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Section A-Research paper

Multi-Objective Load Balancing Based Energy-Efficient Routing on WSN Using Adaptive Rain Optimization

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Abstract

In many applications, the Wireless Sensor Network (WSN) is utilized which needs network lifetime maximization. Several clusteringmethods have been developed, however they experience the adverse effects of irregular clusters, which ultimately make the network inconsistent. This triggers the energy hole problem around the base station. It is, therefore, the basis for a proper clustering of sensor mode, to guide information and effectively conserve energy, and to avoid accidental networkfailure due to the power drain. In this paper, proposed adaptive rain optimization (AROA) algorithm based on energy-efficient load balancing on WSN for efficient routing is proposed. To achieve this concept, two novel fitness functions are developed for the routing and clustering process. The proposed approach consists of two main stages such as clustering and routing. Initially, the sensor nodes are clustered to avoid the load balancing problem. After the clustering process, the routing is performed. The routing process improves the lifetime and decrease energy consumption in the network. The presentation of the projected approach is analyzed in terms of delay, energy consumption, throughput, drop, network lifetime, and overhead and delivery ratio. The projected technique is implemented with the consideration of NS2 simulator and presentation are contrasted with conventional techniques i.e.,Genetic Algorithm (GA)and Particle Swarm Optimization (PSO).

Keywords: *Energy efficient, Load balancing, Performance metrices, Adaptive rain optimization algorithm, Efficient routing.*

1. Introduction

The expansion of advances in various requestsby the WSN quicklyexchanges the data is categorized in addition exchanged between nodes. WSNs are climate-based structures like specific pressure, humidity, light, sound and temperatureand vibration, with targets sent from hundreds of small sensor nodes (SNs) over a network area. SNs are battery-functioned gadgets whichgather information in addition send it to the objective node to move the detected data

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immediately [1]. These nodes have three skills, specifically (I) detection (ii) handling in addition (iii) delivery. SNs have four main parts. These parameters include anexternal memory, a power source, a radio handset and microcontroller. In these parts, there is a very intense energy dissipation through the radio component. These nodes collaborate to collect information. A unique node called the Base Station (BS) can be reported within organizational metrics. This node on the other hand is defined as a sink node [2-4].

Dissimilar different SNs, BS can be provided with alimitless power source. WSNs have established to be a satisfactory and appropriate component for reducing the energy use of SNs. The clustered WSN system, in that the complete system can be divided into separate packages defined clusters [5,6]. This sharing should depend on a variety of factors, for example, distance size, cluster range and within every cluster a node with the most significant incentive for health work is measured a team leader (CH). The health of each individual node is recorded taking into account many boundaries such as BS, node, energy [7], so that non-CH nodes do not have to send their information directly to the PS. They will locate and collect the information and report it to their Cluster Head (CH). It can be the duty of the CHs towards transfer that information to the pond. Thus, it brings control of energy use, with only one node for each group of CHs talking to the Base Station (BS) [8-10].

In the WSN network, the load balancing and energy consumption are considered as the main issues which should be mitigated with the help of protocols or methods [11,12]. Many different methods are developed by the researchers to enhance the energy efficient and load balancing of the WSN. In recent years, the Artificial Intelligence (AI) technique was developed by researchers. The AI techniques are utilized to enhance the load balancing and energy consumption methods [13,14]. The different AI techniques are available such as genetic algorithm (GA), particle swarm optimization (PSO), Gravitational search optimization (GSO) and cuckoo search optimization (CSO) and so on. These methods are affected by convergence rate. To enhance the convergence rate problems, new efficient method should be utilized in the proposed method. This method is utilized to enhance the load balancing and energy efficient control in the WSN system [15]. The remainder of the paper is organized as follows; Section 2 provides a review of relevant research considering energy efficient methodology. Section 3 presents the project organization model with an explanation. Section 4 presents the procedure of the proposed technique. The results of the proposed technique are explained in Section 6. A summary of the article is explained in Section 6.

2. Literature Review

The energy efficient improvement in WSN is a required topic to manage different applications. Few works are reviewed in this portion.

Tianshu Wang *et al.*, [16] have introduced a method for energy efficient technique in WSN that named as genetic algorithm-based energy-efficient clustering and routing approach (GECR). Furthermore, in addition to the excellent arrangement obtained in the last organizational round, the F and Flow round among the basic population further enhances the hunting skills accordingly. What’s more, the cluster and routingmethod are integrated into a single chromosome to detect full energy utilization.Richa Sharma *et al.*, [17] have introduced hybrid energy-efficient clustering based on fuzzy C means and differential evolution algorithm (EEFCM-DE)process in terms of fuzzy C algorithms and differential progression calculation

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(EEFCM-DE). Involve FCM in group formation and then select the best canter as a CH within each cluster.DE. PadmalayaNayak*et al.*,[18] have introduced a clustering technique of calculations based on the Stretch Short 2FL model, hoping to better handle uncertainty selection than the Type-1 FL (T1FL) model. In this review, the entire sensor network was subdivided into a number of stages and at each level, the production cluster head was selected in view of the T2FL model. Three fuzzy descriptions, for example, of remaining battery power, distance to base station and adjustment are considered.

