Advanced Multihead Clustering Routing Algorithm

Chelsea Jyotsna Kanikella
Computer Science and Engineering
National Institute of Technology
AndhraPradesh,India
Email: kcjyotsna999@gmail.com

Ramya Sree Daliparthi
Computer Science and Engineering
National Institute of Technology
AndhraPradesh,India
Email: ramyadaliparthi@gmail.com

BKSP Kumar Raju Alluri
Computer Science and Engineering
National Institute of Technology
AndhraPradesh,India
Email: pavan0712@gmail.com

***Abstract*—In this paper, an advanced multi-cluster-head based clustering routing algorithm for balancing the energy consumption, extending the lifetime of the wireless sensor network and identifying the malicious nodes in the network is proposed. The network is divided into multiple clusters, each cluster contains a cluster head node, an assistant cluster head node, a cluster management node and ordinary nodes. The paper focuses mainly on the energy consumption model of the wireless sensor network and the method for finding malicious nodes. Through simulation results in Matlab, it is observed that the proposed algorithm gives better results than existing algorithms like LEACH protocol and effectively extends the lifetime of wireless sensor network.**

***Keywords*—** Wireless sensor network; Balanced energy consumption; Multi-cluster-head; Malicious node; Traffic balance

I. Introduction

Wireless sensor networks are spatially distributed autonomous sensors and are used to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to other locations. A Wireless Sensor Network (WSN) is a distributed network and it comprises a large number of distributed, self-directed, tiny, low powered devices called sensor nodes[2,3]. Nodes lose the ability to transfer the packets because of the continuous consumption of energy. In clustering routing protocols, nodes are grouped into overlapping clusters. Clustering involves aggregation of routing information and thereby supports scalability and integrity of the routing protocols. Many clustering routing protocols are proposed and LEACH is one of the standard clustering protocols.

In LEACH protocol cluster-head needs to integrate the data sent by other nodes in that cluster and should send to the base station. So, energy consumption of cluster-head node is more. There is an unbalanced consumption of energy between cluster head and ordinary nodes[4]. Due to this unbalanced consumption of energy between nodes in a cluster, the one with more energy depletion die fast which damages the stability and integrity of the network[5]. Hence, balancing energy consumption, traffic is a major challenge and issue which needs to be addressed.

II. Related Work

In LEACH protocol, wireless sensor network is divided into multiple clusters and each cluster contains a cluster-head based on equation 1,2 and 3. Each node in the wireless sensor network selects a value between 0-1 randomly. If that value is less than the threshold value T then the node is selected as the cluster-head node. The below equation (1) is used for calculating the threshold value.

$$T = p/(1 - p * mod(r, round(1/p))) \quad (1)$$

Where p is the probability of a node to become cluster-head and r is round number.

The cluster-head node integrates the data which is received from other nodes in the cluster and sends the data to the base station. Cluster-head nodes will have more energy consumption due to the receiving and transmitting the data frequently. So there will be more burden on cluster-head node. In[1], the authors proposed a multi cluster-head based routing where WSN is divided into multiple clusters and each cluster contains a cluster-head node, an assistant cluster-head node and cluster management node. The assistant cluster-head node integrates the data received from the other nodes in the cluster and sends the data to the cluster-head node, then cluster-head node sends data to the base station.

Cluster management node checks the residual energies of the cluster-head node and assistant cluster-head node in each round and checks if it is necessary to re-elect the cluster-head node and assistant cluster-head node. Energy consumption plays an important role during the transfer of data between the nodes. Nodes which send data frequently have high energy consumption when compared to the nodes which send data less frequently. The energy consumption for sending data by the node in the wireless sensor network is shown in (2) and (3)

$$Econ = (ETX + EDA) * (4000) + Emp * 4000 * (d^4) \quad (d > do) \quad (2)$$

$$Econ = (ETX + EDA) * (4000) + Efs * 4000 * (d^2) \quad (d <= do) \quad (3)$$

Where $do = sqrt(Efs/Emp)$ and d is the distance between the sending node and the receiving node and Efs(Free space fading), Emp (multi-path fading), EDA is data aggregation energy and ETX is the energy consumed for sending the data of one bit by the node.

