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Relay Node Employment for Performance Enhancement of MEDC in Wireless Sensor Network

Amit Chugh, Supriya P Panda

Abstract: ***Wireless Sensor Network (WSN) is a combination of various small size processing units called sensors. Sensors are deployed over a region to monitor the environment and other happenings. Sensors sense the environmental situations and communicate the sensor data to nearby nodes or base stations. Sensor's energy keeps on depleting due to their multiple functionalities like sensing, aggregating of received data and communication with neighbor nodes. Energy constraint is one of the vital challenges for sensor nodes as they are majorly operational in unreachable locations with non-replaceable power resources. Various techniques have been implemented to overcome the challenge of limited power resources. Clustering is one of the techniques that facilitate to prolong the network lifetime through effective utilization of energy resources. Numerous clustering protocols have been implemented based on various parameters. Mutual Exclusive Distributive Clustering (MEDC) is one of the distributed clustering protocols that elect the cluster head based on residual energy. Selected cluster head performs the dual functionality i.e. combining the collected data and sending the same to the base station. This paper present the proposed algorithm which employed relay nodes in MEDC to distribute the load of cluster head and the distribution would lead to further enhance the network lifetime of WSN.***

Key Words: Wireless Sensor Network, Clustering, Relay Nodes, Network Lifetime

I. INTRODUCTION

Wireless Sensor Network (WSN) consists of small sensor nodes and a base station. Sensor nodes monitor the environmental conditions and communicate with each other or base station through wireless medium [5], [19]. Sensor nodes in WSN can be of the same or different configurations. WSN has numerous application areas like environment tracking, defense & security, health examination, stock monitoring and other commercial sectors [13]. There are some major challenges and limitations in WSN like low storage, security, limited lifetime power resource and short range of communication [20].

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***** Correspondence Author
Amit Chugh*, Computer science & Engineering department, Manav Rachna International Institute of Research and Studies, Faridabad, India. Email: amitchugh_9@rediffmail.com
Dr. Supriya P Panda, Computer science & Engineering department, Manav Rachna International Institute of Research and Studies, Faridabad, India. Email: supriya.fet@mriu.edu.in

Limited lifetime power resource is one of the major challenges as the sensor can be deployed at non-reachable locations where they cannot be charged or replaced. Sensors can be deployed in a random fashion or at planned locations in a given region. Many proposed approaches provide ways of effective energy utilization, which leads to an improved lifetime of WSN. For Example, Energy-aware cluster having optimal Cluster Heads can limit energy utilization [3], adaptive routing algorithms also reduce the energy consumption in crisis monitoring with event-based routing [2] and deployment of sensors through Gaussian distribution improves network lifetime [17].

Clustering/grouping of sensor nodes is one of the key approaches that gives solutions for effective energy utilization and enhances the spam of network life. In clustering sensor nodes are grouped and the cluster head is selected among the nodes within the cluster and given the responsibility to aggregate and communicate the data collected from member nodes. Cluster head collects the sensed data from member nodes and is the only node in a cluster that communicates with the base station. So it helps in saving the energy of member nodes of a cluster. There are numerous ways to select cluster head, Cluster members can select their cluster head themselves or it can be selected by the base station.

MEDC is one of the clustering protocols in which cluster members select their cluster head themselves. All cluster members advertise their residual energy to every member of the cluster. The cluster node with the highest residual energy is elected as a cluster head and assigned the responsibility for data aggregation and communication with the base station. The same process gets repeated after every iteration. As the cluster head performs the dual role of data aggregation and communication so it puts an extra burden on cluster head and effects the network lifetime.

The idea of employing the relay node in the cluster would reduce the burden on the cluster head, as the responsibility on the cluster head would get distributed. Relay nodes in a cluster would be responsible for communicating with the base station or other relay nodes and cluster head would only perform the functioning of data aggregation.

II. RELATED WORK

A. Wireless Sensor Network

The sensor is an IC that includes sensing unit, CMOS signal processing, a wireless transceiver with limited battery [5], [19].

Sensor nodes having the capacity to sense the environment around wherever deployed and can communicate the information. These features of sensor nodes make them applicable in various fields. Applications in military, habitat monitoring, medical and environment sensing made the WSN illustrious. Limited battery resource is one of the major challenges in Wireless Sensor Networks.