Zhidong Zhao *et al.*, [19] introduced another organizational model and integrated the first energy use model to develop another strategy for determining the optimal number of groups for energy use reduction.Olayinka O. Ogundile*et al.*,have presented Specific Table Energy-balanced (EB) and Energy-Efficient (EE) Cluster-based techniques Conference, which uses a routing protocol. As mentioned by a few basic and useful guidelines, the demand chart is designed with a focus on the two most defined ways for CH or sink.

3. Proposed System Model

In this work, the WSN network is designed with N sensor nodes in $U * V$ network field. complete nodes are considered in the stationary. In the network structure, each node has a specific identification number. Every node communicates the node through the sink node and monitors the specific environment. To communication of nodes and monitor purposes, the WSN are consuming specific energy based on the distance function. Additionally, the communication links are symmetric in environment. The projected technique structure is presented in figure 1.

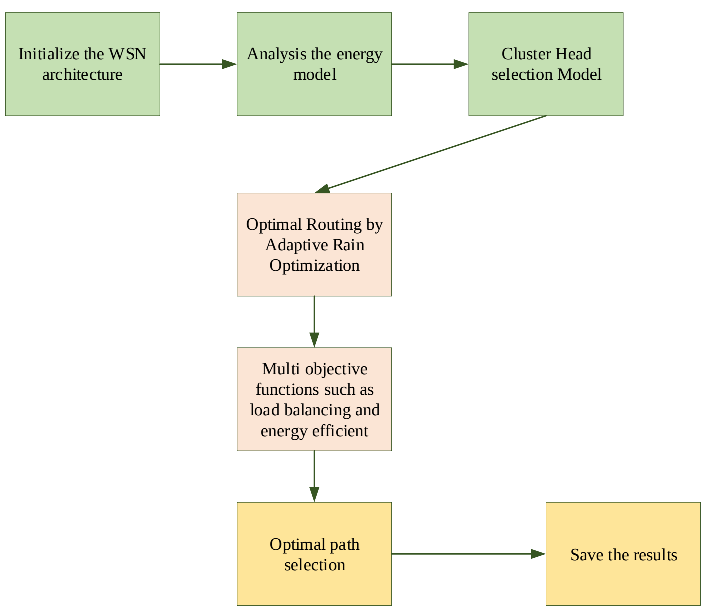

Figure 1: block diagram of the projectedtechnique

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3.3. Multi-Objective Function

The cluster head can bechosenwith the assistanceof level-based clustering method. After that, the multi objective function is formulated for achieving efficient energy clustering and load balancing control. The multi-objective function can be formulated with two objective functions like energy efficient and load balancing. The multi objective function is solved by using adaptive ROA.

$$M.O.F = W1(F1) + W2(F2) \qquad (5)$$

Where, $F1$ and $F2$ can be described as first and second objective function. $W1$ and $W2$ can be described as weight parameters (i.e., 0-1). The objective functions are explained in the below.

3.3.1. Load balancing objective

The initial objective function is a load balancing objective in the WSN. The projected method can be utilized to balancing the load through designing the fitness function. The load balancing fitness function is formulated in this section. The load balancing objective is achieved by considering the distance function.

$$Load\ balanicng(N) = k * |Load\ (N) - distance\ (BS.(N) * \alpha| \qquad (5)$$

$$\alpha = \frac{\sum_{I=1}^{n} Load(N)}{n} \qquad (6)$$

Where, $Load(N)$ can be described as data received by gateway and$distance$ can be described as distance and BS. Based on the load balancing behaviour, the fitness function is formulated as follows,

$$F1 = \frac{\sum_{I=1}^{n} distance\ (N)}{n} \qquad (7)$$

Load balancing fitness function is achieved with the help of proposed method in WSN.

3.3.2. Energy efficient objective

The energy consumption of nodes is an important parameter to improve the lifetime of WSN architecture. The energy efficient method proceeds with optimal routing path selection. Energy consumption in WSN is reduced with the help of proposed algorithm. Remote operation is considered to achieve load balancing control in WSN system [21]. The distance function of nodes can be calculated based on the equation below.

$$Distance = \sum_{I=1}^{n} d\big(N, next(N)\big) \qquad (8)$$

Where, d can be described as distance function of the WSN structure. The whole number of BS can be calculated related on following equation,

$$l = \sum_{I=1}^{S} next\ count\ (N) \qquad (9)$$

In the projected techniques, optimal routing procedure can be chosen which enable efficient energy consumption. The routing process is calculated the least number of gateways and low distance function. So, the low distance can be calculated related on total distance travel, highest fitness value for the number of gateways in addition of solutions. Normally, the number of gateway and distance function is inversely proportional with the WSN routing behaviour. This distance function can be computed with the consideration of highest value which named as optimal solution in the population. The routing procedure is mathematically formulated as follows,

$$F2 = \frac{T}{(W^1 * D + W^2 * H)} \qquad (10)$$

Where, T is representthe proportionality constant and (W^1, W^2)can be defined as the weight value that range is [0,1]. Based on the fitness evaluation, the number of gateways and complete distance is stabilizing the WSN.

