Bio Inspired Approach to Improve the Lifetime of Wireless Sensor Network

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Abstract- WSN consists of large number of small sensor with limited energy deployed in huge numbers which are able to sense, process and transmit information. The clustering of the nodes is commonly used approach in wireless sensor networks to improve lifetime of the network. These clustering approaches cause sensors to expend a lot of energy in the head rotation phase. The proposed scheme used the application of firefly algorithm in the cluster head rotation phase for the enhancement of the network lifetime. It considers the attractiveness factor as the parameter for CH selection. The proposed scheme uses the attractiveness factor of the nodes to assign the IDs. The attractiveness factor of any node will be determined by the energy required by the node to forward a data packet to a base station. The performance of the network was analyzed based on energy consumed in the network, throughput and number of alive nodes which show improvement over existing scheme.

Keywords- WSN, Clustering, Firefly Algorithm, CH rotation.

I. INTRODUCTION

WSNs comprise sensor nodes which are arbitrarily distributed in vast areas, gathering necessary data from their environment. The capacity of sensor nodes are limited and replacing them is not viable. WSNs are to direct the gathered data to Base Stations (BS) or sinks, frequently located away from the network location. Several problems like node deployment, localization, energy-aware clustering as well as data collection are typically considered as optimization issues. One of the optimization techniques for energy-conscious routing is clustering, which discuss the technique of dividing dataset into subcategories known as clusters so that info in every subcategory shares definite joint features. Node clustering procedures are characteristically carried out in dual phases: clustering set up along with maintenance [1]. Low Energy Adaptive Clustering Hierarchy (LEACH) is distributed and self-organizing cluster-based routing protocol. In addition to detection of optimal amount of clusters in sensor networks for conserving energy in addition to augmenting network lifespan. However, the cluster head are selected without considering the residual energy or the other properties of the sensor nodes. Furthermore, the random mechanism of selecting the cluster head does not gurante even distribution of clusters over the network [2]. [3] Genetic clustering algorithm is used in the cluster process, with genetic algorithm to optimize the fuzzy clustering algorithms. GFCM (genetic fuzzy clustering) to divide network into clusters and select cluster heads. The cluster head only accept the data from cluster nodes and then sent it to the BS after the data fusion.[4] This paper proposes a PSO for generating energy-aware clusters by optimal selection of cluster heads. In addition, it implements the PSO-based approach within the cluster rather than base station, which makes it's a semi-distributed method. The selection criteria of the objective function are based on the residual energy, intra cluster distance, node degree and the head count of the probable cluster heads.These clustering approaches cause sensors to expend a lot of energy in the head rotation phase. This paper proposes the application of firefly algorithm in the cluster head rotation phase for the enhancement of the network lifetime.

[5] This technique suggests and examines dual systems, Average Energy based Clustering (AEC) and Threshold Energy based Clustering (TEC). In AEC, a sensor is designated as CH if its remaining energy is beyond the normal energy of its group while in instance of TEC, a sensor is selected as CH if its remaining energy is beyond the threshold energy. Additionally, both AEC and TEC select sensors as Cluster Heads if their distance lies inside security region of the Base Station. Outcomes undoubtedly confirmed that AEC is effective in combining safety at the same time as augmenting totals lifespan of network, load equilibrium and unvarying energy usage.[6] A dual-phase GA is engaged to define the optimum interval of cluster dimension and develop the precise value from the interval. Additionally, the energy hole is an intrinsic difficulty, which leads to a significant reduction in the network's lifetime. This difficulty curtails from the asynchronous energy reduction of nodes situated in different layers of the network. Therefore, the authors suggest Circular Motion of Mobile-Sink with Varied Velocity Procedure (CM2SV2) to balance the energy depletion proportion of cluster heads (CH). Conferring to the consequences, these approaches could mainly largely the network's lifespan by decreasing the energy depletion of nodes and balancing the energy depletion amongst CHs.

[7] addressed each sensor nodes can communicate straight forward with each other or with the base station. To lessen the amount of information to be directed to the base station, the authors incorporated data aggregation. Additionally, the

alternation of CHs and the use of the small-battery sleep method by the sensors that do not contributing in transmitting authorize to poise the load and lessen energy consumption significantly. The NARRATIVE-LEACH systems recommend trustworthy extensive practice area and lengthier lifetime of sensor network. To compare the other parts N-LEACH is the finest improved in terms of stability period although negotiate on lifespan.

[8] Anew routing procedure entitled Game theory based Energy Efficient Clustering routing procedure (GEEC) is suggested. GEEC, which fits to a type of clustering routing procedures, accepts evolutionary game theory method to realize energy deplete even along with lifespan expansion simultaneously. The investigational consequences specify that enhancement in energy equilibrium along with in energy preservation equated with additional two types of famous clustering routing procedures is accomplished.

