle position and velocity: In this step each particle position and velocity is updated by the using the expressions,

$$z_{ij}(t+1)=z_{ij}(t)+v_{ij}(t+1) \tag{7}$$

$$v_{ij}(t+1)=\begin{cases} v'_{ij}(t+1) & \text{if } \; v'_{ij}(t+1)<V_{\max j} \\ V_{\max j} & \text{if } \; v'_{ij}(t+1)\ge V_{\max j} \end{cases} \tag{8}$$

where $z_{ij}(t+1)$ is the position i^{th} particle in j^{th} transmitter and in equation (8) , $v_{ij}(t+1)$ represents the velocity of i^{th} particle in j^{th} transmitter with next $(t+1)^{th}$ iteration and $V_{\max j}$ indicates the maximum particle velocity in the j^{th} transmitter.

Retrieval Number: K21350981119/19©BEIESP
DOI: 10.35940/ijitee.K2135.0981119
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

Step 5: Finding the best solution: Each updated solution of the swarm the fitness is computed for and the solution having better fitness is replaced over the iterations.

Step 6: Check the stopping criterion: Once the velocity and the position of the particles are updated, the solution feasibility is verified. The optimal location of the particle is adapted with the new location of the particle, if the current solution is enhanced than the previous solution.

Step 7: Terminate: Until the best solution is obtained the process is continued for the maximum iteration.

IV. RESULTS AND DISCUSSION

This section describes the results and discussions of the FPSO based power allocation system, and based on the evaluation metrics comparative analysis is performed, namely BER , Achievable rate, spectral power and Energy.

A. Comparative Methods and Parameters

The methods considered are Maximization Energy Efficiency (Max-EE) [5], Normalized Gain Difference Power Allocation (NGDPA) [12] and Gain Ratio Power Allocation (GRPA) [13]. The comparative analysis of the FPSO based power allocation system by evaluating the performance using the metrics, like BER, Achievable rate, spectral power and Energy.

B. Analysis based on 64 transmitting antennas

In Figure 3, 64 transmitting antennas are used for comparative analysis based on the corresponding evaluation metrics are presented. Figure 3.a shows the variation of BER with respect to Signal to Noise Ratio (SNR). When the value for SNR is 0, the corresponding BER values for the methods, like Max-EE , GRPA , NGDPA and FPSO are 0.016024, 0.016042, 0.016149 and 0.015342. When the value for SNR is 10, the BER values for the methods, like Max-EE, GRPA, NGDPA and FPSO are 0.001355, 0.00136, 0.001364 and 0.001293. Similarly, when the SNR value is 20, the BER values for Max-EE, GRPA, NGDPA and FPSO are 0.000557, 0.000564, 0.000567 and 0.00051. It is clearly indicates that the increase in SNR value the BER value decreases. The FPSO based approach is gives the better BER with the minimum value of 0.00051 than the existing methods. Figure 3.b shows the variation of spectral power analysis with respect to SNR. When the value for SNR is 0, then the spectral power values for the methods, Max-EE, GRPA, NGDPA and FPSO are 17.22627dB, 7.712371dB, 0.083922dB and 17.9728dB. When the value for SNR is 2, then the corresponding spectral power values for Max-EE, GRPA, NGDPA and FPSO are 30.88407dB, 23.83379dB, 0.181839dB and 31.21052dB. When the value for SNR is 10, the spectral power values for the methods, Max-EE, GRPA, NGDPA and FPSO are 68.00624dB, 44.52891dB, 11.9112dB and 69.79955dB. Similarly, when the SNR value is 20, then the spectral power values obtained using Max-EE, GRPA, NGDPA and FPSO are 127.8099, 116.9949, 68.67225 and 129.6773dB. Thus, it is shown that SNR increases the corresponding spectral power increases simultaneously.

Figure 3.c shows the performance of achievable rate by the variation of SNR. When the value of SNR is 0, then the achievable rate obtain by the methods, namely Max-EE, GRPA, NGDPA and FPSO are 0.942778Mbps, 0.429408Mbps, 0.427974Mbps and 1.967358Mbps.