4. Adaptive Rain Optimization (ARO) based data transmission

The ARO algorithm is utilized to select optimal path selection for achieving multi objective function.This optimization algorithm is developed based on their raining behaviour on the earth's surface. The rain optimization algorithm is developed based on rain behaviour. If two precipitations with radius R1 in addition R2 is near to every other which consumes a general section with every one, it isattach to generate a greaterdrop of radius R. This function can be formulated as follows,

$$R = (R_1^N + R_2^N)^{1/N} \qquad (11)$$

Where, N can be described as variable count in every droplet

- If a drop with radius $R1$cannotchange which related with the soil characteristics that can be presented byα , some percentage of volume, it is adsorbed.

$$R = (\alpha R_1^N)^{1/n} \qquad (12)$$

In fact, it presents the size of a drop that is invested in every priority. Also, the number from 0 to 100%. We can also classify a site as a drop spawn arm. The drops will disappear at moderate intervals of that rain. Well thought out, the population will decline after the two priorities and the big ones.

The step by step procedure of the ROA can be presented follows,

Step 1: Initialization Phase

Initialize the parameters such as soil absorption constant, rain speed, number of jointed droplets, initial droplets radius, the domain of variables, number of variables, maximum iteration and population number. Initialize droplets size, radius and position.

Step 2: Fitness Evaluation

Compute each droplet with the objective function to achieve each droplet cost and sort population.

$$FF = Min\,(M.O.F) \qquad (13)$$

Based on the fitness function, the optimal path is selected which enhance the WSN performance.

Step 3: Exploration and Exploitation

Accelerating the tracking of the correct answer (s) will drastically reduce the population.It should be noted that there are some significant discrepancies between the proposed improvements. In this work the calculation of the Rain Optimization Algorithm (ROA) and the late generated search calculationAkai Kapoli et al. (2016) Named Rainfall Algorithm (RFA) is compiled as follows:

- Despite the RFA and many other follow-up calculations in the ROA, the population is beginning to change. After each insistence, as nearby drops or dirt are absorbed.
- In RFA and many other trial calculations, there will be people in every cycle focuses on some other irregular neighbour's and the bells will be working on a platform by accident.

Step 4: Termination condition

Finally, the maximum iteration condition is checked and final optimal paths are saved.

In light of the approximations and compliments mentioned above, the rainfall calculation can be summarized algorithm 1 [22]. Adjusting the boundaries of this calculation in the calculation, for example, starting with the number of raindrops (populationNo.), starting with the interval of raindrops (scan the interval for each population), and, in the initial section calculation. Based on the ROA, the optimal routing path is selected in the WSN which empowers the system life time.

5. Results and discussion

The experimental results of the projectedtechniqueareanalyzed in the section. The presented technique is implemented using NS2 simulator.The proposed methodology is utilized to attain two objective functions namely, load balancing and energy efficient. These objective functions are achieved with the help of proposed algorithm. The proposed techniqueis utilized to compute optimal routing path in WSN architecture. The efficiency of the presented method is analyzed with performance metrices such as overhead, lifetime, energy consumption, delivery ratio, throughput, drop and delay. These variablescan be analyzed with scenarios. To validate the proposed methodology, it is analyzed with performance analysis and comparison analysis. The implementation variables of the proposed methodology areformulated in table 1.

Table 1: Simulation variables

S. No	Description	Value
1	receive power	0.395
2	transmit power	0.660
3	idle power	0.035
4	Initialization of nodes	100
5	Initial energy	10
6	Simulation time	100
7	Maximum packets	2500
8	Dimension of Y	1000
9	Dimension of X	1000
10	Antenna	Omni Antenna
11	MAC	802_11
12	Propagation	Two ray rounds
13	Channel	Wireless channel

The main objective ofpresented technique is reducing energy consumption and balancing load on data transmission. These objective functions are achieved with the consideration of optimal path selection by ROA. The presented technique is used to choose the optimal path for efficient operation of energy consumption and load balancing.

