Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X

IJCSMC, Vol. 3, Issue. 5, May 2014, pg.1111 – 1118

RESEARCH ARTICLE

Improved Inter-Cluster Data Aggregation HEER Protocol

Sakshi Sharma[1], Malti Rani[2]

[1]Department of Computer Science, Punjab technical University, India

[2]Department of Computer Science, Punjab technical University, India

[1] sakshi1511@gmail.com; [2] malti_87@yahoo.co.in

Abstract— Wireless Sensor network consist of independent large number of sensors and energy efficiency is one of the most important concerns in Wireless Sensor Network. To resolve issues of energy consumption, reliability and data aggregation several routing algorithms have been proposed earlier. We can prolong network lifetime and stability period by reducing energy consumption. The proposed protocol focuses on some defects of existing HEER protocol and improves network lifetime. In the proposed protocol, improved inter cluster data aggregation is introduced to perform better and provide uniform energy consumption. Finally, simulation result shows that our proposed protocol has better network lifetime and stability period than that of existing HEER.

Keywords— wireless sensor network; routing protocol; clustering; threshold values; aggregation

I. INTRODUCTION

Wireless sensor network is a popular area for research and is considered as one of the most important technology now-a-days. Many recent advances in MEMS- microelectronic mechanical system and wireless communication technologies are enabled. Smart sensors are deployed in a physical area and networked through wireless links. A wireless sensor network consist of a large number of low cost, small in size, low power and multifunctional sensor nodes deployed in network [1]. The basic components of sensor node structure consist of power unit (Battery), sensing unit (sensor, ADC- analogue to digital converter), processing unit (memory, microprocessor/ microcontroller) and communication unit (radio channels). However, the routing technology of network layer is critical in reducing the energy consumption in wireless sensor network. There are two types of routing method: static routing and dynamic routing: Dynamic routing performs the same function as static routing but it is more robust. Static routing allows routing tables to be set up in specific routers in a static manner so network routes for packets are set. To solve issues of energy consumption, reliability and data aggregation several energy efficiency algorithms have been proposed but the routing protocol should be fault tolerant in dynamic related environment [2] [9]. Fig. 1 shows classification of Routing protocols in WSN.

