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An improved Fuzzy-based Ant colony Optimization Approach for Energy-aware Cluster Head Selection in WSN

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ABSTRACT: Cluster head selection is one of the highest challenges in the routing of the Wireless Sensor Network (WSN). Literature workshop have introduced a colourfull ways for chancing the optimal cluster head for establishing the communication path. The query issues prevailing in the WSN makes way for the selection of the cluster head through the optimization algorithms. In this paper, the Fuzzy grounded optimization approach has been introduced for the optimal selection of the cluster head. This paper proposes the Penguin Fuzzy grounded Ant colony optimization (PFuzzy ACO) algorithm for the cluster head selection in the WSN. The proposed PFuzzyACO algorithm utilizes a multi-objective fitness function grounded on the parameters, similar as energy, distance, detention, business viscosity, and link continuance. The results prove that the proposed PFuzzyACO algorithm behaves better than the relative models for the system of 50 bumps with the values of 10,0.08783, and 0.67651 for the number of alive bumps, network energy, and the outturn, independently. The proposed PFuzzyACO model has better values of 26,0.10857, and 0.68116 for the bumps, network energy, and the outturn independently for WSN with 100 bumps.

KEYWORDS: Cluster head selection, Optimization, network energy, multi objective fitness, throughput

I. INTRODUCTION

WSNs have the collection of various sensor nodes scattered through the large wireless environment. The nodes installed in the WSN are initially set up with the maximum battery power. Applications incorporating the WSN, design the WSN to have the maximum network lifetime for the uninterrupted processing. One of the major challenges involved in the clustering process is selection of the cluster head. In the optimization process, the selected cluster head changes optimally for each iteration round. Various QoS parameters are involved in the selection criteria for the selection of the best cluster head and thereby, increasing the network lifetime. Hence, the major design criteria for improving the lifetime of the network would be to reduce the energy consumption of the nodes.

II. RELATED WORK

1) LEACH (Low-Energy Adaptive Clustering Hierarchy)

LEACH [14] is a cluster technique which involves selection of the cluster heads among all the nodes randomly in such a way that each of the node gets chance to be selected for the job. The LEACH algorithm is performed in rounds or iterations where each involves two phases, that are the setup phase and the transmission phase [14]. The setup phase, involves the selection of the cluster heads and associating other nodes around these cluster heads forming clusters. Transmission phase involve, transmission of data by each node to their respective cluster heads which aggregates and transfers it to the base station. LEACH proves to be better in terms of energy savings and network lifetime on

comparing it with fixed clustering and other conventional algorithms [14]. LEACH has also got some drawbacks too, which are: Random selection of cluster heads which does not consider the energy consumption, no uniform distribution of cluster heads, not suitable for large area and densely deployed networks.

2)NORIA (Network Role-Based Routing Intelligence Algorithm)

NORIA [10] is a routing algorithm which supports effective resource utilization for WSN [6, 8] and significantly improves the energy efficiencies and data rates. NORIA selects the node with better resources to be the data router which forwards the data of the neighbouring nodes. It uses the capabilities of fuzzy logic system to improvise the decision making process, reducing the number of packets and gateways while keeping the routing time as low as possible. This algorithm uses the parameters or linguistic variable of itself as well as of its neighbours to inference the fuzzy result. On the basis of the output produced by the fuzzy logic system, routing decisions and role assignment decisions are taken. This methodology saves global energy and transfers data packets to the nodes in better state.

