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A Survey of Nature Inspired Algorithms for WSN Clustering

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Abstract - *For a long time, research in the field of WSN for various aspects is being done by researchers. But increasing network lifespan and load distribution of power is still a very crucial issue. So far algorithms motivated by natural phenomena performed well than the other classical approaches. This paper explains about the study of literature, especially for nature-inspired algorithms for cluster head selection in the wireless sensor network.*

Key Words: Nature Inspired, Clustering, LEACH, Cluster Head, Firefly Algorithm, Wireless Sensor Network

1. INTRODUCTION

Nature-inspired algorithms are a special class of algorithms used for many complex problem-solving. Recently many researchers are utilizing nature-inspired algorithms for different situations. Following are some examples of nature-inspired algorithms:

- Ant colony optimization algorithms
- Particle swarm optimization
- Firefly optimization
- Spider monkey optimization

2. RELATED WORK

Altakhayneh A. et al. (2019) proposed an algorithm for Cluster Head(CH) selection by using a Genetic Algorithm(GA). For the comparison with Genetic LEACH (G-LEACH) author use the LEACH. The G-LEACH node with the most energy is opted as a CH using a GA. Node energy, CH energy, the distance of nodes from CH, the distance of entire CHs from the sink, and participants in clusters work as inputs for the G-LEACH. Both the algorithms run in parallel after the 1000 iteration the simulation end and the results are evaluated. G-LEACH does better concerning increased life, high packet transfer ratio, alive nodes, and whole energy consumption.

Baskaran et al. (2015) proposed an approach for CH selection using a synchronous Firefly Algorithm (FFA). Against LEACH and the Energy Efficient Hierarchical Clustering (EEHC) algorithm, it is demonstrated that the stated method decreases packet failure and boosts the network energy efficiency. For choosing CH, the criteria opted are fitness quality, the interval in packet transfer, packet failure, and the power considered as an input for the function. For selecting the worthy firefly's tournament selection technique is run based on fitness value than these fireflies perform crossover and after that mutation for reproduction. This method provides quicker convergence and also eliminates numerous local optima.

Gupta et al. (2014) present an approach to allocating cluster heads using a Modified Ant Colony Optimization(ACO) Algorithm. This algorithm works with LEACH, at first, CH and cluster nodes are selected using LEACH and then calculate the pheromone amount of them where the power of the sensor serves as parameters for the pheromone calculation. And from the distance and pheromone, the probability is determined. Then by comparing the probability and threshold, the set of CHs was selected. Only nodes that have high energy is picked, after the value update of pheromone as cluster heads. CH with the topmost probability has opted as CH leader. Head Nodes collect data sent by the participants of the cluster and this head passes on it to the CH leader, that leader transfers all the records to the recipient sink node. The intended algorithm is energy efficient, and growth in the lifecycle and decreased consumption of power are achieved.

Karimi et al. (2012) authors proposed two schemes for CH choice, the First one is by using the Genetic partition-based LEACH (GP-LEACH) method and the second is by using the HS-LEACH method. GP-LEACH functions in two-part, the first is to partition the network area and the second is choosing the optimal CH. By partitioning the network this algorithm overcomes the density problem of CH in one area. The network is partitioned into a reasonable number of sections same as in Partition-based LEACH(P-LEACH), Haosong et al. (2010). It ensures that each separation has a CH by which the energy utilization is balanced in the system. The logical amount of CH in the considered area is pre-decided and constant. Then by using parameters energy and node position in the GA the optimal CH is selected in each partition.

HS-LEACH works like GP-LEACH the only difference is instead of the GA, the HS algorithm is used for advantageous CH selection. By comparing it is concluded that GP-LEACH is surpassed the LEACH and HS-LEACH is best than both algorithms regarding power intake and network lifetime.

Vipin Pal et al. (2015) present an approach using the GA, in this approach CH selection, for a centralized clustering algorithm is done. Since it is the centralized approach all the major work is done by the base center. Sensor nodes send information. Their location and energy to the center. According to this information, the base node applies the GA for pinpointing the CHs. In the GA remaining energy, the quantity of CHs, total intracluster communication distance, and the total distance from CH to sink serve as a parameter for the fitness. This also optimizes the quantity of CH in each round.

Rao Srinivasa et al. (2016) come up with the technique of using Particle Swarm Optimization(PSO) for CH selection. This algorithm works in two steps, one is CH selection and the other is the setup of the clusters. The CH is chosen using the PSO algorithm where the remaining power, average intracluster distance, and the sensor node distance to the base, serve as parameters. Nodes send their collected information to the base center, where they need to pass eligibility criteria to be a CH, the eligibility criteria are the threshold energy which is the average of entire energy.

