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Distributed Energy Efficient Clustering Algorithm to Optimal Cluster Head by Using Biogeography Based Optimization

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Abstract Wireless sensor network consist of hundred to thousand of sensor nodes with limited energy capacity. It is generally difficult to recharge or replace these sensor nodes. Energy efficiency is thus a primary issue to maintain a wireless network. The problem of energy depletion of nodes is common for all data collection scenarios in which cluster head have a heavy burden of gathering and relaying information. In this paper we propose an energy efficient clustering algorithm “Distributed energy efficient clustering biogeography based optimization algorithm” to elect optimal cluster head based on highest residual energy and appropriate packet forwarding to the sink with respect to sensor nodes. This algorithm gives the better simulation results in comparison to DEEC algorithm.

Keywords: Heterogeneous wireless network, DEEC-BBO, Lifetime of network, DEEC, Energy efficiency.

I. INTRODUCTION

With the advancement within the field of extremely integrated digital electronics technology and wireless communication, a new category of distributed system known as Wireless Sensor Network (WSN) has come into existence. Wireless Sensor Networks are used for collecting high fidelity data where setting up of wired network is not possible or too difficult or too costly. Building a wireless sensor network first of all needs the constituting nodes to be developed and available. These nodes have to compelled the requirement that comes from the precise

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requirement of given application, they may have to be compelled to be tiny, low cost or energy efficient, they need to be equipped with the right sensor, the mandatory computation and memory resources and that they would like adequate communication facilities.

As sensors in wireless sensor network changes there location regularly, so organizing a communication system for them could be a typical task. To solve this problem clustering algorithms for WSN are introduced which provides a structured way of communication for unstructured WSN. This algorithm divides WSN nodes into clusters selecting a cluster head for every node that performs data aggregation and processing task for whole cluster to saving energy. Cluster head therefore consume a lot of energy than other nodes.

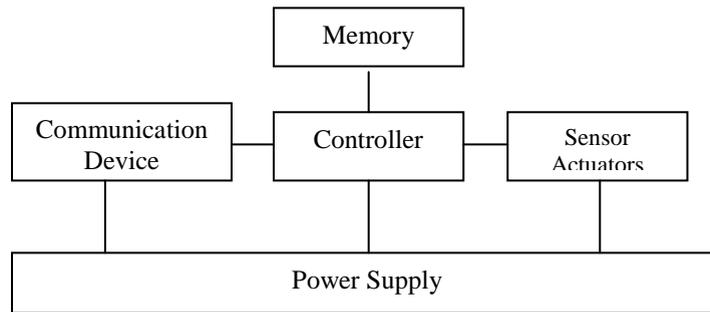


Fig 1.Sensor Network Architecture

Clustering is the activity of creating sets of similar objects. Nodes during a clustered wireless sensor network may also be classified as primary nodes and secondary nodes. Primary nodes can perform information aggregation and data processing function alternately secondary nodes only performs data forwarding functions.

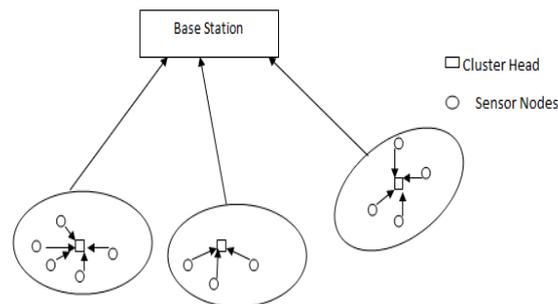


Fig.2 Wireless Sensor Network with Clusters

The clustering is done in such a way that data has to travel minimum distance. Only cluster heads communicates with cluster head thus diminishing the data redundancy which usually happens when each node perform its own data aggregation and transmission function uniformly. This algorithm provides very efficient way of communication in sensor networks. Clustering in WSN network makes them appropriate to be use in uneven environments.

II. RELATED WORK

There are two types of energy efficient clustering technique for WSNs. The clustering techniques applied in homogeneous WSNs are called homogeneous clustering technique, and the clustering techniques applied in heterogeneous WSNs are called heterogeneous clustering technique. Low energy adaptive clustering hierarchy (LEACH) is one of the first clustering algorithms which play an excellent role in reducing energy consumption of the nodes and increasing the network lifetime. LEACH contributes a balance of energy consumption through a random rotation of CHs. However, a CH dissipates more energy while transmitting the data to the sink, which