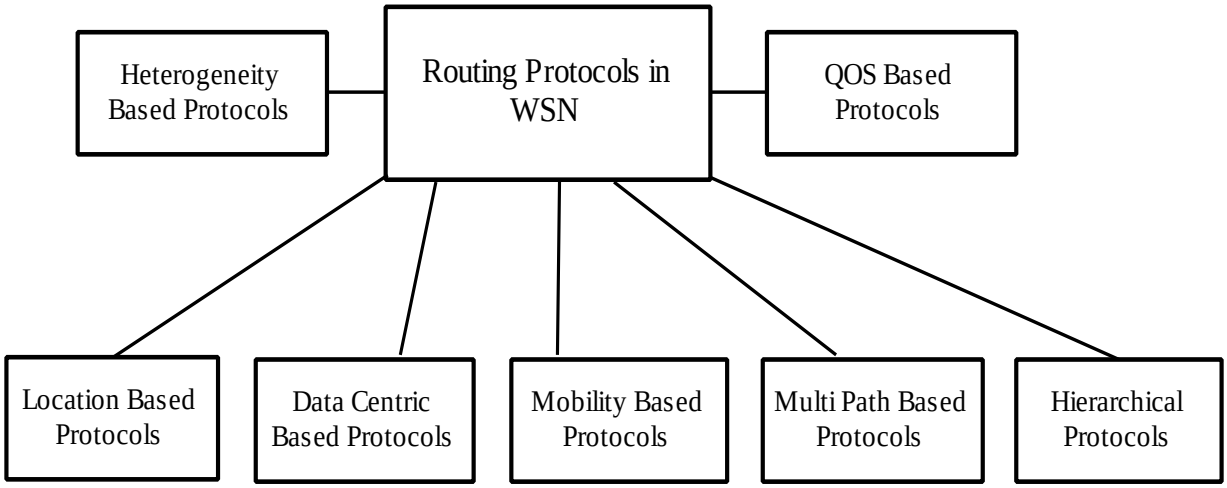

Fig. 1 Classification of Routing protocols in WSN

But the most important issues in wireless sensor network are energy efficiency and to prolong network lifetime. Various communication protocols and algorithms are proposed to find ways to reduce power consumption. In this paper, performance of HEER protocol is improved to provide better energy consumption and network lifetime. HEER performs best for time critical applications and reduces the number of transmissions by using threshold value. The problem in HEER was that it does not use data aggregation at the sink by individual nodes therefore causes flooding of data which consequences in maximum energy consumption. So, proposed HEER give better results when compared to previous HEER protocol.

II. RELATED WORK

J. Peng et al. [3] introduced the first hierarchical and conventional clustering routing algorithm for wireless sensor network called LEACH- Low Energy Adaptive Clustering Hierarchical Protocol. LEACH is an energy efficient self-adaptive routing protocol and outperforms classical clustering algorithm. The main idea is to form clusters and further nodes are divided into two types: cluster head nodes and normal nodes. In this protocol, LEACH defines work period as round and every round consist of two phases: set up phase and steady phase. LEACH performs well in homogenous environment but in heterogeneous environment its performance deteriorates. Sometimes, nodes on remote position are elected as cluster head which result in maximum energy consumption and also there is unequal distribution while cluster formation [10].

Manjeshwar et al. [4] describe TEEN protocol and it is first reactive protocol. TEEN is threshold-sensitive energy efficient protocol and in this algorithm, closer nodes form clusters with cluster head to transmit collected data to upper layer. The cluster head selection and cluster formation is same as that of LEACH but in this cluster head broadcast two threshold values i.e. hard threshold and soft threshold. Hard threshold is absolute value beyond which a sensor turns its transmitter on to report sensed data and soft threshold is small change in value of sensed attribute. However, threshold values: hard threshold and soft threshold reduces the number of transmissions and increases network lifetime.

Li Qing et al. [5] proposed DEEC protocol i.e. Distributed Energy efficient Clustering Protocol and is proactive protocol for heterogeneous wireless sensor network. In DEEC protocol, cluster head selection is based on ratio between residual energy and average energy of network. In this algorithm, nodes with highest initial and residual energy has grater chances to be elected as cluster head. DEEC prolong network lifetime and perform well in multi-level heterogeneous network.

N. Javaid et al. [6] proposed hybrid energy efficient reactive (HEER) protocol for homogeneous wireless sensor network. In HEER, cluster head selection is same as that of DEEC i.e. ratio of residual energy of node and average energy of network. To conserve more energy, hard threshold and soft threshold values are transmitted. HEER improves stability region for clustering process and works well for both homogeneous and

heterogeneous environment. This algorithm does not require any global knowledge of energy while election round. HEER performs best for time critical applications and reduces number of transmissions results in reduction of energy consumption. The stability period of HEER is much longer than that of TEEN and DEEC.

III. PROPOSED WORK

In TEEN after the death of first node, all the remaining nodes die within small number of rounds as a consequence equal remaining energy distributed. In the presence of high energy nodes TEEN results in large unstable region because all high energy are equipped with same energy hence the process of cluster selection process become unstable. So, HEER was proposed to give better result for time critical applications in homogenous and heterogeneous environment by using threshold value and distributing load among high energy nodes, low energy nodes. But HEER does not use data aggregation at the sink by individual nodes therefore causes flooding of data and consumes maximum energy. To address this problem, a novel technique is proposed in this paper i.e. it has same features as existing HEER but has better inter cluster data aggregation. Therefore, it increase the network lifetime and handle the problem of flooding at base station.