The setup of clusters relies upon the weight function, whose parameters are the power, node degree of CHs, and distance. This approach extends the network lifecycle, increases packet transfer plus reduces power consumption.

Vijayalakshmi et al. (2018) proposed an effectual way for CH selection by using the multiobjective tabu with the PSO algorithm. It is a hybrid technique where PSO is combined with Tabu Search(TS) to get the benefit of each other and found a beneficial solution. The local finest position of particles is found using PSO and the information of the global finest position serves as input for the Tabu record. The swapping of the route is done here and from the Tabu list node with the best fitness value and the minimum hop route is selected as CH. This approach improves the routing besides CH selection and also increases the network lifespan.

Ahmad T. et al. (2019) present a technique for CH selection by using the Artificial Bee Colony(ABC) technique. In this algorithm, it is assumed that clusters are already formed. Each cluster holds a CH, which is selected by ABC optimization. The node's residue power, intracluster distance, and Base Station(BS) distance serve as the composition of the fitness. The optimal sensor node in the cluster has opted for CH. It is also observed in that approach for best results the best position for the BS is the center of the network.

Ali et al. (2020) proposed an approach for CH selection using a population-based system ARSH-FATI, which switches between discovery and manipulation during the search, dynamically. It is put together with a Novel Ranked-based Clustering (NRC) algorithm. In the ARSH-FATI algorithm, only the finest member and worst member are selected for the candidate solution of the recent population. According to fitness, CH is picked. In the cluster configuration phase, the Greedy method is applied. Node's current energy, the entire energy of nodes, the power of CHs, along the complete energy of CHs behave as input for the NRC algorithm. Nodes search for a temporary CH according to their rank until the best-ranked CH is not found. Then sensors were appointed as the CHs. This approach increases the lifespan of the system.

Ni et al. (2015) proposed an approach for clustering and CH selection by using Fuzzy and the PSO algorithm. At first, the area is split into clusters by Fuzzy clustering then after this CH is assigned for every cluster using PSO. Fuzzy clustering is used to initialize. Sensor nodes are divided into initial fuzzy subsets based on their location in the network. Each node has some probability to be a segment of the initial subset. An improved PSO algorithm applies to pick up CHs. Each subset then runs in parallel to select cluster heads. In PSO for the fitness, energy consumption and intracluster distance and distance of CH to the base center are considered. Life is extended including the network and nodes' life.

Cai et al. (2019) presented an approach for CH selection by merging the Triangle Flip Bat Algorithm (FTBA) with the curve strategy. The improved Bat algorithm with triangle flip and curve strategy (FTBA-TC) is employed for the LEACH. In this approach, two main complications are addressed, first is the distance of nodes to its CH and the distance of CH from the base center. In both scenarios, if the distance is lengthier than it will exhaust more energy, which leads to an inefficient network. To triumph these problems reasonable selection of CH becomes necessary. Firstly, the tentative CH has opted and its left energy is calculated if the energy of the tentative CH is beyond the average of all energy then it becomes CH and broadcasts its ID otherwise, the network is waiting for the optimal CH by using the algorithm.

Gupta et al. (2018) proposed an integrated approach for clustering along with routing as well, based on Cuckoo search (CS) and Harmony Search (HS) techniques. All the procedure of clustering is executed on the BS. For finding the best positions of CHs improved CS algorithm was applied. In the CS algorithm, the multi-objective function for fitness is run for finding the group of optimal positions for cluster heads. In the function residue energy of node, its degree, intracluster distance, with the CH range considered as the parameters. After CH selection the Cluster formation is done. Then the route discovery process is started by using the upgraded HS algorithm. Each node analyzes hop count, and sink distance from the node. Intermediate nodes can be either a cluster or non-CH. Then each node calculates the probability for the next node in its route. And the improved HS algorithm is applied.

Zhang et al. (2014) presented a method of clustering routing by using the Simulated Annealing (SA) with the GA. The clusters are modeled and their center is located using the algorithm, this central location is the potential coordinates of the CHs. The cluster average energy is recorded and compared with the sensor energy. Sensor nodes having greater energy than the average energy are put into the candidate cluster head queue, and their distance from the cluster midpoint is measured. The candidate CH sensor node nearby to the center position becomes CH and in the later round it is debarred and a new cluster head selected from the updated candidate cluster queue, this approach ensures the energy utilization in the cluster.