consume high energy. LEACH performs well under homogeneous network, however it fails in heterogeneous WSN as a result the low-energy nodes will die sooner than high-energy nodes. Clustering has been the most energy efficient scheme for wide applications in the past few years and numerous clustering algorithms have been introduced for energy saving. In [6] author have studied LEACH scheme and proposed two new schemes (i.e. energy-LEACH and multi-hop LEACH). Energy-LEACH enhances the CH election method and multi-hop LEACH (M-LEACH) enhances the communication mode from single-hop to multi-hop between CH and the sink. Both the schemes show better performance than LEACH scheme. In Low-Energy Adaptive Clustering [10] is one of the best in clustering algorithms. The aim of Low-Energy Adaptive Clustering was to elect nodes as cluster heads in such a way that every node gets an opportunity to become cluster head. As cluster head deplete higher energy then non cluster heads, so load is equally distributed among nodes. Thus a single node does not leave of energy once a brief time span simply because it was often elected as cluster head.

III. PROPOSED METHODOLOGY

This section proposes a significant energy efficient algorithm. The proposed algorithm is applicable for heterogeneous wireless sensor network. The network is heterogeneous in nature so two type of nodes are exist, normal node and advance node. Energy of normal nodes is less in comparison to advance nodes. The proposed scheme BBO_DEEC (Biogeography based optimization distributed energy efficient clustering algorithm) uses soft computing technique to elect optimal cluster head. In BBO_DEEC the cluster head has elect according to the initial energy, residual energy and cost function. The node which have high residual energy has more chances to being elect as cluster head, and another criteria to elect cluster head is cost function ,the node which have best cost got elect as main cluster head.

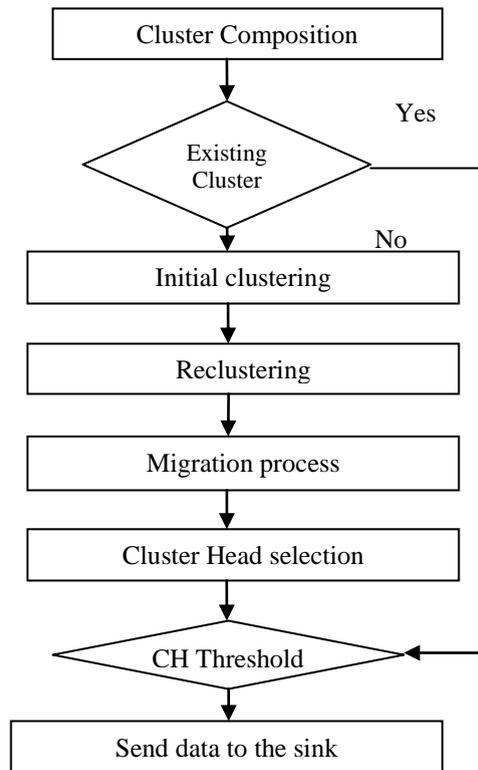


Figure 3.Flow chart of proposed protocol BBODEEC

IV. IMPLEMENTATION AND RESULTS

In BBO_DEEC 100x100 is used where position of base station is fixed at the centre of the network. Here we create

grid to provide the connectivity and less reduction of energy. Calculate the x position of node to the sink and y position of the node to the sink to distribute the energy significantly.

Then we calculate the distance of grid to the cluster head and apply the cost function of BBO among all cluster head to find the best cost, average geographic distance of cluster head to other cluster head. The node which has minimum cost and average distance among all clusters will elect as main cluster head. The cluster head which have less distance to base station and optimal routing path will elect as main cluster head through the migration process of BBO. The main cluster head will send the aggregated data to the base station, so no need that each node communicates to base station directly.

Table 1: Simulation Parameters

1.1.1. Parameters	1.1.2. Value
1.1.3. Number of rounds	1.1.4. 2000
1.1.5. Number of nodes	1.1.6. 200
1.1.7. Initial energy	1.1.8. 0.5J
1.1.9. Data aggregation rate	1.1.10. 5 KJ/s
1.1.11. Network size	1.1.12. 100x100
1.1.13. Sink position	1.1.14. 0.5
1.1.15. Probability function of CH	1.1.16. 0.1
1.1.17. Fraction of energy	1.1.18. 1.5 J
1.1.19. No. of decision Variable	1.1.20. 5
1.1.21. No. of population size	1.1.22. 50
1.1.23. Mutation probability	1.1.24. 0.1
1.1.25. Variable for lower bound	1.1.26. -10
1.1.27. Variable for upper bound	1.1.28. +10