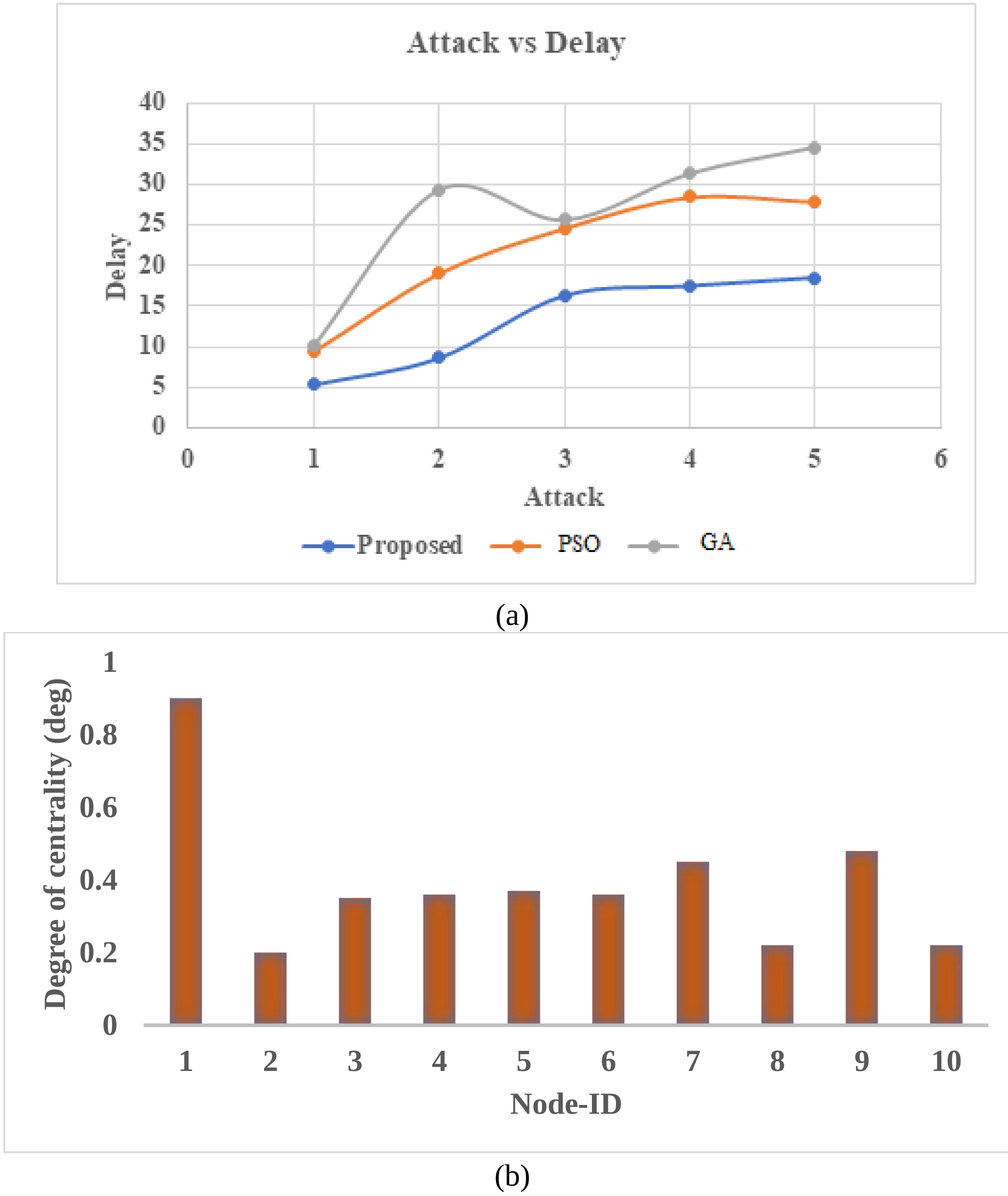

Figure 2: Experimental results (a) Delay and (b) Degree of centrality

The nodes with delay are outlined in Figure 2. Furthermore, the degree of centrality is shown in Figure 2. Proposed method should be at a low point, thatcan be considered the optimal framework. The delay of the projected framework can be at least 5 and the most extreme ratio is 20. The delay of the compound calculation structure decreases. PSO calculation achieves basic delay of 10 and largest delay of 26. Similarly, GA calculation of basic delay of 10 and maximum delay of 35. Related on the analysis, the presented techniquecan be executed with the least delay as the optimal arrangement. Different and common techniques, the proposed strategy gives the goodoutcome. The experimental results based on delivery ratio are shown in Figure 3. The delivery ratio of the structure should be undeniable, thatcan be considered the optimal structure.

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The delivery ratio of the presented technique is varies from 0.6- 0.9. The proposed calculation reduces the delivery ratio of the structure. The PSO calculation is that the base delivery ratio is 0.7 and the largest delivery ratio is 0.5. Basically, the GA calculation has a base delivery ratio of 0.1 and a maximum delivery ratio of 0.8. Based on the analysis, the proposed technique can be implemented with a high delivery ratio which is considered to be the optimal arrangement. For different and common strategies, the proposed technique gives the best results.