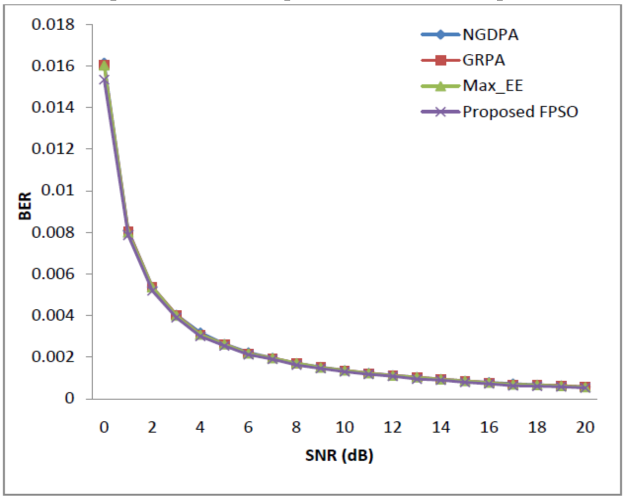

Fig.3.a. BER Performance analysis based on 64 transmitting antennas

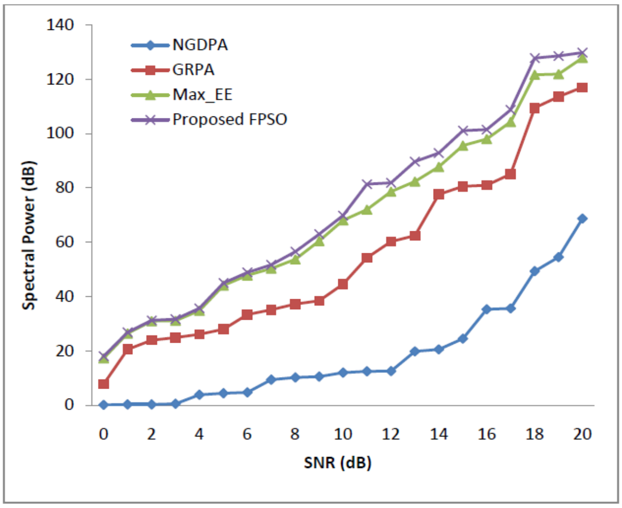

Fig. 3.b. Spectral Power Performance analysis based on 64 transmitting antennas

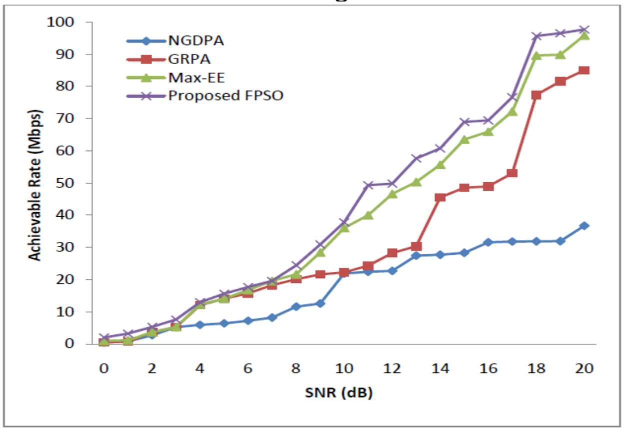

Fig. 3.c. Achievable Rate performance analysis based on 64 transmitting antennas

Retrieval Number: K21350981119/19©BEIESP
DOI: 10.35940/ijitee.K2135.0981119
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-8 Issue-11, September 2019