Sarma et al. (2014) proposed an approach using the Jumper Firefly Algorithm (JFA) for clustering. This algorithm is run on the base node for the required number of CHs. It is run for reducing the function of cost. In the function distance concerning the CH and its members and the residue energy of the candidate, CH is considered for optimization. In the JFA, a status table is maintained for each firefly which contains all the detailed information. These tables help to identify the agents. The table helps in decision making that agents have to

jump or not from one situation to another, the situation contains the location of a firefly in the search area.

Ali Alghamdi (2020) presented a mixture algorithm for CH selection by merging the Dragon Fly algorithm (DA) and Firefly algorithm (FF). The DA is better at finding an accurate approximation, so the hybridization of the FF and DA finds the economical CHs. The alteration in DA is done as when DA has no neighbor node then its position is updated helping the FF algorithm. criteria for picking the CH are delay, energy, distance, and security.

Priya et al. (2020) proposed a method for thermal CH election and clustering. That includes the Fuzzy and Spider optimization Algorithm (SOA). The community location is shared into the Fuzzy subsets in step with nodes location, the clusters are created via way of means of the Fuzzy set of rules the usage of PageRank, and controlling the location of the clusters is depended upon the Eugen centrality and reduce set method. For the goal characteristic common electricity and distance from contributors to CH, universal electricity expenditure, and universal community temperature upward push is taken into consideration as a parameter. While at the contrary, CHS elected the usage of the SOA and planned the temperature and the space of each node in the cluster.

P. Subramanian et al. (2020) presented a hybrid methodology by combining the Grey Wolf Optimization (GWO) with Crow Search Optimization(CSO) for picking CH optimally. The GWO strategy is to change the place of the agents in the search distance, this will lead the premature convergence. To vanquish this limitation, it is merged with the CSO algorithm. GWO was used in the discovery of the potential location for cluster heads. While CSO helps in locating the optimal CH. The node with the top fitness value and the secondary node with maximum fitness is potential nodes for cluster heads. This proposed method improved the mean residue energy and decrease the packet latency.

P. Visu et al. (2020) proposed a dual CH optimized routing algorithm that uses Dual cluster head-Krill Herd Optimization. The network area is initially clustered using a pillar algorithm with a k-means centroid algorithm. The primary centroid collects the analyzed data and the secondary centroid provides for each path the detail about the Path trust value. The initial centroid node which performs as aggregator and router is only allowed to aggregate data, a node with the utmost residue energy becomes the CH and aggregate data and after aggregation, this data is passed on to the subsequent CH. Using the path trust value, the Krill herd optimization algorithm optimizes the path into the network.

3. CONCLUSIONS

It is clear from the review work that various nature-inspired techniques are used for picking the CHs and cluster setup, to boost the life of the system and its performance. Among these approaches, the FFA tends to be a beneficial algorithm. Hence, the FFA should be contemplating the CH selection in clustering, for enhancing the lifespan of the network. Its use against LEACH and the Energy Efficient Hierarchical Clustering (EEHC), validated that the said technique decreases packet failure and boosts communication efficiency.

REFERENCES

[1] Ahmad, T., Haque, M. and Khan, A.M. 2019. An Energy-Efficient Cluster Head Selection Using Artificial Bees Colony Optimization for Wireless Sensor Networks. In : Shandilya S., Shandilya S., Nagar A. eds. Advances in Nature-Inspired Computing and Applications. EAI/Springer Innovations in Communication and Computing. Springer, Cham. pp. 189-203.

[2] Alghamdi, T.A. 2020. Energy efficient protocol in wireless sensor network: optimized cluster head selection model. Telecommun Syst. 74: 331-345.

[3] Ali, H., Tariq, U.U., Hussain, M., Lu, L., Panneerselvam, J. and Zhai, X. 2020. ARSH-FATI a Novel Metaheuristic for Cluster Head Selection in Wireless Sensor Networks. IEEE Systems Journal. pp. 1-12.

[4] Altakhayneh, W.A., Ismail, M., Altahrawi, M.A. and AbuFoul, M.K. 2019. Cluster Head Selection Using Genetic Algorithm in Wireless Network. In : 2019 IEEE 14th Malaysia International Conference on Communication (MICC), Selangor, Malaysia. pp. 13-18.