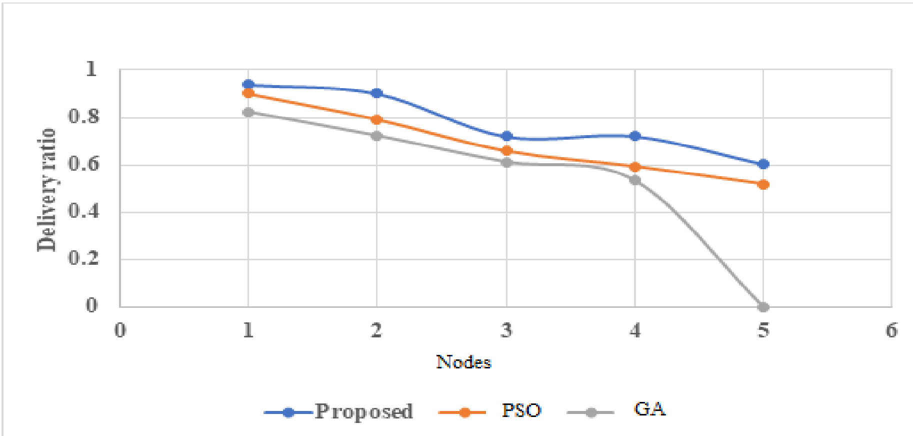

Figure 3: Analysis of Delivery ratio

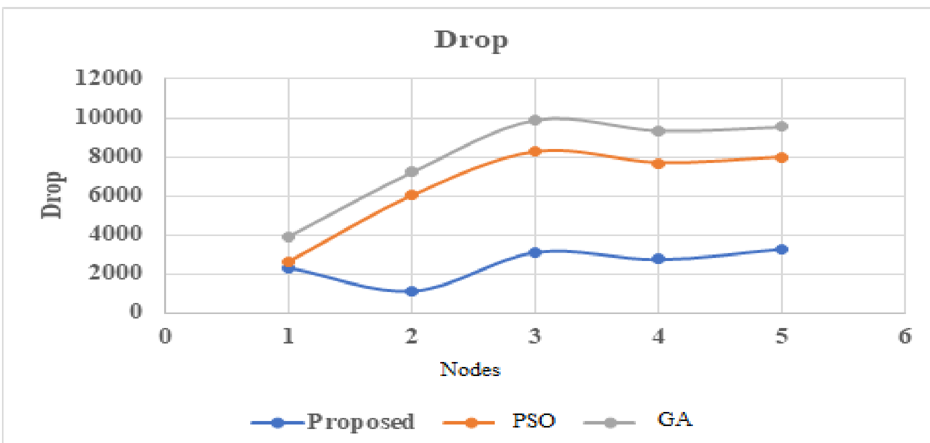

Figure 4: Analysis of Drop

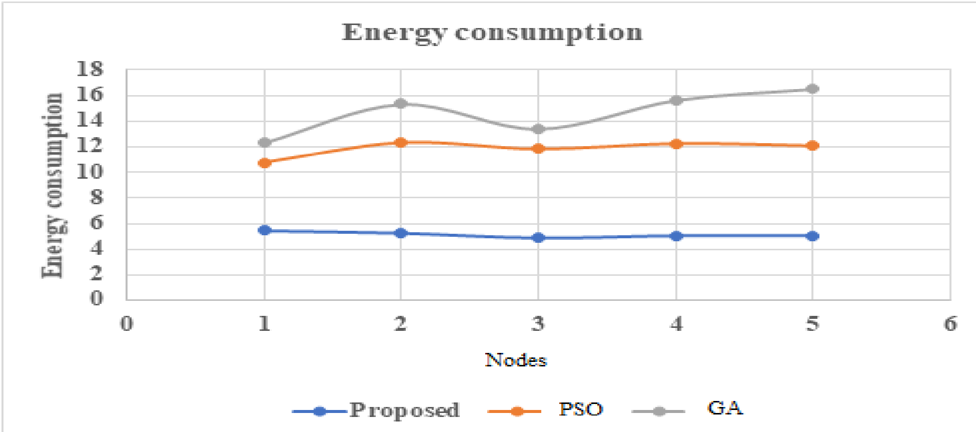

Figure 5: Analysis of Energy consumption

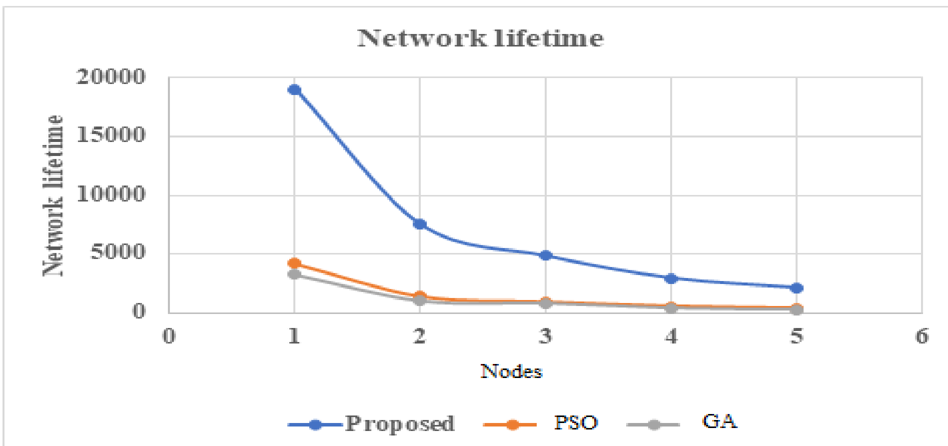

Figure 6: Analysis of Network lifetime

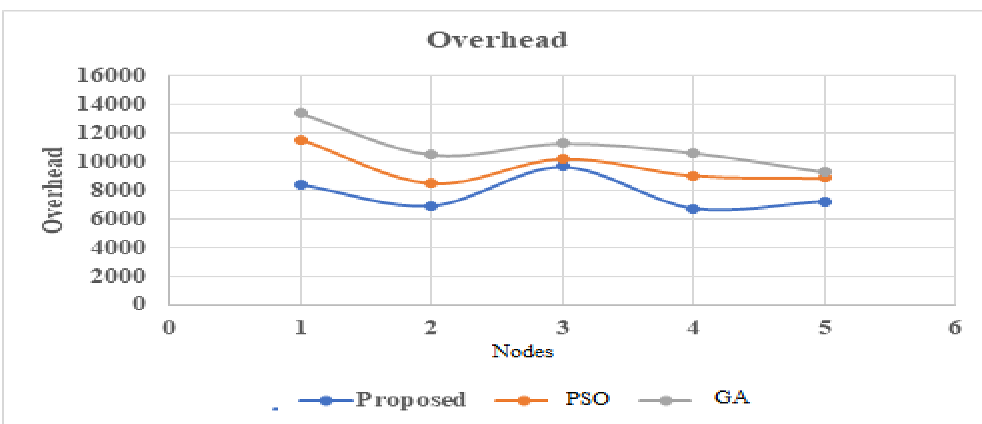

Figure 7: Analysis of Overhead

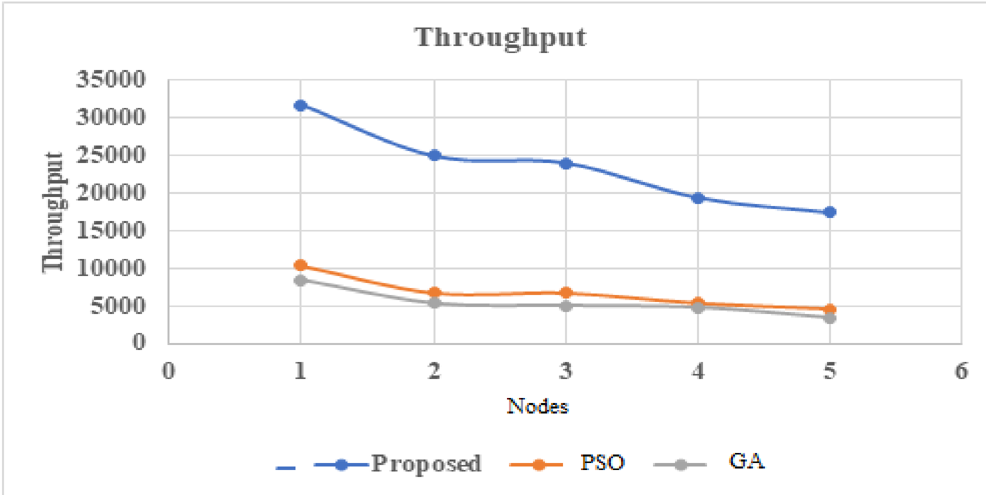

Figure 8: Throughput

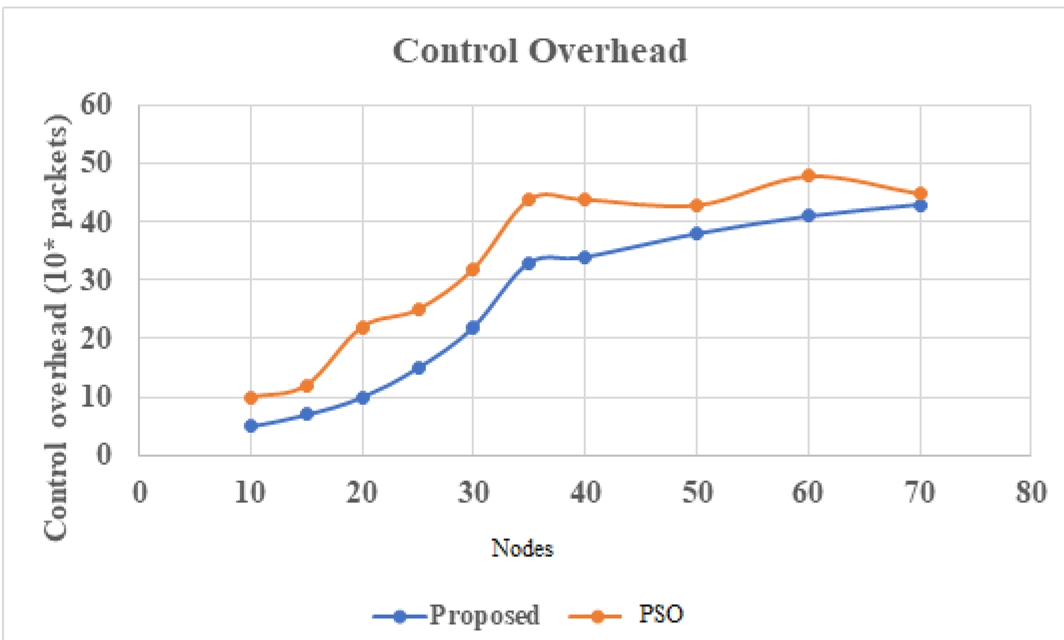

Figure 9: Analysis of Control overhead

The nodes with drop execution are outlined in Figure 4. The proposed structure should be at a low level, which can bemeasured the best structure. The drop of the projected structure can be at least 2000 and 2500 at the most extreme rates. Proposed calculation minimizes the collapse of the structure. The base drop for the PSO calculation is 2000 and the most extreme drop is 8000. In addition, the GA calculation is for a base drop of 4000 in addition a maximum drop of 8000. Related on analysis, the projected strategy can be considered the best arrangement to be implemented with minimal drop. Different and common techniques, the proposed strategy gives

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the optimal results. The nodes with energy consumption metric are shown in Figure 5. The energy utilization of the structure should be kept at an undeniable level, that can be considered to be the optimal structure. The energy consumption of the projected structure is a minimum of 4 in addition a very extreme ratio of 5. The energy consumption of the composite structure of the compound is minimized. PSO calculation achieves basic energy use 10 and largest energy use 12. Similarly, GA calculation uses basic energy use 12 and largest energy use 16. From the conclusion, the proposed strategy is considered to be the best system for less executed energy use. Around the different and existing techniques, the proposed strategy gives the best results.