Data aggregation in wireless sensor network helps in reducing the amount of redundant transmissions in the network. To diminish this problem a new data aggregation technique is proposed which improve the performance of the heterogeneous WSNs by using the group based data aggregation also called hybrid data aggregation method. The results will be shown using MATLAB tool. The proposed algorithm used consist of three steps, firstly, to select cluster head according to highest residual energy, secondly, to implement and show inter-cluster aggregation and thirdly, design and simulate the proposed algorithm.

The main objective is to do inter cluster aggregation that is to elect the cluster head and decide the additive and divisible functions to be used at cluster head in order to minimize the packet count on the basis of data correlation either same or different in packets sensed by the sensor nodes that are participating in the cluster and to perform inter cluster aggregation that is to reduce the power consumption by assembling the clusters for transmitting data packets to the sink. The flowchart for aggregation to be performed in proposed HEER is shown in Fig. 2.

The flowchart for aggregation is divided into six phases: in first step deploy sensor nodes in network, in second step organize nodes into cluster i.e. cluster formation and cluster head selection is carried out in this step and cluster head is selected according to ratio of residual energy and average energy of network, in third step sensor nodes that have similar data are assembled, in fourth step aggregation function is applied i.e. additive and divisible functions, in fifth step each cluster head collect data from sensor nodes and in last step cluster head perform inter-cluster aggregation to remove redundant data and send valid packets to sink.

Each cluster has the N/n nodes where n is the number of clusters, so the energy utilized in transmitting k bit of packet by the cluster head is

$$E_{ch} = (k * E_e + k * E_s d^2) + \left(\left(\frac{N}{n}\right) - 1\right) * k * (E_e + E_{DA})$$

Where EDA is effective data aggregation cost, Es represent amplification energy when distance is more than the minimum distance (d0) and Ee represent energy amplification when distance is less than the minimum distance (d0). The given energy means; how much energy is taken by these parameters, while packets transmission.

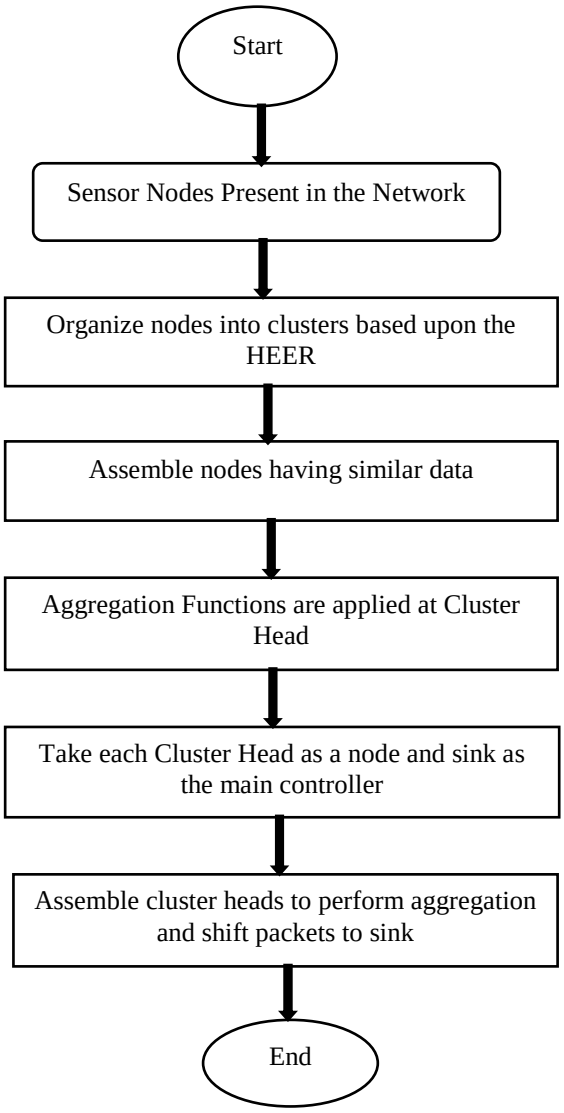

Fig. 2 Flowchart for aggregation in proposed HEER

IV. SIMULATION RESULTS

In this section, we simulate an environment with field having dimensions 100 x 100 square units. The number of sensor nodes deployed is 100 and base station is assumed at centre of sensing nodes. To evaluate the performance of proposed HEER- IICDAHEER, we simulate it with existing HEER. The parameters used in our simulation are listed in Table I. Our aim in conducting the simulation is as follow: to examine the performance of existing HEER and proposed HEER for prolonging network lifetime and stability period.