III. EXISTING METHOD

The selection of the cluster head through the optimization approaches faces the following difficulties, The nodes present in the WSN has restricted energy and computing capacity. The open nature of the nodes in the WSN arise to new challenges, such as link breakage, data loss, etc. The dynamic nature of the WSN gives rise to various cluster configurations. Hence, the automatic organization of clustering and the cluster head selection becomes more complex. The WSN with the complex structure has uncertainty issues, and hence, the cluster head selection can be done as an optimal problem. The WSN model with the hierarchical clustering has the hotspot problem. The cluster near the base station do more works than the other cluster heads. Hence, the workload of the nodes is not evenly distributed. Besides, due to the heavy workload of the nodes near the base station, they tend to die more early than other nodes in the WSN. This leads to the coverage and the connectivity issue for the selection of cluster heads in the WSN, only three objectives, such as energy, delay, and distance, are considered. As the objective of the work is maximizing the network lifetime, it is essential to consider other important objectives like link lifetime, traffic density, and so on, for the effective communication. Moreover, the ABC algorithm employed in the work for the optimal selection does not utilize the global best solution.

IV. PROPOSED METHOD

This project allows the selection of the effective cluster head for the establishment of the routing path for the communication in the WSN. The block diagram of the proposed PFuzzyACO algorithm. The proposed PFuzzyACO algorithm integrates the Fuzzy ACO algorithm and the PeSOA algorithm for the optimization process. The proposed model derives a multiobjective fitness function based on the energy, distance between the nodes, delay, LLT, and the traffic present in the network. The proposed fitness function is derived as the maximization function. Based on the fitness function, the proposed PFuzzyACO model finds the optimal cluster head.

V. ALGORITHMIC TECHNIQUE

ALGORITHMIC PROCEDURE OF THE PROPOSED PFuzzy ACO ALGORITHM

The proposed PFuzzyACO algorithm finds the optimal cluster head based on the results of the Fuzzy ACO and the PeSOA algorithm. Various steps involved in the optimization of the proposed PFuzzy ACO algorithm are briefed as follows.

Step 1. Population initialization.

The initial step in the optimization procedure of the proposed PFuzzyACO algorithm is the initialization of the population. The population of the proposed model is randomly initialized with the size of J . The randomly initialized population for the proposed PFuzzyACO algorithm is expressed in the following expression,

$$\{ \}^{123}, , , X XXXXX = nJ$$

where, the term X_n represents the nth solution of the proposed PFuzzyACO algorithm.

Step 2. Fitness evaluation.

The fitness of each random solution initialized in the population is found in this step. The fitness of each solution obtained through the optimization process depends on the proposed multi-objective fitness function. In this step, the fitness of the solution.

Step 3. Find PeSOA X based on the PeSOA algorithm.

The solution is directly fed to the existing PeSOA algorithm and the solution update is found. The PeSOA algorithm finds the optimal solution based on the prey search behaviour of the penguins. The penguins communicate with the other penguins through the vocalization. The vocalization allows unique identification of the other penguins. The food for the penguins is found through the holes. The food present in the holes vary based on the hole level. When a group of whales finds the food in the hole, the whale alerts the other groups. When the hole contains no food the penguin moves into other hole position. The position update of the penguin is represented by the following equation.

Step 4. Find the worst solution based on the fitness function.

The proposed PFuzzyACO algorithm requires the worst solution from the algorithm. The worst solution is found based on the proposed fitness value. For the each iteration t , the fitness of the each solution (1) PeSOA $X_t + 1$ is found and then the solution with the worst fitness value is retained at the end. The worst solution from the PeSOA algorithm.

Step 5. Find ACO X based on the fuzzy ACO algorithm.

In the next step, the solution $X_t()$ is directly fed to the conventional Fuzzy ACO algorithm.

The existing Fuzzy ACO algorithm provides improved results since it acts on the pheromone behaviour of the ants. When the population is fed to the existing Fuzzy ACO algorithm, the solution gets updated based on the pheromone update provided by the ants.