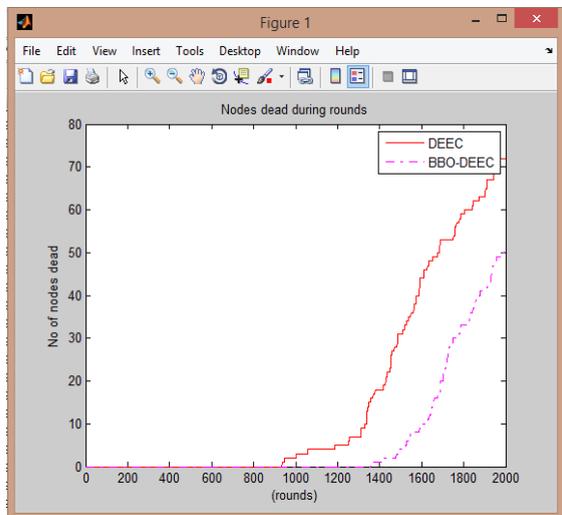


Figure 4. Number of dead nodes in BBO_DEEC

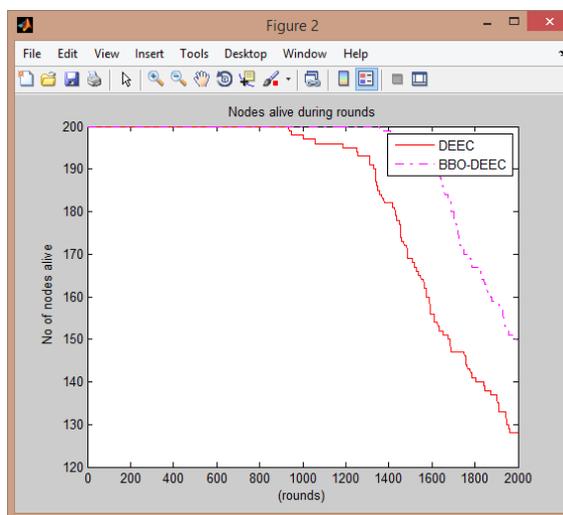


Figure 5. Number of alive nodes in BBO_DEEC

Table 2: Performance of BBO_DEEC for Dead nodes

1.1.1. No. of Dead nodes during rounds	1.1.2.	1.1.3. DEEC	1.1.4. Performance Increase
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	<i>BBO_DEEC</i>		
<i>1.1.5. 1200</i>	<i>1.1.6. 00</i>	<i>1.1.7. 7</i>	<i>1.1.8. 100%</i>
<i>1.1.9. 1400</i>	<i>1.1.10. 02</i>	<i>1.1.11. 18</i>	<i>1.1.12. 90%</i>
<i>1.1.13. 1800</i>	<i>1.1.14. 33</i>	<i>1.1.15. 60</i>	<i>1.1.16. 82%</i>
<i>1.1.17. 2000</i>	<i>1.1.18. 48</i>	<i>1.1.19. 73</i>	<i>1.1.20. 52%</i>

The lifetime of network is defined by the number of rounds and number nodes. Figure 4 shows the number of dead nodes during 2000 rounds. Here 50x50 networks is used, number of nodes we have taken 200 and number of rounds 2000. The proposed protocol BBO_DEEC gives always better results than DEEC

Table 3: Performance of BBO_DEEC for Alive nodes

<i>1.1.1. No. of Alive nodes during rounds</i>	<i>1.1.2. BBO_DEEC</i>	<i>1.1.3. DEEC</i>	<i>1.1.4. Performance Increase</i>
<i>1.1.5. 1200</i>	<i>1.1.6. 200</i>	<i>1.1.7. 195</i>	<i>1.1.8. 5.2%</i>
<i>1.1.9. 1400</i>	<i>1.1.10. 198</i>	<i>1.1.11. 183</i>	<i>1.1.12. 8.1%</i>
<i>1.1.13. 1600</i>	<i>1.1.14. 192</i>	<i>1.1.15. 155</i>	<i>1.1.16. 25%</i>
<i>1.1.17. 2000</i>	<i>1.1.18. 156</i>	<i>1.1.19. 125</i>	<i>1.1.20. 24%</i>

The number of alive nodes is also considered to increase the lifetime of wireless sensor network. Nodes run with the initial energy $E_0=0.5$, probability of cluster head selection $P=0.1$. In figure 5 during 2000 rounds small number of nodes are alive in DEEC while in BBO_DEEC the number of alive nodes is larger than DEEC.

Figure 6 shows the performance of BBO_DEEC in packet transmission give better rate then DEEC protocol. Here the data aggregation rate is $EDA= 5KJ/s$, $E_{fs}=10$. The overall performance of BBO_DEEC is better in Comparison to DEEC in distributed wireless sensor network.