[9] suggested for sensor networks where midpoint procedure is used to enhance primary centroid election process. The suggested method yields balanced clusters to eventually poise the load of cluster heads (CHs) and extend the network lifespan. It reflects remaining energy as the factor in addition to Euclidean distance used in simple K-means procedure for suitable CH election. Multi-hop communique from CH nodes to BS occurs dependent on their proximities from BS. Experimental outcome displays that the suggested method outclasses LEACH-B, poised parallel K-means, Park's method and Mk-means pertaining to network lifespan and energy effectiveness. Experimental outcome also validates that the suggested method can decrease the energy depletion at most 50% associated to LEACH-B, 14% associated to BPK-means procedure, 10% associated to Park's method and 6% associated to Mk-means.

[10] claimed that hierarchical agglomerative clustering (HAC) delivers an appropriate basis for planning extremely energy effective communique procedures for sensor networks. To this completion, they study a novel method for electing CHs centered both on the physical position of the nodes and their remaining energy. Additionally, they study diverse forms of communique among the CHs and the base station relying on the probable broadcast ranges and the capability of the nodes to act as traffic relays. In specific, networks lifespan is augmented by more than 60% matched to LEACH and HEED, and by more than 30% matched to K-means clustering.

II. PROPOSED WORK

First, the deployment of the nodes in the network is done randomly. To form the balanced clusters, the distance of each node is computed from origin. Then, these distance values is sorted out in the ascending order and partitioned in four equal sets, which will give four clusters having equal number of nodes, i.e. a balanced cluster is obtained. For each set, middle point are taken as initial centroid.

After the application of midpoint algorithm, the node closest to the centroid is elected as the CH. The proposed scheme calculates the attractiveness factor of the nodes, which is computed according to the formula:

$$\text{Attractiveness} = A0 * \ e^{-1*\gamma*d*E(i\rightarrow B.S.)}$$

E(i->B.S.) where E is the energy required by the node (i = no. of nodes) to communicate with the BS;

d is the distance between the node and the BS.

γ is the light coefficient of attractiveness, it determine the brightness and its value is usually taken as 0.96.

And A_0 is the constant, and its value is 1.

After computing the attractiveness value, the nodes are arranged in the descending order of their attractiveness and the node with the highest attractiveness is assigned smaller ID, the node with second highest attractiveness will be assigned next ID and so on. Thus, if during the data transmission phase, the energy of the any CH node goes below the threshold value, T_e, the next node with the smaller ID will take over the role for CH.

During the data transmission, All the CHs compare their distance from the threshold value, T_d. If their distance is more than threshold value, then the CHs will forward their data to that neighboring CH whose attractiveness value is highest.

If their distance is less than threshold value, then they will forward the aggregated data directly to the BS.

III. SIMULATION RESULT

The network was simulated using MATLAB. The two factors, which mainly determine the lifespan of the network, are number of alive nodes, throughput and energy consumed in the network.

- Number of alive nodes: This will reflect how many nodes are still operational at any specific round of the network.
- Energy consumed: This reflects lifetime of the network. More the energy consumed, lesser is the network's lifetime.
- Throughput: It is the amount of data delivered at the base station in the network.

Table1: Simulation Parameters

Parameter	**Value**
Number of nodes	100
Network size	100 * 100 sq. Metres
Base station's location	0,0
Number of clusters	4
Initial energy of the node	1 Joules
Data packet	3200 bits
E_{elec}	50 nJ/bit
E_{fs}	10 pJ/bit/m^2
T_d, Threshold distance	88 meters

The sensor nodes are randomly deployed in area of 100m x 100m sensor field. The protocol run for 4500 rounds. The nodes in the network were supplied with energy of 1 Joules. The performance of the network was analyzed based on number of nodes alive, energy consumed in the network and throughput.