Various methods and techniques have been discussed to improve the network lifetime of WSN. Clustering is the technique of grouping the sensor nodes that effectively utilize the energy of nodes and that leads to longer survival of the network.

B. Clustering Protocols

Cluster is the method that works to overcome the challenge of limited energy resources in WSN. Clustering is a scheme of grouping the sensor nodes. Sensor nodes within their range of communication will form a cluster. A cluster head would be elected among the nodes in the formed cluster. Cluster head can be selected either by members of the formed cluster or by the base station. The cluster head is given the responsibility to collect the data from member nodes and communicate the same to other cluster heads or directly to the base station.

Clustering helps in saving the energy of sensor nodes that leads to improvement in the lifetime of the sensor network. Various clustering protocols have been defined by different means of Cluster Head selection [12], [15]. In centralized clustering, Cluster Head is selected by the base station, while in distributed clustering the same is elected by the cluster members [14], [15], [18]. MEDC is one of the distributed clustering protocols that select the cluster head based on the residual energy of cluster members. Node with the highest residual energy will be elected as cluster head. A new cluster head will be selected within a cluster after every round. On-demand clustering can also be performed rather than in rounds [16].

C. Relay Nodes

The cluster head is selected within a cluster by different means and given the role to collect the sensed data of all the cluster members. Cluster Head further aggregates the data and communicate the same to other cluster heads or base station [1]. Cluster head's energy can be depleted rapidly as it is burdened with the dual role of data aggregation and communication. Relay nodes can be introduced in a cluster to reduce the load over the cluster head. Relay node can be assigned the role to communicate the data to other relay nodes or base station and that would reduce the burden of cluster head. Reduction of the burden over the cluster node will optimize the energy of sensor nodes and results in improved network lifetime. Relay nodes can be positioned in an optimized manner through different placement approaches [4], [6], [7]. Various approximation algorithms have also been presented for relay nodes placements [8]. Relay nodes have shown magnificent results with clustering to improve the network lifetime in WSN [9]. Relay nodes can be introduced in the MEDC protocol to enhance their performance.

III. PROPOSED ALGORITHM

A. Network Model and Assumptions

Sensor nodes of equal capabilities are considered in random deployment over a region. Sensors keep monitoring and communicating due to which energy depletion will be there as per standard energy equations.

Various energies are considered for communication requirements which are as follows; Transmission energy as Etx and Receiving Energy as Erx. Further energy consumption Ec can be calculated by adding Startup Energy(Est), Switching energy (Esw), Transmission Energy (Etx) and Receiving Energy (Erx) given in (1). Startup Energy can be calculated as the product of power to start functioning (PLO) with the time requirement of start-up (tst) shown in (2). Energy equations of transmission energy and receiving energy are given in (3) and (4) respectively. Further PPA power consumption of power amplifier ttx time it takes to transmit packet PRX power consumption by decoder trx time it takes to receive a packet

$$Ec = Est + Esw + Etx + Erx \quad (1)$$

$$Est = PLO \cdot tst \quad (2)$$

$$Etx = (PLO + PPA)ttx \quad (3)$$

$$Erx = (PLO + PRX)\, trx \quad (4)$$

B. Relay Node Employment in MEDC

MEDC is one of the clustering protocols that select cluster head based on residual energy of sensor node. The sensor node that has the highest residual energy within the cluster would be elected as a cluster head. Cluster head would aggregate the data collected from cluster members and send the same to other cluster head or base station. A new cluster head would be selected after every iteration or round. The proposed algorithm has introduced the concept of a relay node in the MEDC protocol [11].

In MEDC clustering protocol cluster heads have been assigned dual responsibility of aggregated the collected data and communicating with the base station. The proposed algorithm has distributed the workload of the cluster head by employing the relay node in the cluster. As the cluster node is a node with the highest residual energy, the Relay node will be the second-highest residual energy node within the cluster and perform the role to communicate with other relay nodes or base stations. So cluster head will only perform the duty of data aggregation and its energy will not deplete sharply. Due to that more nodes will remain alive for a longer period and that would improve the network lifetime.