III. Proposed Approach for Multicluster-head Algorithm

In [1] authors have not mentioned about the working of management cluster-head, have not considered malicious nodes in the clusters and detecting such nodes. We are addressing these drawbacks in our algorithm. We improved approach discussed in [1] by adding conditions to the cluster management node in the cluster. Initially we should give a threshold energy as input, then Cluster management node checks the energies of the cluster-head node and assistant cluster-head node for every round and if any of the residual energies, or both of the energies are less than threshold then cluster management node re-elects them. The cases we considered for electing them are:

1) Case A: Energies of cluster-head node and assistant cluster-head node are less than threshold.

2) Case B: Energy of cluster-head node is less than threshold and energy of assistant cluster-head node is greater than threshold.

3) Case C: Energy of cluster-head node is greater than threshold and energy of assistant cluster-head node is less than threshold.

In all the three cases, the management node has various functionalities like: It makes sure that the energies of assistant and cluster head nodes are not exhausted below threshold. Meanwhile, the algorithm follows the process mentioned in [1], Cluster-head node which needs to send the aggregated data, or the nodes which want to transfer data to the sink chooses a shortest, energy-efficient path for sending data to the base station. Dijkstra's algorithm is used for finding the shortest path from source node to the base station. We can send our data either by single-hop or multi-hop way to the base station such that the energies of nodes in shortest path are above threshold. If the energies of nodes in shortest path are less than threshold, we will search for next best shortest path for sending data to sink.

The proposed algorithm identifies the malicious nodes in the shortest path from cluster-head node to the base station by using Hamming code error-detection and correction algorithm, i.e; if there is a node in the shortest path which introduces error in the data to be sent, then such nodes which are manipulating data will be detected as malicious nodes. We are also detecting if there are any malicious cluster-heads or malicious nodes in the cluster using two methods.

The flow of proposed work in shown in Figure 1

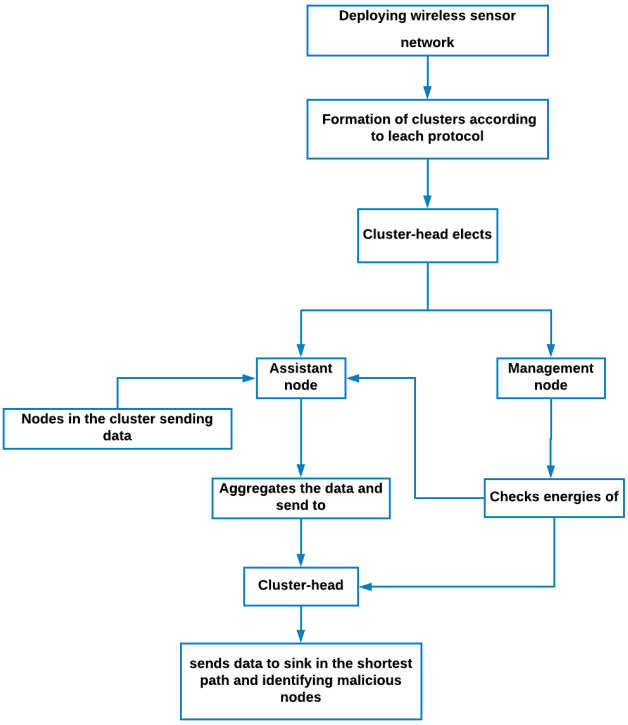

Figure 1. Flow chart of proposed work

The first method calculates the number of packets or bits sent to base station. The second method checks the energies of all nodes and compare their energies with the average energy of the network for every epoch. Then increment their suspicious count by one each time the energy of node is greater than the threshold and if we find that the suspicious-count of a node is greater than or equal to three then we will mark such nodes as suspicious. Once malicious node is detected then it won't get a chance to get elected as a cluster-head again. Our proposed protocol improves the overall lifetime, energy and security of the wireless sensor network.

IV. Experimental Results

We have conucted the simulations in matlab. The figure 2 shows the nodes deployed in the network and the clusters obtained from it. Different kinds of nodes observed in figure 2:

1) : Green colour triangles-Cluster-head nodes
2) : Red colour triangles-Assistant cluster-head nodes
3) : Blue colour triangles-Cluster management nodes
4) : Green colour circles-Ordinary nodes
5) : Black colour circles-Malicious nodes detected
6) : Black colour '+' symbols-Advanced nodes
7) : Red colour lines-Shortest path between nodes and sink
8) : 'x' symbol in the middle of the graph-sink

Figure 3 is the graph for existing leach protocol where x-axis represents number of rounds completed and y-axis shows Average energies of nodes. Figure 4 is the graph plotted

between number of rounds completed and Average energies of nodes for the proposed protocol.