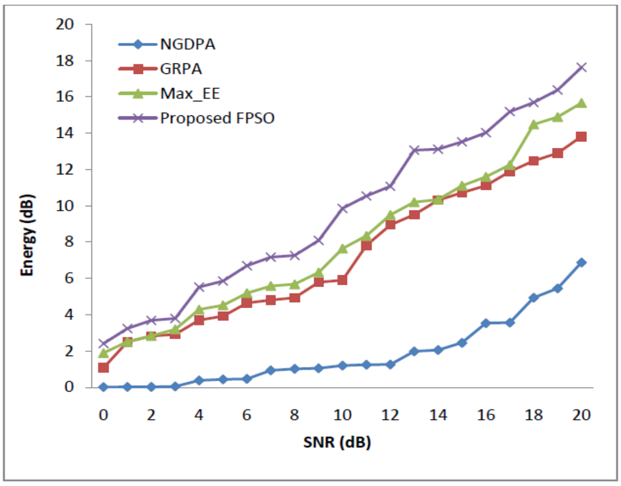

Fig. 3.d. Energy Performance analysis based on 64 transmitting antennas

. When the value for SNR is 2, the achievable rate computed by the methods, Max-EE, GRPA, NGDPA and FPSO are 3.67995Mbps, 3.6693971Mbps, 2.711904Mbps and 5.286323Mbps, respectively. When the value for SNR is 10, the achievable rate obtained by Max-EE, GRPA, NGDPA and FPSO are 36.006235Mbps, 22.212851Mbps, 21.867296Mbps and 37.79955Mbps. Similarly, when the value for SNR is 20, then the achievable rate obtained by the methods, namely Max-EE, GRPA, NGDPA and FPSO are 95.809892Mbps, 84.9949Mbps, 36.672246Mbps and 97.67729Mbps, respectively. It is shown that, SNR increases the values of achievable rate increases and thus, FPSO achieves better achievable rate as 97.67729Mbps. Figure 3.d shows the performance of energy with respect to variation of SNR value. When the value for SNR is 0, the energy computed by the methods, like Max-EE, GRPA, NGDPA and FPSO is 1.884916dB, 1.064215dB, 0.008398dB and 2.404749dB. When the SNR value is 2, then the energy values computed by Max-EE, GRPA, NGDPA and FPSO are 2.831738dB, 2.814903dB, 0.018198dB and 3.679786dB, respectively. When the SNR value is 10, then the energy obtained by the methods, namely Max-EE, GRPA, NGDPA and FPSO is 7.639716dB, 5.896307dB, 1.192074dB and 9.854288dB. When the SNR value is 20, the energy values obtained using the methods, such as Max-EE, GRPA, NGDPA and FPSO are 15.663598dB, 13.81745dB, 6.872722dB and 17.62426dB. Thus, the FPSO achieves high energy value than the existing methods with the maximum energy of 17.62426dB.

C. Analysis based on variation in number of users

The analysis based on the number of users is shown in Figure 4, for the evaluation metrics, like, achievable rate, BER, energy and spectral power by variation of SNR. Figure 4.a shows the variation of BER by variation of number of users. When the number of user is 2, the BER rate obtain by the methods, namely Max-EE, GRPA, NGDPA and FPSO is 0.000581, 0.000629, 0.000632 and 0.000527. If the number of user is 20, the methods, Max-EE, GRPA, NGDPA and FPSO obtained the BER rate as 0.000446, 0.000475, 0.000479, and 0.000422 respectively. Similarly, if the user is 40, then the BER rate obtained by the methods, Max-EE, GRPA, NGDPA and FPSO is 0.0000163, 0.0000167, 0.0000168 and 0.0000152. Thus, it clearly shows that FPSO getting better BER rate. Figure 4.b shows the variation of spectral power with respect to the number of users. When the number of user is 2, the spectral power obtained by the methods, Max-EE, GRPA, NGDPA and FPSO is 16.41063dB, 16.41041dB, 2.193629dB and 16.41063dB.