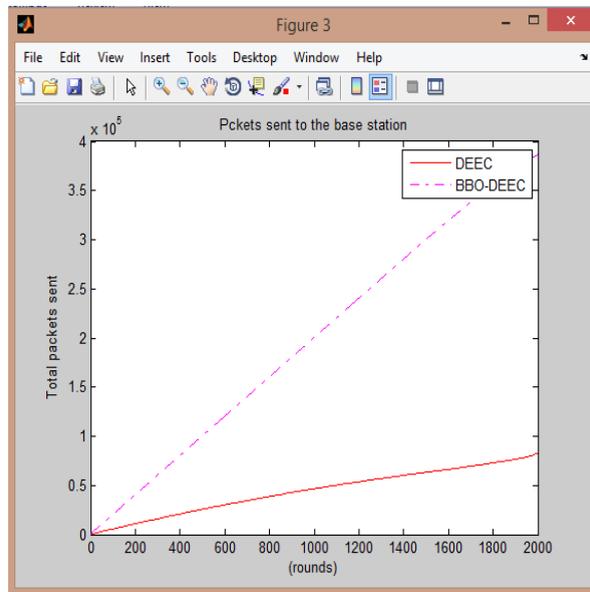


Figure 6. Number of packet send.

Table 4: Performance of BBO_DEEC for Packet Transmission

1.1.1. No. of Data Packet Sends during rounds	1.1.2. BBO_DEEC	1.1.3. DEEC
1.1.4. 600	1.1.5. $0.8 \times 0.5 L$	1.1.6. $0.3 \times 0.5 L$
1.1.7. 1000	1.1.8. $0.2 \times 0.5 L$	1.1.9. $0.5 \times 0.5 L$
1.1.10. 1400	1.1.11. $2.8 \times 0.5 L$	1.1.12. $0.8 \times 0.8 L$

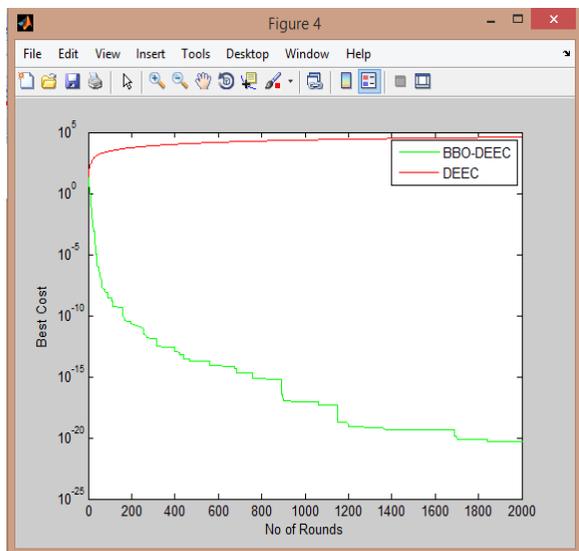


Figure 7. Best cost of BBO_DEEC

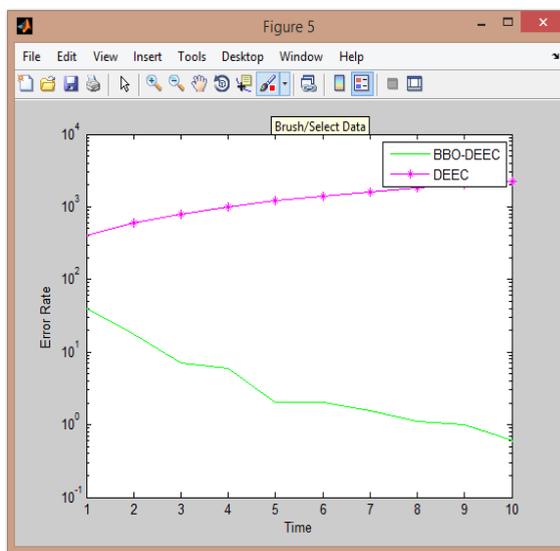


Figure 8. Error rate in DEEC and BBO_DEEC

Figure 7 shows the best cost in both DEEC and BBO_DEEC on the basis of distance between the nodes over the network. Figure 8 depict the Error rate in DEEC and BBO_DEEC occur because of failure in transmission, delay in packet transmission and ratio of traffic control

V. CONCLUSION

In this paper presented a novel clustering technique which provides energy efficiency. The proposed protocol selects Cluster Head according to the mutation technique of BBO, Cost of each node and residual energy. These cluster head possesses the highest energy level in the wireless sensor network. This is done so because the cluster head utilises more energy as compared to the other nodes in the network as it receives the data packet send by its cluster member, it aggregates and fuses the gathered data and send the data to the Base Station

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