TABLE I
PARAMETERS USED IN OUR SIMULATION

Parameter	**Value**
n- no of nodes	100
Initial Energy, E_0	0.5 J
Transmitting and Receiving Energy	5nJ/bit
Amplification energy minimum	10pJ/bit/ m^2

Amplification energy maximum	0.013pJ/bit/ m^4
Percentage of advance nodes, m	0.3
Energy of advance nodes	$E_0(1+a)$

In simulation result of proposed HEER cluster head are selected in each cluster, network is divided into various clusters and then data is transmitted to base station. In this normal and advance nodes are used so that energy consumption is minimized by first distributing load to all high nodes and then on to low energy nodes. All advance or normal sensor nodes transmit data to their respective cluster heads and then all cluster heads transmit data to base station. Proposed HEER: IICDAHEER – improved inter cluster data aggregation HEER protocol solve the problem of flooding at base station efficiently as existing HEER does not use inter-cluster data aggregation but proposed HEER perform inter cluster data aggregation at base station thus, increase network lifetime more efficiently.

In simulation representation Fig. 3, shows scenario of all nodes with advance and normal nodes. In Table II the representation of simulation is described.

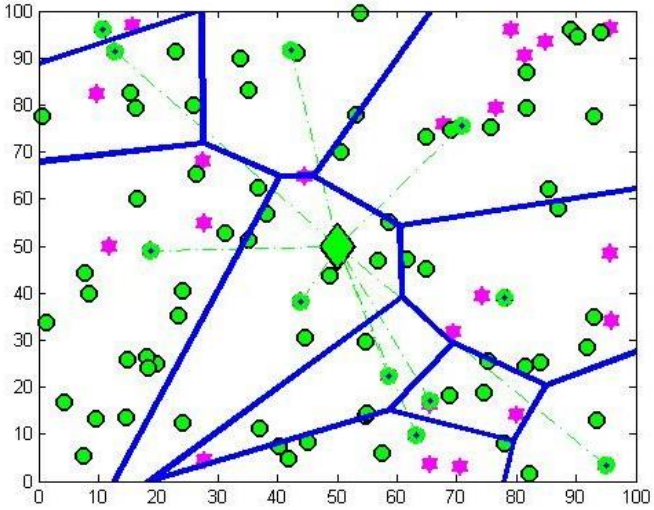

Fig. 3 All Nodes Alive

TABLE III
SIMULATION REPRESENTATION

Graph representation	**Parameter**
X-axis and Y-axis	No. of Nodes
	Alive nodes- Normal Nodes
	Advance Nodes
	Alive nodes- Cluster Head Nodes
	Base station
	Data transmission from cluster head to base station
	Divide the network into various clusters

Now, we compare existing HEER and proposed HEER protocols in network environment. We observe from Fig. 4 that in existing HEER first node dies at 1500 and last node dies at 3792 but in proposed HEER it is seen in graph that first nodes dies at 1734 and last node dies at 4417. So, it is clearly understood that network lifetime of proposed HEER is more than that of existing HEER.