VI. BLOCK DIAGRAM

This research allows the selection of the effective cluster head for the establishment of the routing path for the communication in the WSN. Figure 1 presents the block diagram of the proposed PFuzzyACO Algorithm and the optimization process using the proposed work uses the proposed multi-objective fitness function. The proposed PFuzzyACO algorithm blends the Fuzzy ACO algorithm [22] and the PeSOA. PeSOA [21]. The existing Fuzzy ACO algorithm modifies the ACO algorithm with the fuzzy-based logic. The Fuzzy ACO algorithm was primarily designed to solve the routing behaviour in the WSN, but it needs more performance improvements and more computational time. The use of the PeSOA algorithm with the FuzzyACO algorithm improves the speed of convergence since the solutions in the PeSOA is divided between the local and the global minimum values. The hybridization of PeSOA algorithm with other algorithms can be potentially fruitful. Hence, we combine these two algorithms for optimally selecting the cluster head in WSN. The use of the PeSOA algorithm with the FuzzyACO algorithm improves the speed of convergence since the solutions in the PeSOA is divided between the local and the global minimum values. Also, we develop the new multi-objective fitness function, by considering various factors, such as energy, distance, delay, traffic density, and link lifetime of the nodes present in the WSN. energy all the possible routes.

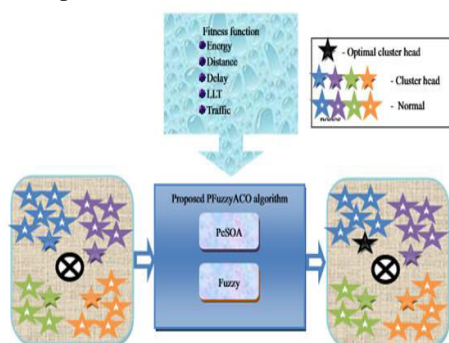


Fig 1. Block diagram of the proposed PFuzzy ACO algorithm

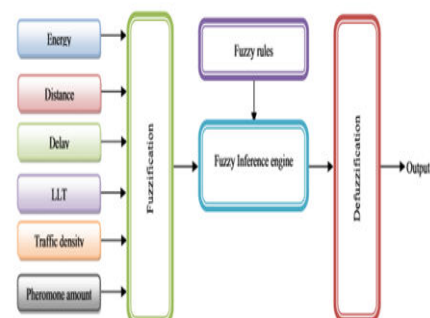


Fig 2. General architecture of the Fuzzy ACO

Fuzzification: In the Fuzzification block, the objective functions of the proposed fitness function and the pheromone update are provided as the input value. Based on the input values provided to the system, the fuzzy system obtains the membership degree. Hence, the input values of the system are converted to the crisp values in the Fuzzification block.

Inference Engine: The inference engine contains a set of fuzzy values obtained from the Fuzzification block. Then, these values are processed based on the set of fuzzy rules. The fuzzy inference engine finds the suitable rule sets for the input values and based on the rules, the output is provided as the linguistic value.

Defuzzification: In the defuzzification block, the linguistic values are converted to the nonfuzzy values. The fuzzy model makes use of the centroid technique for finding the fuzzy output.