IV. IMPLEMENTATION

The MEDC and the proposed algorithm have been implemented using MATLAB 7.0. Both algorithms have been compared on different RCs (range of communications) that are 15, 20 and 25 over the 1000 rounds of iterations. The network lifetime corresponding to MEDC and the proposed algorithm is compared over 1000 rounds of iteration on 15, 20 and 25 range of communications.

Comparative results of MEDC and proposed algorithm are shown in Table-I, II and III also with given Fig. 1, 2 and 3.

At RC 15 Proposed algorithm has 9 live sensor nodes at 900 rounds however all nodes are dead in MEDC at the same no of rounds.

The proposed algorithm has enhanced the network's lifetime. The comparison of live nodes at RC 15 is given in Table-I and the graph corresponding to that is shown in Fig.1.

Table-I: Comparison of proposed algorithm with MEDC at RC 15

RC 15		
ROUNDS	NO. OF LIVE NODES	
	MEDC	PROPOSED ALGORITHM
100	100	100
200	93	94
300	93	94
400	83	91
500	80	82
600	68	71
700	57	49
800	25	28
900	0	9
1000	0	1

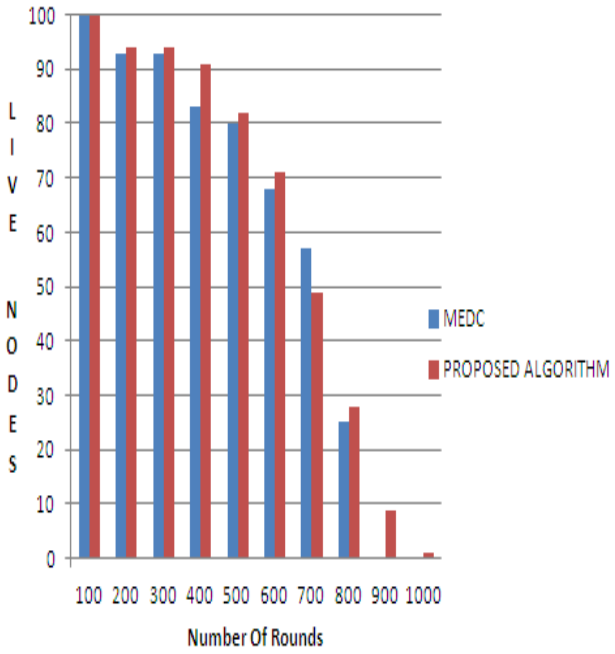

Fig.1. Results on RC 15

At RC 20 it has been drawn that at 600 rounds, there is no live node in MEDC but network of proposed algorithm is sustaining with 11 live nodes.

The proposed algorithm has improved the lifetime of network through effective utilization of energy by using relay nodes. Table-II defines the comparison of live nodes in MEDC and proposed algorithm and the same is been plotted and displayed in fig.2.

Table-II Comparison of proposed algorithm with MEDC at RC 20At RC 25 it has been concluded from the result that MEDC has no live node at 400 rounds however proposed algorithm has still sustained with 7 live nodes. The proposed algorithm has improved the network lifetime by effective energy utilization through relay nodes. The data showing a comparison of both the algorithm is given in Table-III. The graphical comparison of the same is shown in Fig. 3.