The node with the network lifetime function metric can be outlined in Figure 6. The lifespan of the structure of the structure should be significant, which is considered to be the best structure. The organizational lifespan of the proposed structure is a minimum of 4500 and a maximum rate of 20000. The lifespan of the structure of the crossover calculation structure is reduced. The PSO calculation is that the basic enterprise lifetime is 2000 and the largest enterprise lifetime is 5000. Furthermore, the GA calculation is the basic organizational lifetime of 2000 and the most intensive system lifetime is 4000. Related on the analysis, the projected strategy can be implemented High system lifetime which is defined the optimal arrangement. Around the different and conventional techniques, the projected strategy gives the finestoutcome.

The node with the overhead execution metric is outlined in Figure 7. The overhead of the structure should be kept to a minimum, which is defined the optimal structure. The overhead of the projected structure is a minimum of 8000 in addition a maximum ratio of 6000. The overhead of the semi-racial calculation structure is reduced. The PSO calculation is the basic overhead 10000 and the most serious overhead 12000. Also, the GA calculation is the basic overhead 13000 and the largest overhead 10000. From the end, the projected technique can be accomplished by low overhead as the optimal arrangement. Different and common techniques, the proposed strategy gives the best results. Performance analysis based on throughput is given in Figure 8. When analysing figure 8, the presented approach attained the maximum throughput. Similarly, in figure 9, control overhead is analysed. Compared to PSO based data transmission, proposed approach affected by minimum overhead. From the outset, the proposed strategy is implemented with the performance considered to be the best arrangement. The proposed strategy gives better results when compared with different and existing techniques.