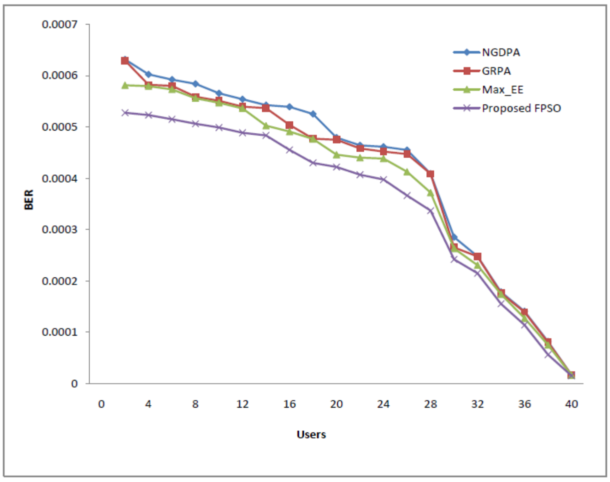

Fig. 4.a. BER Performance analysis based on the number of users

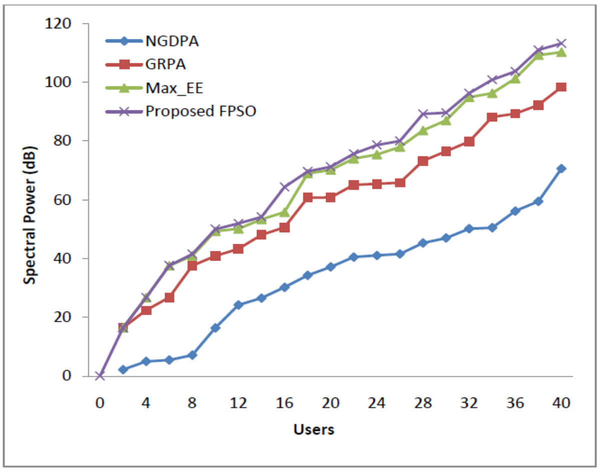

Fig. 4.b. Spectral Power Performance analysis based on the number of users

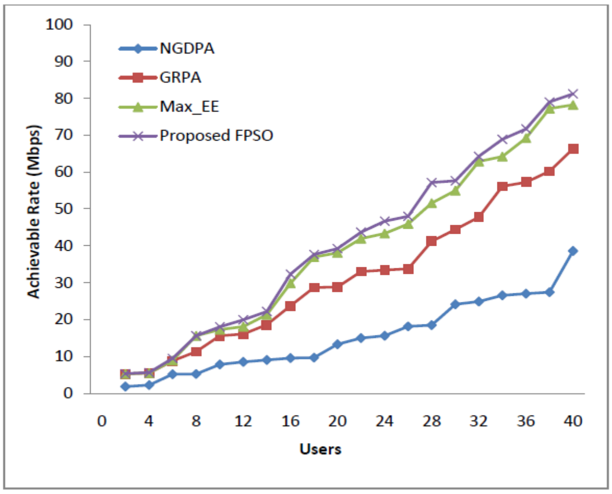

Fig. 4.c. Achievable rate Performance analysis based on the number of users

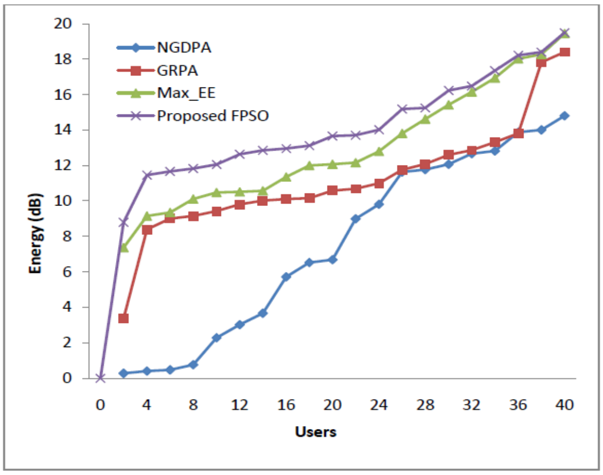

Fig. 4.d. Energy Performance analysis based on the number of users

If the number of user is 20, then the methods, Max-EE, GRPA, NGDPA and FPSO obtained the spectral power as 70.09796dB, 60.77334dB, 37.14604dB and 71.21081dB, respectively. If the number of user is 40, the methods, Max-EE, GRPA, NGDPA and FPSO attained the spectral power as 110.2021, 98.30306dB, 70.58808dB and 113.1915dB, respectively. Thus, it clearly shows that FPSO obtained the better spectral power of 16.410dB.