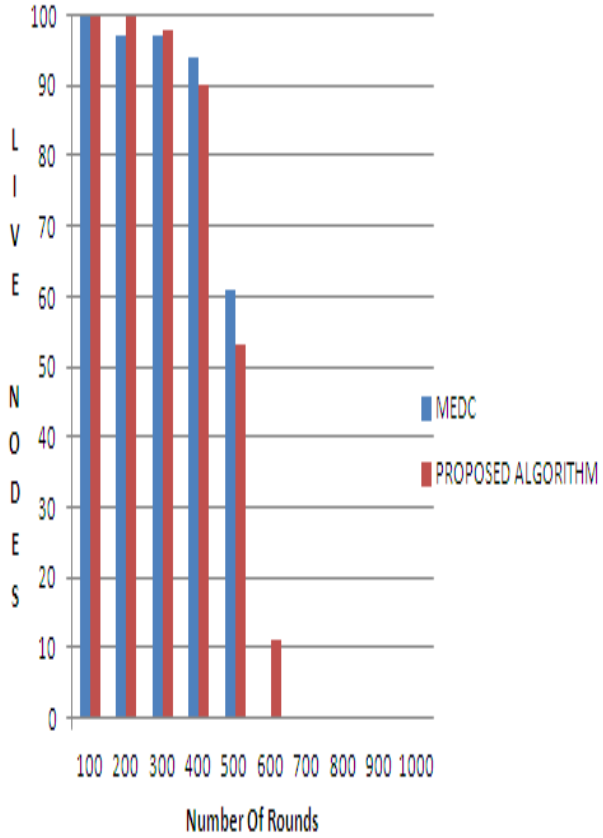

Fig.2. Results on RC 20

Table-III Comparison of proposed algorithm with MEDC at RC 25

RC 25		
	NO. OF LIVE NODES	
ROUNDS	MEDC	PROPOSED ALGORITHM
100	100	100
200	100	97
300	82	70
400	0	7
500	0	1
600	0	0
700	0	0
800	0	0
900	0	0
1000	0	0

RC 25		
	NO. OF LIVE NODES	
ROUNDS	MEDC	PROPOSED ALGORITHM
100	100	100
200	100	97
300	82	70
400	0	7
500	0	1
600	0	0
700	0	0
800	0	0
900	0	0
1000	0	0

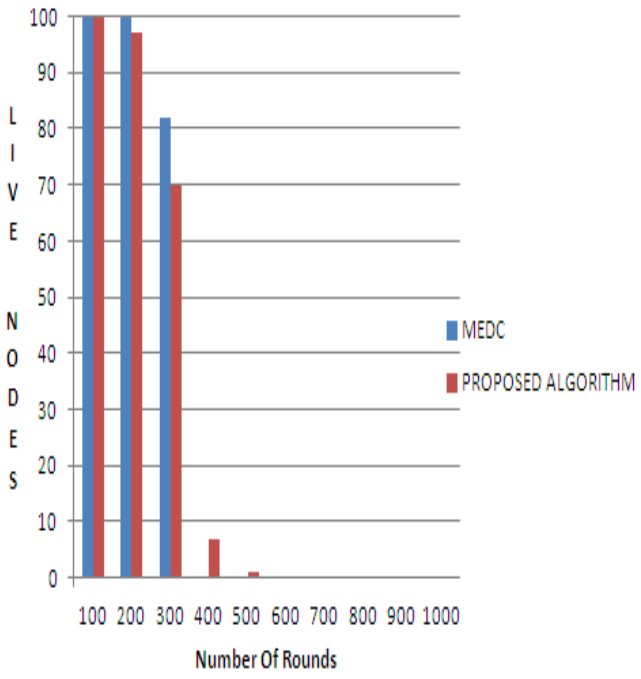

Fig.3. Results on RC 25

V. CONCLUSION

WSN can be aimed at any of the application areas but the concern is to keep sensors alive. Sensors deplete their energy by performing specific activities. So for saving sensors energy clustering was opted. Clustering saves the energy of a group of sensors by assigning major communication role to the group head. Group members deplete the only small amount of energy for communication till the cluster head only. Cluster head will aggregate and forward the aggregated information to the far located base station. Network lifetime can be further enhanced is the concept of the relay node is merged with clustering. This paper has proposed evaluated and presented the results of the MEDC protocol with the relay node. Experimental evaluation has shown results after a number of rounds. The proposed algorithm is giving better results because the relay node is sharing the load of the cluster head.