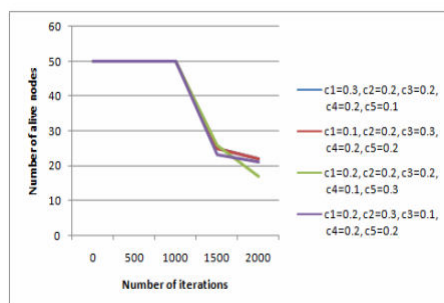


Fig 3. No of alive nodes

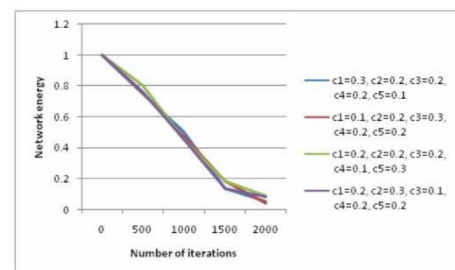


Fig 4. Noof network energy

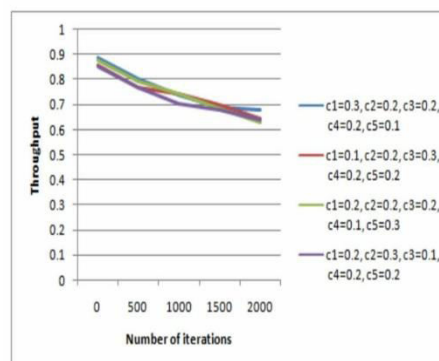


Fig 5. Noof throughput

VII. EXPERIMENTAL SETUP

Fuzzy Logic Control

The fuzzy model are composed of different blocks which are fuzzifier, fuzzy rule, fuzzy inference engine and the Fuzzifier which converts the fuzzy output to crisp data. These different blocks are responsible for various processes which need to be implemented for solving a problem using fuzzy logic:

1. Fuzzifier:

The crisp data cannot be directly processed by the fuzzy machine so it requires a fuzzifier device which converts the crisp input data to fuzzified data which is then feed to the fuzzy inference system.

2. Fuzzy rule base:

These are the if-then statements which manipulate the linguistic variables and produce the fuzzy output.

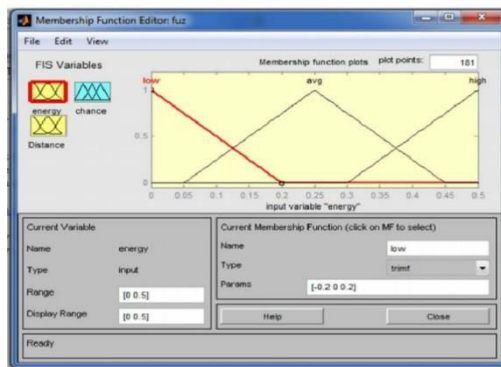


Fig 6. Membership function editor for residual energy

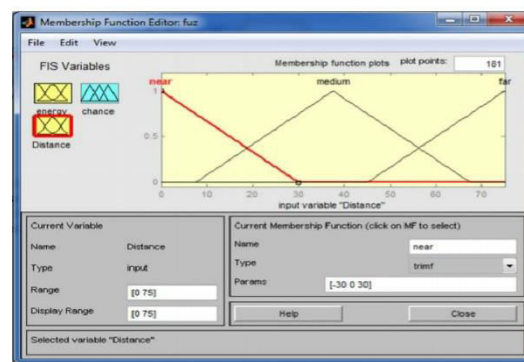


Fig 7. Membership function editor for proximity energy

VIII. EXPERIMENTAL RESULT

Simulation parameters	Values
Area of the network dimension	100*100
Total number of nodes present in the WSN	50, 100
Bit rate for the transmission	4000bit
Initial energy of each node in the WSN	0.5
Energy utilized by the node for the transmission of the bit	50 nJ/bit/m ²
Number of iterations for the simulation	2000

Table 1. Simulation setup for the PFuzzyACO algorithm

IX. FUTURE SCOPE

The proposed approach uses the random deployment of the sensor nodes which could be improved further as future work by using a systematic deployment approach for these sensor nodes. Then the energy efficiency could be increased further with overall increase in the coverage region of these sensor nodes. In the proposed approach the experiments have been carried out for the homogeneous environment, further result can be improved for the heterogeneous environment. In future various approaches such as integration of multiple sink-nodes and mobility context of sensors along with ACO and Particle swarm optimization shall be studied to further improve the performance of wireless sensor network.

XI. CONCLUSION

This paper introduces the PFuzzyACO algorithm for finding the optimal cluster head in the WSN environment. The proposed PFuzzyACO model integrates the PeSOA, Fuzzy logic and the ACO algorithm for the optimization procedure. Besides, the fitness for the selection of the optimal cluster head is done based on the proposed multiobjective fitness.

Comparative methods	Computational Time(sec)
ABC	3
ACD	4.5
FABC	2
LEACH	3.5
Fuzzy ACO	2.5
PeSOA	4
Proposed PFuzzy ACO	1.5

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