6. Conclusion

In this paper, proposed AROA algorithm based on energy-efficient load balancing on WSN for efficient routing is proposed. To achieve this concept, two novel fitness functions have been developed for the routing in addition clustering process. The proposed approach consists of two main stages such as clustering and routing. Initially, the sensor nodes have been clustered to avoid the load balancing problem. After the clustering process, the routing has been performed. The routing process decrease energy consumption and improves the lifetime of the network. The efficiency of presented technique is analyzed in terms of delay, drop, throughput, energy consumption, network lifetime, and overhead and delivery ratio. From the analysis, the presentedapproach has been achievedbetter results in terms of performance metrices. In future, efficient method will be developed to analysis the energy hole problem in the WSN architecture.

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7. References

[1]. Salim El Khediri, NejahNasri, RehanUllah Khan, and AbdennaceurKachouri. "An improved energy efficient clustering protocol for increasing the life time of wireless sensor networks." Wireless Personal Communications 116, no. 1 (2021): 539-558.

[2]. Biswa Mohan Sahoo, TarachandAmgoth, and Hari Mohan Pandey. "Particle swarm optimization based energy efficient clustering and sink mobility in heterogeneous wireless sensor network." Ad Hoc Networks 106 (2020): 102237.

[3]. Alma Rodríguez, Carolina Del-Valle-Soto, and Ramiro Velázquez. "Energy-efficient clustering routing protocol for wireless sensor networks based on yellow saddle goatfish algorithm." Mathematics 8, no. 9 (2020): 1515.