The table 1 shows us the comparison between the LEACH and the proposed protocol, we observed that the existing protocol (in second column) where the number of dead nodes is increasing proportionally when number of rounds is increasing. The proposed protocol (in third column) gives less no of dead nodes than LEACH. So, we can say that our proposed algorithm has better results in terms of load balance ,average energy and security of the network. So, we can say that our protocol has improved the security, load balance of the sensor network.

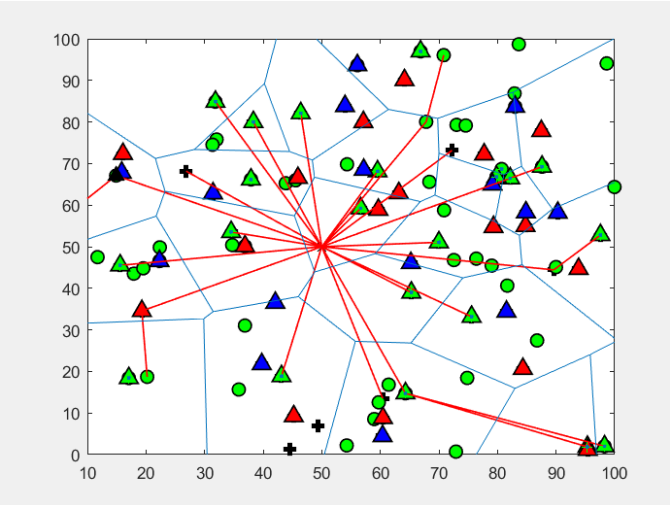

Figure 2. Our proposed protocol

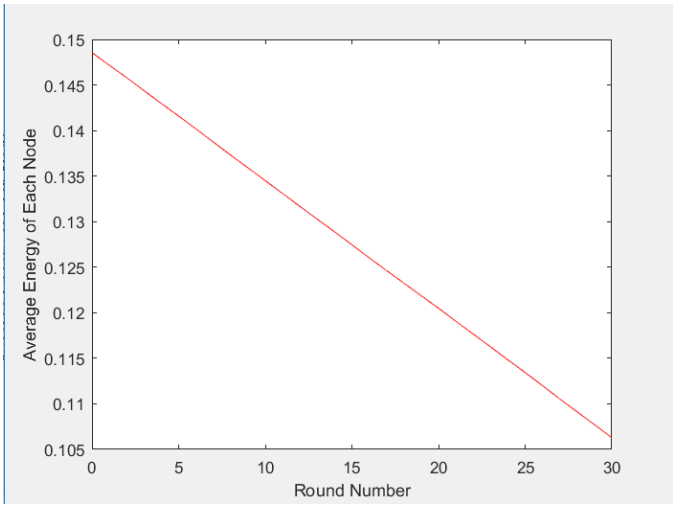

Figure 3. Graph of existing protocol

Table I
DEAD NODES IN WIRELESS SENSOR NETWORK

Round no	Dead nodes in LEACH	Dead nodes in Proposed
10	0	0
20	0	0
30	6	1
40	13	2
50	24	4