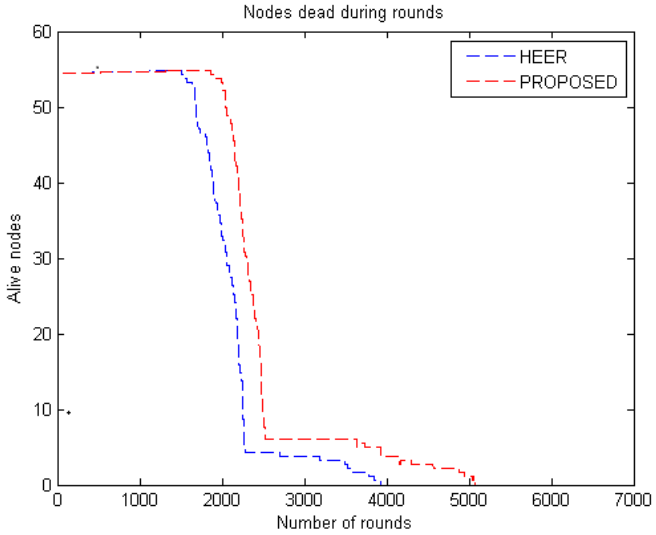

Fig. 4 Graph- Alive nodes vs no of rounds to calculate nodes dead during rounds

In Fig. 5 and Fig. 6 graph is plotted to show packet transmission rate to base station by cluster heads and packet rate to cluster heads by sensor nodes and from graphs it is observed that stability period of proposed HEER is much longer as it uses HT (hard threshold) value which decreases the number of transmissions to base station which in result increases network lifetime and also inter-cluster aggregation is performed as cluster head is elected, it decide additive divisible functions to be used at cluster head so that packet count is minimized. Therefore, with inter- cluster aggregation power consumption is reduced by assembling the clusters for transmitting data to base station.

