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A Hybrid Firefly Algorithm with Particle Swarm Optimization for Energy-Efficient Optimal Cluster Head Selection in Wireless Sensor Networks

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ABSTRACT: -In the Wireless Sensor Networks is a problem of concern is clustering for many researchers. The major challenge is to propose an algorithm that can optimize the values of various performance parameters like packet delivery ratio and network lifetime of a node in the network. This paper shows an implementation of the firefly algorithm to perform clustering in wireless sensor networks. Simulation results have shown an improvement in the performance parameters. A lifetime of a node is improved as the energy exhaustion is reduced while transferring data in the network range.

KEYWORDS: Wireless Sensor Networks LEACH-C Algorithm Firefly Algorithm (FA) Particle Swarm Optimization.

I. INTRODUCTION

The wireless sensor network is one of the emerging technologies in recent years, which has been significantly used for the development of Micro Electrical Mechanical Systems (MEMS) The sensor networks are mainly utilized for military and civil applications and also extended to medical and health care, industrial applications, agricultural, animal tracking, and habitat monitoring. The sensor network consists of a group of sensor nodes that are randomly distributed and collect information from the environment through the intermediate node. The sensor nodes are restricted in computation and processing resources, as they are operated using a battery source. are randomly distributed and collect information from the environment through the intermediate node. The sensor nodes are restricted in computation and processing resources, as they are operated using battery optimization.

II. RELATED WORK

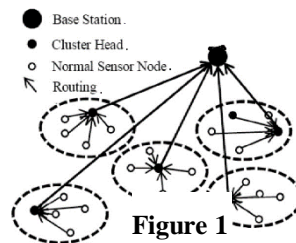
Albath et al. [3] have developed the minimum dominating set-based efficient clustering

For randomly selecting the cluster heads. Large-scale integration is provided by this algorithm. Zhang et al. [33] have discussed an optimization algorithm for selecting the energy harvesting nodes to act as a dedicated relay node for cluster heads to extend the lifetime of single-cluster networks.. Liu et al. [14] have presented the energy-balancing unequal clustering approach to maintain the minimum hop count to the sink. This method balances energy utilization among the cluster heads to extend the lifetime of the network, and it is limited to providing balanced energy consumption among the cluster head during packet loss and retransmission. Bagci et al. [4] have presented a fuzzy energy-aware unequal clustering algorithm to handle the uncertainties in cluster head radius estimation.

III. CLUSTERING IN WIRELESS SENSOR NETWORKS

Clustering is one of the significant methods that assemble the group of nodes. The entire sensor network are grouped into several clusters, and each cluster is controlled by the cluster head node. The role of the cluster head is to coordinate the data transmission activities of the sensor node within the group. LEACH-C algorithm was the extended version of

LEACH, which is used to generate the optimal clusters. This algorithm has two phases: (1) the setup phase and the (2) steady-state phase. In the setup phase, each sensor node collects the position and energy level of the nodes and



sends the same to the base station, where the base station finds the average energy level of the node. This approach evaluates the fitness function by using the remaining energy of the nodes and the distance between the sensor nodes and cluster heads for finding the optimal positioning of cluster heads.

IV. METHODOLOGY

A meta-heuristic approach is presented in the proposed work to perform clustering in a wireless sensor networks. Fireflies work on the fundamental phenomenon of bioluminescence. Bioluminescence is the process in which Firefly insect yields flashes of short duration. Hence it can be said that for all firefly insects, the intensity of flash is an essential parameter. There are three rules for the firefly approach [10, 11, 12]

The brightness of flash is termed as the attractive factor. This factor is depending on the intensity of light. The two most common variables of this firefly algorithm are attractiveness factor and light intensity. Fireflies can attract the other firefly of any gender. When the fireflies attract tower fireflies, then it depends on the brightness of the flash.

Firefly Algorithm:

- 1) Begin;
- 2) Initialize all variables;
- 3) $f(x)$: objective function where $x=(x_1, \dots, x_d)$
- 4) Initialize fireflies x_i ($i=1, 2, \dots, n$)
- 5) Calculation of Light Intensity I_i at x_i
- 6) While ($t < \text{MaxGen}$), where MaxGen is maxed generations
- 7) For $i = 1 : n$
 - a) For $j = 1 : n$
 - If ($I_j > I_i$), Firefly i : j end if
- 8) Attractiveness $= \text{Exp} [-\gamma r^2]$, where γ is the light absorption coefficient and r is the distance between fireflies
- 9) Update intensity value 10) End for j ;
- 11) End for I ;
- 12) End while;

Light intensity is inversely proportional to distance from the light source. This relation proves that light intensity increase as the distance from the light source decrease and vice versa.