[4]. RamadhaniSinde, Feroza Begum, KaroliNjau, and ShubiKaijage. "Refining network lifetime of wireless sensor network using energy-efficient clustering and DRL-based sleep scheduling." Sensors 20, no. 5 (2020): 1540.

[5]. S. T.Sheriba, and D. Hevin Rajesh. "Energy-efficient clustering protocol for WSN based on improved black widow optimization and fuzzy logic." Telecommunication Systems 77, no. 1 (2021): 213-230.

[6]. HakanKoyuncu, Geetam S. Tomar, and Dinesh Sharma. "A new energy efficient multitier deterministic energy-efficient clustering routing protocol for wireless sensor networks." Symmetry 12, no. 5 (2020): 837.

[7]. Zhenhua Zhou, and YugangNiu. "An energy efficient clustering algorithm based on annulus division applied in wireless sensor networks." Wireless Personal Communications 115, no. 3 (2020): 2229-2241.

[8]. SathyapriyaLoganathan, and Jawahar Arumugam. "Energy efficient clustering algorithm based on particle swarm optimization technique for wireless sensor networks." Wireless Personal Communications (2021): 1-29.

[9]. AmrutaLipare, Damodar Reddy Edla, RamalingaswamyCheruku, and DiwakarTripathi. "GWO-GA based load balanced and energy efficient clustering approach for WSN." In Smart Trends in Computing and Communications, pp. 287-295. Springer, Singapore, 2020.

[10]. UshusElizebeth Zachariah, and LakshmananKuppusamy. "A hybrid approach to energy efficient clustering and routing in wireless sensor networks." Evolutionary Intelligence (2021): 1-13.

[11]. Zahid Yousif, Intesab Hussain, SoufieneDjahel, and YassineHadjadj-Aoul. "A Novel Energy-Efficient Clustering Algorithm for More Sustainable Wireless Sensor Networks Enabled Smart Cities Applications." Journal of Sensor and Actuator Networks 10, no. 3 (2021): 50.

[12]. Nhat-Tien Nguyen, Thien TT Le, Huy-Hung Nguyen, and Miroslav Voznak. "Energy-efficient clustering multi-hop routing protocol in a UWSN." Sensors 21, no. 2 (2021): 627.

[13]. Wang Fei, Bai Hexiang, Li Deyu, and Wang Jianjun. "Energy-efficient clustering algorithm in underwater sensor networks based on fuzzy C means and Moth-flame optimization method." IEEE Access 8 (2020): 97474-97484.

[14]. Junfeng Chen, Samson Hansen Sackey, Joseph Henry Anajemba, Xuewu Zhang, and Yurun He. "Energy-Efficient Clustering and Localization Technique Using Genetic Algorithm in Wireless Sensor Networks." Complexity 2021 (2021).

ISSN: 2063-5346
Section A-Research paper

[15]. SK Sathya Lakshmi Preeth, R. Dhanalakshmi, R. Kumar, and P. Mohamed Shakeel. "An adaptive fuzzy rule based energy efficient clustering and immune-inspired routing protocol for WSN-assisted IoT system." Journal of Ambient Intelligence and Humanized Computing (2018): 1-13.

[16]. Tianshu Wang, ,Gongxuan Zhang, Xichen Yang, and AhmadrezaVajdi. "Genetic algorithm for energy-efficient clustering and routing in wireless sensor networks." Journal of Systems and Software 146 (2018): 196-214.

[17]. Richa Sharma, VasudhaVashisht, and Umang Singh. "EEFCM-DE: energy-efficient clustering based on fuzzy C means and differential evolution algorithm in WSNs." IET Communications 13, no. 8 (2019): 996-1007.

[18]. PadmalayaNayak, and BhavaniVathasavai. "Energy efficient clustering algorithm for multi-hop wireless sensor network using type-2 fuzzy logic." IEEE Sensors Journal 17, no. 14 (2017): 4492-4499.

[19]. Zhidong Zhao, Kaida Xu, Guohua Hui, and Liqin Hu. "An energy-efficient clustering routing protocol for wireless sensor networks based on AGNES with balanced energy consumption optimization." Sensors 18, no. 11 (2018): 3938.

[20]. Olayinka O. Ogundile, Muyiwa B. Balogun, Owoicho E. Ijiga, and Elijah O. Falayi. "Energy-balanced and energy-efficient clustering routing protocol for wireless sensor networks." IET Communications 13, no. 10 (2019): 1449-1457.

[21]. AmrutaLipare, Damodar Reddy Edla, and VenkatanareshbabuKuppili. "Energy efficient load balancing approach for avoiding energy hole problem in WSN using grey wolf optimizer with novel fitness function." Applied Soft Computing 84 (2019): 105706.

[22]. Kaboli, S. Hr Aghay, J. Selvaraj, and N. A. Rahim. "Rain-fall optimization algorithm: A population based algorithm for solving constrained optimization problems." Journal of Computational Science 19 (2017): 31-42.