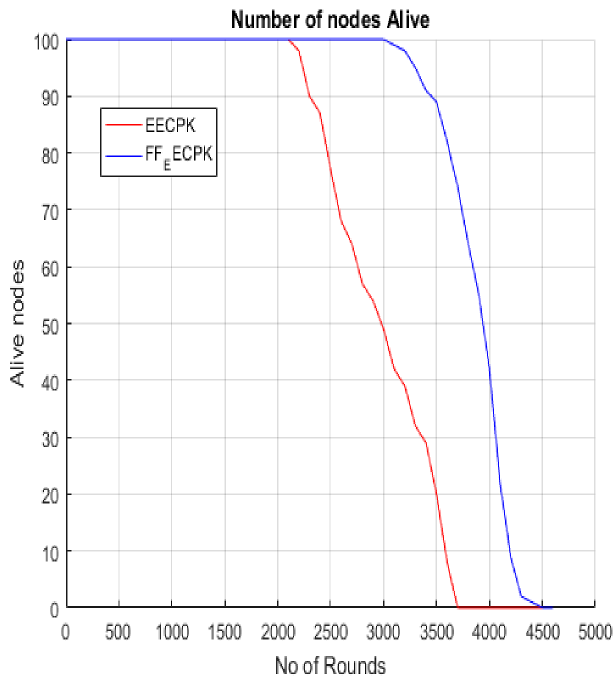

Fig.1: Comparison of number of alive nodes Vs Number of rounds

This graph shows the number of nodes that remain alive during the entire lifetime of the network. The firefly approach shows the improvement for this graph. The first node goes dead at around 3165 rounds for the proposed scheme and at around 2120 for existing approach. The half node goes dead at around 3946 for proposed scheme and 3080 for previous scheme. The last node, on the other hand, goes dead at around 4396 and 3700 respectively.

Table 2. Comparison of Network Lifetime with respect to FND, HND and LND

Protocol	Round First Node Die	Round Half Node Die	Round Last Node Die
EECPK-means	2120	3080	3700
Proposed scheme	3165	3946	4396

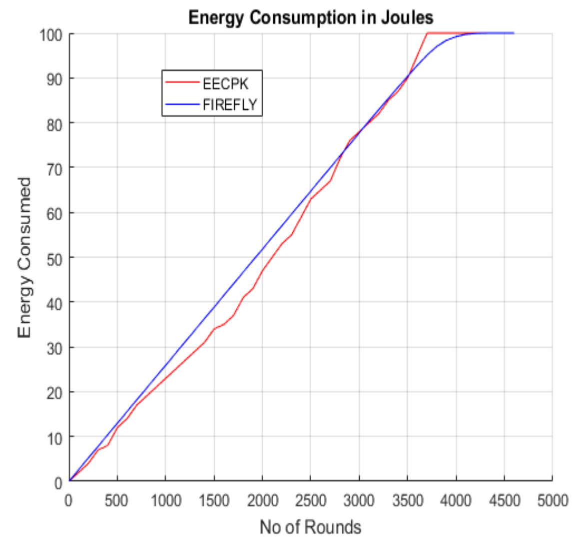

Fig.2: Comparison of number of energy consumed Vs Number of rounds

This graph shows the energy consumption of the network, the nodes in the network when working according to the firefly algorithm consumed lesser energy as compared to other scheme. This is because cluster heads attractiveness depends on the node's residual energy as well as distance from base station. When the cluster heads are selected taking distance into consideration, the amount of energy consumption also gets reduced in the network. This increases the network lifetime.

Table 3: Comparison of Half Energy Consumption with Number of Rounds

Protocol	Number of rounds with HEC
EECPK-means	2020
Firefly algorithm	1940

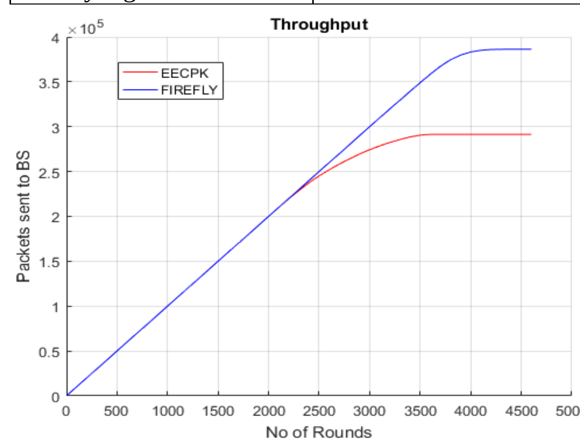

Fig.3: Comparison of throughput of network between existing and proposed scheme

This graph indicates number of packets sent to BS, i.e. throughput of the network. Since number of nodes alive are more for the proposed scheme, the more number of packets tend to reach the base station. Thus, it indicates healthy network performance.

IV. CONCLUSION

The proposed work was focused at improving the lifetime of the wireless sensor network by making changes to the cluster head rotation phase of the clustering approach. The attractiveness factor considers distance of the node from the base station as well as energy required by a node to forward the data to the base station. Thus, it helps to choose the candidate for the role of CH in a better way as compared to the existing scheme. The number of alive nodes in network for proposed scheme is approx. 22 at simulation of 4100 rounds. Similar to this, whole energy is consumed after 4100 round. Also, while selecting the relay node for multi-hop transmission of data to the base station, again the node with highest attractiveness is considered. Thus, the improvement of these factors helps to conclude that the proposed scheme has outperformed the existing scheme.

V. REFERENCES

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