[5] Eberhart, R. and Kennedy, J. 1995. A new optimizer using particle swarm theory. In : MHS'95. Proceedings of the Sixth International Symposium on Micro Machine and Human Science. Nagoya, Japan. pp. 39-43.

[6] Gou, H. and Yoo, Y. 2010. An Energy Balancing LEACH Algorithm for Wireless Sensor Networks. In : 2010 Seventh International Conference on Information Technology: New Generations. Las Vegas, NV. pp. 822-827.

[7] Gupta, Govind and Jha, Sonu. 2018. Integrated clustering and routing protocol for wireless sensor networks using Cuckoo and Harmony Search based metaheuristic techniques. Eng. Appl. Artif. Intell. 68:101-109.

[8] Gupta, V. and Sharma, S.K. 2014. Cluster Head Selection Using Modified ACO. In : Proceedings of Fourth International Conference on Soft Computing for Problem Solving. Advances in Intelligent Systems and Computing. Das, K., Deep, K., Pant, M., Bansal, J., Nagar, A. eds. New Delhi, Springer. pp. 11-20.

[9] Heinzelman, W.R., Chandrakasan, A. and Hari, B. 2000. Energy-Efficient Communication Protocol for Wireless Sensor Networks. In : Proceedings of the 33rd Annual Hawaii International Conference on System Sciences. pp. 1-10.

[10] Karimi, M., Naji, H.R. and Golestani, S. 2012. Optimizing cluster-head selection in Wireless

Sensor Networks using Genetic Algorithm and Harmony Search Algorithm. In : 20th Iranian Conference on Electrical Engineering (ICEE2012), Tehran. pp. 706-710.

[11] Madhusudhanan, Baskaran and Chitra, Sadagopan 2015. Synchronous Firefly Algorithm for Cluster Head Selection in WSN. Sci. World J. 2015:7 p.

[12] Ni, Q., Pan, Q., Du, H., Cao, C. and Zhai, Y. 2017. A Novel Cluster Head Selection Algorithm Based on Fuzzy Clustering and Particle Swarm Optimization. In : IEEE/ACM Transactions on Computational Biology and Bioinformatics. vol. 14, no. 1. pp. 76-84.

[13] Pal, V., Singh, G. and Yadav, R.P. 2015. Cluster head selection optimization based on genetic algorithm to prolong lifetime of wireless sensor networks. Procedia Comput. Sci. 57: 1417-1423.

[14] Palan, N.G., Barbadekar, B.V. and Patil, S. 2017. Low energy adaptive clustering hierarchy (LEACH) protocol: A retrospective analysis. In : 2017 International Conference on Inventive Systems and Control (ICISC), Coimbatore. pp. 1-12.

[15] Priya, R.K. and Venkatanarayanan, S. 2020. Implementation of thermal aware wireless sensor network clustering algorithm based on fuzzy and spider optimized cluster head selection. J Ambient Intell Human Comput. 11:1-11.

[16] Prof. Sarma, N.V.S.N and Gopi, Mahesh. 2014. Energy Efficient Clustering using Jumper Firefly Algorithm in Wireless Sensor Networks. International Journal of Engineering Trends and Technology (IJETT). 10(11): 525-532.

[17] Rao, P.C.S., Jana, P.K. and Banka, H. 2017. A particle swarm optimization based energy efficient cluster head selection algorithm for wireless sensor networks. Wireless Netw. 23:2005-2020.

[18] Subramanian, P., Sahayaraj, J.M. and Senthilkumar, S. 2020. A Hybrid Grey Wolf and Crow Search Optimization Algorithm-Based Optimal Cluster Head Selection Scheme for Wireless Sensor Networks. Wireless Pres Commun. 113: 905-925.

[19] Vijayalakshmi, K. and Anandan, P. 2019. A multi objective Tabu particle swarm optimization for effective cluster head selection in WSN. Cluster Comput. 22:12275-12282.

[20] Visu, P., Praba, T.S. and Sivakumar, N. 2020. Bio-inspired dual cluster heads optimized routing algorithm for wireless sensor networks. J Ambient Intell Human Comput.

[21] Yang, X.S. 2012. Nature-Inspired Metaheuristic Algorithms: Success and New Challenges. J Comput. Eng. Inf. Technol. 1:1-3.

[22] Zhang, Haitao., Zhang, Shiwei. and Bu, Wen. 2014. A Clustering Routing Protocol for Energy Balance of Wireless Sensor Network based on Simulated Annealing and Genetic Algorithm. Int. J. Hybrid Inf. Technol. 7: 71-82.