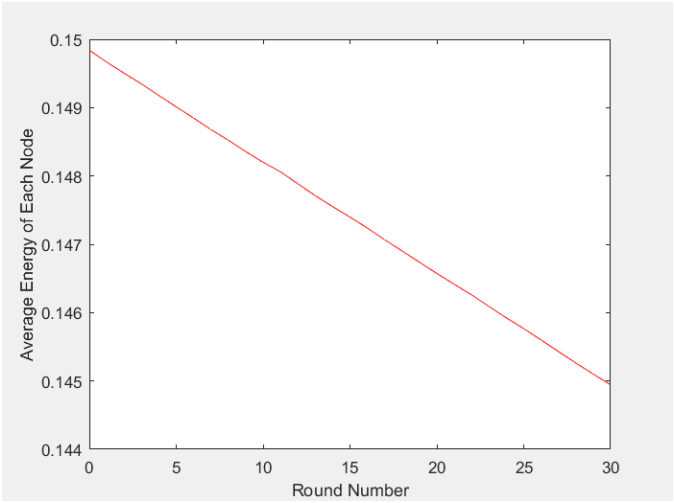

Figure 4. Graph of proposed protocol

V. CONCLUSION

In the WSN, the nodes with the highest energy consumption will become dead nodes. Increase in the number of dead nodes will lead to shortening of the life span of the WSN. In this paper, an advanced multicluster-head based clustering routing algorithm is proposed. The paper mainly concentrates on energy consumption, load balancing and identifies malicious nodes in the network. Once malicious node is detected then it won't get a chance to get elected as a cluster-head again. According to the results of simulation and tests conducted in MATLAB, it is shown that the proposed algorithm gives better results than existing algorithms in terms of load balance, average energy and security of the network.

REFERENCES

[1] Jie Huang. "Research on Balanced Energy Consumption of Wireless Sensor Network Nodes Based on Clustering Algorithm",978-1-5386-3981-8/17 © 2017 IEEE DOI 10.1109/ICCNEA.2017.74.

[2] Y. Xu, L.J. Chen and L.X. Gan, "Principles and Applications of Wireless Sensor Network," Beijing, Tsinghua University Press, 2015, pp. 23-36.

[3] M.N. Yang, D. Yang and C. Huang, "An Improved HEED Clustering Algorithm for Wireless Sensor Network,"Journal of Chongqing University, vol. 35, Aug. 2012, pp. 101-106.

[4] X.L. Lu, Y.Y. Wang, H.B. Wang and B.G. Xu, "Energy-balanced Unequal Clustering Algorithm in Wireless Sensor Network, " Computer Science, vol. 40, May. 2013, pp. 78-81.

[5] C.X. Yang, L. Gao and C. Lu, "Research on the Clustering Algorithm of a Balanced Energy Consumption of Nodes for WSN," Journal of Jiamusi University(Nztural Science Edition), vol. 33, Nov. 2015, pp. 925-928.

[6] X.Q. Wang, Y.J. Ou and N.L. Huang, “Design and Implementation of ZigBee Wireless Sensor Network,” Benjing, Chemical Industry Press, 2012, pp. 125-150.
[7] L. Kang and Z.S. Dong, “An Improved Unequal Clustering Algorithm Based on Cluster Head Classification,” Chinese Journal of Sensors and Actuators, vol. 28, Dec. 2015, pp. 1841-1845.
[8] Z.Y. Tao and S.F. Jiang, “Clustering Algorithm for Wireless Sensor Networks with Mobile Clusterheads,” Computer Engineering and Applications, vol. 52, Mar. 2016, pp. 75-78.
[9] H.B. Yu, W. Liang and P. Zeng, “Intelligent Wireless Sensor Network System,” Beijing, Science Press, 2013, pp. 161-173.
[10] Z.Y. Sun and C. Zhou, “Adaptive Clustering Algorithm in WSN Based on Energy and Distance,” Journal of Northeast Dianli University, vol. 36, Feb. 2016, pp. 82-86.
[11] C.S. Zhang, J. Xing and S.Q. Zhao, “Energy-efficeent Uneven Clustering Algorithm, ” Computer Engineering and Applications, vol. 52, Apr. 2016, pp. 106-109.
[12] J.Z. Li, H.T. Wang and A. Tao, “An Energy Balanced Clustering Routing Protocol for WSN,” Chinese Journal of Sensors and Actuators, vol. 26, Mar. 2013, pp. 396-401.
[13] Metcalfe, Robert M., and David R. Boggs. ”Ethernet: Distributed packet switching for local computer networks.” Communications of the ACM 19, no. 7 (1976): 395-404.
[14] Akyildiz, I. F., Su, W., Sankarasubramaniam, Y., Cayirci, E. (2002). Wireless sensor networks: a survey. Computer networks, 38(4), 393-422.
[15] Chiu, Dah-Ming, and Raj Jain. ”Analysis of the increase and decrease algorithms for congestion avoidance in computer networks.” Computer Networks and ISDN systems 17, no. 1 (1989): 1-14.
[16] Comer, D.E. and Droms, R.E., 2003. Computer networks and internets. Prentice-Hall, Inc..