REFERENCES

1. Chen, L., Liu, L., Qi, X. and Zheng, G., 2017, Cooperation forwarding data gathering strategy of wireless sensor networks, International Journal of Grid and Utility Computing, 8(1), pp.46-52.
2. Zhang, J., Yang, T. and Zhao, C., 2016, Energy-efficient and self-adaptive routing algorithm based on event-driven in wireless sensor network, International journal of grid and utility computing, 7(1), pp.41-49.
3. Li, D.A., Hao, H., Ji, G. and Zhao, J., 2015, An adaptive clustering algorithm based on improved particle swarm optimisation in wireless sensor networks, International Journal of High Performance Computing and Networking, 8(4), pp.370-380.
4. Xu, K., Hassanein, H. and Takahara, G., 2005, September. Relay node deployment strategies in heterogeneous wireless sensor networks: multiple-hop communication case. In 2005 Second Annual IEEE Communications Society Conference on Sensor and Ad Hoc Communications and Networks, 2005. IEEE SECON 2005. (pp. 575-585), IEEE.
5. Press, C.R.C., 2016, Wireless sensor networks: Current status and future trends, CRC press.
6. Han, X., Cao, X., Lloyd, E.L. and Shen, C.C., 2009, Fault-tolerant relay node placement in heterogeneous wireless sensor networks, IEEE Transactions on Mobile Computing, 9(5), pp.643-656.
7. Liu, H., Wan, P.J. and Jia, X., August ,2005 , Fault-tolerant relay node placement in wireless sensor networks, In International computing and combinatorics conference (pp. 230-239), Springer, Berlin, Heidelberg.
8. Tang, J., Hao, B. and Sen, A., 2006, Relay node placement in large scale wireless sensor networks, Computer communications, 29(4), pp.490-501.
9. Tarhani, M., Kavian, Y.S. and Siavoshi, S., 2014, SEECH: Scalable energy efficient clustering hierarchy protocol in wireless sensor networks, IEEE Sensors Journal, 14(11), pp.3944-3954.
10. Singh, Y. and Chugh, U., 2013, Mutual Exclusive Distributive Clustering (MEDC) Protocol for Wireless Sensor Networks, International Journal of Sensors Wireless Communications and Control, 3(2), pp.101-107.
11. Chugh, A. and Panda, S., 2018, Strengthening Clustering through Relay Nodes in Sensor Networks, Procedia computer science, 132, pp.689-695.
12. Chugh, A. and Panda, S., 2019, Energy Efficient Techniques in Wireless Sensor Networks, Recent Patents on Engineering, 13(1), pp.13-19.
13. Arampatzis, T., Lygeros, J. and Manesis, S., 2005, June, A survey of applications of wireless sensors and wireless sensor networks, In Proceedings of the 2005 IEEE International Symposium on, Mediterrean Conference on Control and Automation Intelligent Control, 2005. (pp. 719-724), IEEE.
14. Younis, O., Krunz, M. and Ramasubramanian, S., 2006, Node clustering in wireless sensor networks: recent developments and deployment challenges, IEEE network, 20(3), pp.20-25.
15. Abbasi, A.A. and Younis, M., 2007, A survey on clustering algorithms for wireless sensor networks, Computer communications, 30(14-15), pp.2826-2841.
16. Adhikary, D. and Mallick, D.K., 2019, Energy-Aware On-Demand Fuzzy-Unequal Clustering Protocol For Wireless Sensor Networks, Journal of Engineering Science and Technology, 14(3), pp.1200-1219.
17. Wang, Demin, Bin Xie, and Dharma P. Agrawal. "Coverage and lifetime optimization of wireless sensor networks with Gaussian distribution." Mobile Computing, IEEE Transactions on 7.12 (2008): 1444-1458
18. Bagchi, S., 2010, A distributed algorithm for energy-aware clustering in WSN, International Journal of Sensor Networks, 7(1-2), pp.37-43.
19. Akyildiz, I.F., Su, W., Sankarasubramaniam, Y. and Cayirci, E., 2002, Wireless sensor networks: a survey. Computer networks, 38(4), pp.393-422.
20. Karl, H. and Willig, A., 2007, Protocols and architectures for wireless sensor networks, John Wiley & Sons.

AUTHORS PROFILE

Mr. Amit Chugh pursuing Ph.D in computer science and engineering from Manav Rachna International Institute of Research and Studies (MRIIRS), deemed to be university, Faridabad.

He is currently working as assistant professor in CSE department, MRIIRS and has 12 years of vast experience in industry and academics. He has done M.Tech and B.Tech in CSE from MDU Rohtak, Haryana. His area of research is clustering in wireless sensor networks.

Dr. Supriya P Panda currently working as professor and head of department in CSE department Manav Rachna International Institute of Research and Studies (MRIIRS).She completed her Ph.D and MS from BGSU, Ohio, USA in 1990 and 1986 respectively. She has vast experience of more than 30 years in teaching. She has taught a different range of subjects and guided many B.Tech, M.Tech students towards project and thesis.