Figure 4.c shows the variation of achievable rate with respect to the number of users. When the number of user is 2, the achievable rate obtained by Max-EE, GRPA, NGDPA and FPSO is 5.290574Mbps, 5.259844Mbps, 1.817751Mbps and 5.35564Mbps. If the number of user is 20, the methods Max-EE, GRPA, NGDPA and FPSO obtained the achievable rate as 38.09796Mbps, 28.77334Mbps, 13.27609Mbps and 39.21081Mbps, respectively. If the number of user is 40, then the achievable rate attained by the methods, Max-EE, GRPA, NGDPA and FPSO is 78.20208Mbps, 66.30306Mbps, 38.58808Mbps and 81.19153Mbps, respectively. Thus, it clearly shows that FPSO getting better achievable rate 81.19153Mbps. Figure 4.d shows the variation of energy concerning with number of users. When the number of users is 2, the energy values calculated by the methods, namely Max-EE, GRPA, NGDPA and FPSO are 7.355912dB, 3.363999dB, 0.268761dB and 8.792075dB. When the user is 20, the methods, Max-EE, GRPA, NGDPA and FPSO calculated the energy as 12.06097dB, 10.57782dB, 6.684843dB and 13.65222dB respectively. Similarly, if the user is 40, then the energy values attained by Max-EE, GRPA, NGDPA and FPSO is 19.44463dB, 18.39752dB, 14.80117dB and 19.4898dB, respectively. Thus, it clearly shown that FPSO obtained better energy value of 7.8463dB.

D. Comparative Discussion

The comparative of the power allocation methods, like Max-EE, GRPA, NGDPA and FPSO using the metrics, such as BER, Achievable rate, spectral power and Energy depends on the variation of users and the corresponding tabulated metrics is given with respect to 40 number of users is shown in Table I. The BER rate obtain by the methods Max-EE, GRPA, NGDPA and FPSO is 0.0000163, 0.0000167, 0.0000168 and 0.0000152 respectively. The spectral power achieved by Max-EE, GRPA, NGDPA and FPSO is 110.2021dB, 98.30306dB, 70.58808dB and 113.1915dB

Table -I: Comparative discussion of the methods

Methods	Metrics			
	BER	Spectral Power (dB)	Achievable Rate(Mbps)	Energy (dB)
Max-EE [5]	0.0000163	110.2021	78.20208	19.44463
GRPA [13]	0.0000167	98.30306	66.30306	18.39752
NGDPA [12]	0.0000168	70.58808	38.58808	14.80117
Proposed FPSO	0.0000152	113.1915	81.19153	19.48980

respectively. Similarly, the achievable rate obtain by the methods, Max-EE, GRPA, NGDPA and FPSO are 78.20208Mbps, 66.30306Mbps, 38.58808Mbps and 81.19153Mbps. The energy computed by Max-EE, GRPA, NGDPA and FPSO are 19.44463dB, 18.3975dB, 14.80117dB and 19.4898dB respectively. Thus, it is identify that using the FPSO algorithm, the, achievable rate, spectral power and energy are maximum and the BER rate is minimum than the existing methods.

V. CONCLUSION

The MIMO and NOMA both are is integrated for better fitness estimation of users to utilize the energy effectively. In this paper, the power allocation in MIMO-NOMA system is carried out by using FPSO to the users for energy efficiency. The optimal solution is achieved by the FPSO based on the users fitness estimation function for getting better energy efficiency. Thus, To allocate the power effectively to the user the power scheduling is performed using the FPSO algorithm. The experimentation of the FPSO algorithm is evaluated using the metrics, such as Achievable rate, BER, spectral power and energy efficiency. The FPSO algorithm produce better results with increase in the achievable rate, spectral power and energy as 81.19153 Mbps, 113.1915Mbps and 19.4898dB and minimum BER rate as 0.0000152, respectively.