$$I(n) = I_0 \cdot e^{(-\alpha d_{ij}^2)} \quad (2)$$

Where I is the light intensity I_0 is its initial value

α is the light absorption coefficient d distance between firefly i and j

The values of the distance and residual energy are supplied to the objective function. A fitness value is calculated which is used for the clustering of nodes. The firefly algorithm is used to calculate the value of residual energy supplied to the fitness function. Each node in the network broadcasts its energy value to the other nodes. The light intensity value is calculated by the other nodes using the light intensity formula given in Eq.2. The fireflies with more value of light intensity are attracted towards the other nodes and thus form a cluster. The attractiveness value of the algorithm is matched with the residual energy of the node. The distance is given by the relation

$$d_{ij} = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

We have compared our approach with Energy-Aware Clustering[18]. In Energy-Aware Algorithm the nodes are clustered based on energy and the node with the highest energy is chosen as the cluster head and it must be changed after every transaction cycle.

V. SIMULATION ENVIRONMENT

The Simulation Environment is created using 500*500 size grids in Network Simulator ns-2.35 and 40 nodes are positioned in the network. Every node in the system is constituted of a wireless channel and Omni-directional antenna type. MAC layer is used in the simulation with standard following IEEE 802.11. The reactive routing [19] and radio model has been accepted.

VI. RESULT AND DISCUSSION

Figure 2 shows the network lifetime of a node in the network. The graph shows that with the application of the firefly approach the energy exhausted by the nodes is less as compared to the Energy-Aware Clustering approach [18]. The figure shows the graph between residual energy and the time of simulation. Figure 3 shows the packet delivery ratio (PDR) of the nodes in the network. PDR is termed as the number of packets received at the terminus to the number of packets produced at the source. As shown in the graph the packets lost in the network are reduced and so the packet delivery ratio is improved.

VII. CONCLUSION AND FUTURE SCOPE

Clustering in Wireless Sensor Networks is a widely researched problem in recent years. A meta-heuristic Firefly algorithm is presented in this work and the results of the proposed approach are compared with the existing Energy Aware clustering algorithm. The application of firefly algorithm for the problem of clustering shows improvement in the performance parameters like network lifetime and the packet delivery ratio of nodes in the network. As the packet

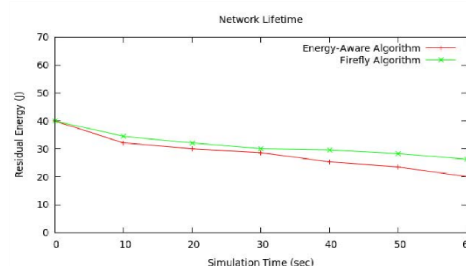


Figure 2

delivery ratio is improved in comparison to the basic approach, this signifies that the loss of packets in the network is reduced. The graph verifies the implementation and shows improved results with the firefly algorithm. in.

FIG 2. Network Lifetime of the Network

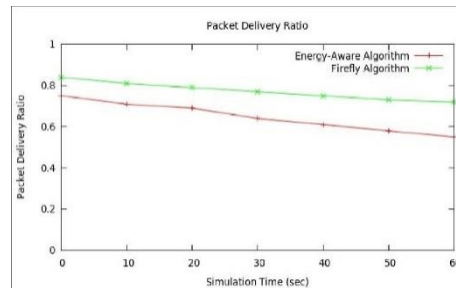


Figure 3

In future, other machine learning approaches for clustering in WSN can be applied, and compare their results with the Packet Delivery Ratio of the Network.

REFERENCES

- [1] Bagci, Hakan, and Adnan Yazici, "An energy-aware fuzzy approach to unequal clustering in wireless sensor networks," *Applied Soft Computing*, 2013, 13(4), pp: 1741-1749.
- [2] Bajaber, Fuad, and Irfan Awan, "Adaptive decentralized reclustering protocol for wireless sensor networks, " *Journal of Computer and System Sciences*, 2011, 77(2), pp: 282-292.
- [3] Yu, Jiguo, et al. "A cluster-based routing protocol for wireless sensor networks with nonuniform node distribution, " *International Journal of Electronics and Communications*, 2012, 66(1), pp: 54-61.
- [4] Khalil, Enan A., and A. Attea Bara'a, "Energy-aware evolutionary routing protocol for dynamic clustering of wireless sensor networks, " *Swarm and Evolutionary Computation*, 2011, 1(4), pp: 195-203.
- [5] Xu, Ning, Aiping Huang, Ting.Wei Hou, and Hsiao.Hwa Chen, "Coverage and connectivity guaranteed topology control algorithm for cluster-based wireless sensor networks, " *Wireless Communications and Mobile Computing*, 2012, 12(1), pp: 2

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