REFERENCES

1. Yemini M., Zappone A., Jorswieck E. and Leshem A., "Energy efficient bidirectional massive MIMO relay beamforming", *IEEE Signal Processing Letters*, 24(7), pp.1010-1014. 2017.
2. Khan T.A., Yazdan A. and Heath R.W., "Optimization of Power Transfer Efficiency and Energy Efficiency for Wireless-Powered Systems With Massive MIMO", *IEEE Transactions on Wireless Communications*, vol. 17, no. 11, pp.7159-7172, 2018.
3. Zhang H., Fang F., Cheng J., Long K., Wang W. and Leung V.C.,. "Energy-Efficient Resource Allocation in NOMA Heterogeneous Networks", *IEEE Wireless Communications*, vol. 25, no. 2, pp.48-53, 2018.
4. Wang, B., Dai, L., Wang, Z., Ge, N. and Zhou, S., 2017. Spectrum and energy-efficient beamspace MIMO-NOMA for millimeter-wave communications using lens antenna array", *IEEE Journal on Selected Areas in Communications*, vol. 35, no. 10, pp.2370-2382.
5. Zeng M., Yadav A., Dobre O.A. and Poor H.V., "Energy-efficient power allocation for MIMO-NOMA with multiple users in a cluster", *IEEE Access*, vol. 6, pp.5170-5181, 2018.
6. Do Dung Nguyen, Yong Liu, and Qingchun Chen, "On the Energy Efficient Multi-Pair Two-Way Massive MIMO AF Relaying With Imperfect CSI and Optimal Power Allocation", *IEEE Access*, vol. 6, pp.2589-2603, 2018.

Retrieval Number: K21350981119/19©BEIESP
DOI: 10.35940/ijitee.K2135.0981119
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

7. Eskandari M., Doost-Hoseini A.M., Jung J. and Lee I., “Antenna selection and power allocation for energy efficient MIMO systems”, *Journal of Communications and Networks*, vol. 20, no. 6, pp.546-553, 2018.
8. Wei Z., Ng D.W.K. and Yuan J., “Joint Pilot and Payload Power Control for Uplink MIMO-NOMA with MRC-SIC Receivers”, arXiv preprint arXiv:1801.07884, 2018.
9. Choi J., “On the power allocation for MIMO-NOMA systems with layered transmissions”, *IEEE Transactions on Wireless Communications*, vol. 15, no. 5, pp.3226-3237, 2016.
10. Chang Z., Wang Z., Guo X., Han Z. and Ristaniemi T.,. “Energy-efficient resource allocation for wireless powered massive MIMO system with imperfect CSI”, *IEEE Transactions on Green Communications and Networking*”, vol. 1, no. 2, pp.121-130, 2017.
11. Z. Ding, F. Adachi, and H. V. Poor, “The application of MIMO to nonorthogonal multiple access,” *IEEE Transactions on Wireless Communications*, vol. 15, no. 1, pp. 537–552, January 2016.
12. C. Chen, W.-D. Zhong, H. Yang, and P. Du, “On the Performance of MIMO-NOMA Based Visible Light Communication Systems,” *IEEE Photonics Technol. Lett*., vol. 30, no. 4, pp. 1–1, 2017.
13. H. Marshoud, V M. Kapinas, G. K. Karagiannidis, and S. Muhaidat, “Non-orthogonal multiple access for visible light communications,” *IEEE Photonics Technology Letters*, Vol. 28, No. 1, pp. 51–54, 2016.
14. Zhang X. and Duan H., “Comments on “Particle swarm optimization with fractional-order velocity”, *Nonlinear Dynamics*, vol. 77, no. 1-2, pp.427-429, 2014.

AUTHORS PROFILE

Khaleelahmed Shaikk is currently pursuring Ph.D in Acharya Nagarjuna University. He received M.Tech in Communications and Signal Processing from same university and B.Tech in Electronics and Communication Engineering from Jawaharlal Nehru Technology University. His area of interest are 4G&5G Communications, MIMO, OFDM, NOMA, Optimization Techniques and Energy Efficient Algorithms.

VenkateswaraRao Nandhanavanam received B.Tech in Jawaharlal Nehru Technology University, M.E from Osmania University and Ph.D from Jawaharlal Nehru Technology University. He is currently professor in Department of Electronics and Communication Engineering. He is a member of ISTE and published several research papers in referred international journals and conferences. His area of interest are Mobile Communications, Radar Engineering, Microwave Engineering and Artificial Neural Networks.

Retrieval Number: K21350981119/19©BEIESP
DOI: 10.35940/ijitee.K2135.0981119
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)