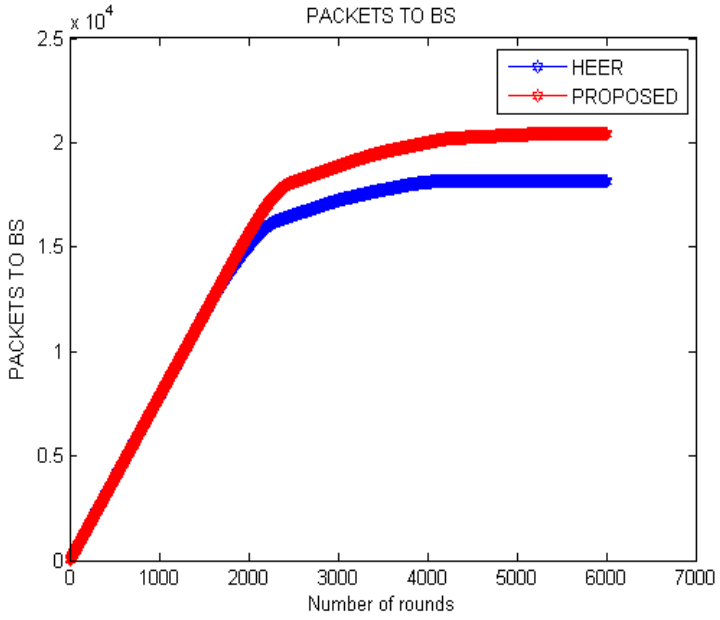

Fig. 5 Graph- PACKETS TO BS Analysis

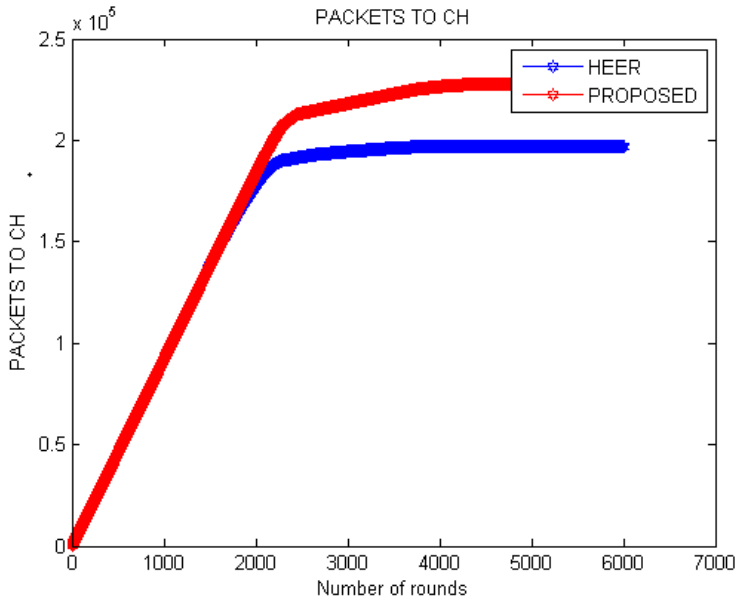

Fig. 6 Graph- PACKETS TO CH Analysis

Thus, simulation results show that proposed HEER: IICDAHEER – improved inter cluster data aggregation HEER protocol performs better than existing HEER- Hybrid Energy efficient reactive protocol in terms of network lifetime and stability period.

V. CONCLUSION

In this paper, we present an improvement of hybrid protocol of TEEN and DEEC i.e. HEER. In this simulation of existing HEER and Proposed HEER i.e. IICHDAHEER- improved inter-cluster data aggregation HEER protocol, it is clearly observed that network lifetime and stability period of proposed HEER is more. Proposed HEER protocol minimizes energy consumption by distributing load to all high nodes and then on to low energy nodes and also solve the problem of flooding at base station It is well suited for time critical applications and is more efficient than other data aggregation protocols: TEEN, DEEC.

ACKNOWLEDGMENT

Foremost, I Sakshi Sharma would like to express our sincere gratitude to my Head of the Department, Mr Rajdeep Singh and my guide Mrs. Malti Rani for their continuous support, their patience, motivation, immense knowledge and their complete guidance for this research paper.

REFERENCES

[1] Renna, S. Phulre and R. Pandit, "Wireless Sensor Network and its Routing Protocol: A Survey Paper", *in proceeding of IJCSMC*, vol.2, pp. 60-64, 2013.

[2] D. Mantri, N. R. Prasad and R. Prasad, "Grouping of clusters for efficient data aggregation (GCEDA) in wireless sensor network" *in proceeding of Advance Computing Conference (IACC),* IEEE 3rd International, pp. 132-137, 2013.

[3] J. Peng, W. Chengdong, Z. Yunzhou and C. Fei, "A Low-Energy Adaptive Clustering Routing Protocol of Wireless Sensor Networks*", in proceeding of IEEE International Conference on Wireless Communications, Networking and Mobile Computing (Wi COM),* pp. 1-4 September 2011.

[4] A.Manjeshawar and D.P.Agrawal, TEEN: A Routing Protocol for Enhanced Efficiency in wireless sensor network, *in Proceeding of IEEE,* 2001.

[5] L. Qing, Q. Zhu and M. Wang, "Design of a distributed energy-efficient clustering algorithm for heterogeneous wireless sensor networks", *in Proceeding of Science Direct*, pp.2230-2238, March 2006.

[6] N. Javaid, S. N. Mohammad, K. Latif, U. Qasim, Z. A. Khan and M. A. Khan, "HEER- Hybrid Energy Efficient Reliable Protocol for Wireless Sensor Networks", *in proceeding of IEEE*, 2013.

[7] D. Mantri, N. R. Prasad and R. Prasad, "BHCDA: Bandwidth efficient heterogeneity aware cluster based data aggregation for Wireless Sensor Network" *in proceeding of Advances in Computing, Communications and Informatics (ICACCI), International Conference IEEE*, pp. 1064-1069, 2013.

[8] A. Yektaparast, F.H. Nabavi and A. Sarmast, "An Improvement on LEACH Protocol (Cell-LEACH)", *in proceeding of IEEE 14th International Conference on Advanced Communication Technology*, pp. 992-996, February 2012.

[9] S.Sharma and M. Rani, "An improvement for HEER Protocol in wireless sensor network", *in proceeding of IJCSIT*, pp. 3399-3402, vol.5, 2014.

[10] L. Tao, Z.Q. Xin and Z. Luqiao, "An Improvement for LEACH Algorithm in Wireless Sensor Network", *in proceeding of IEEE 5th Conference on Industrial Electronics and Applications*, pp. 1811-1814, June 2010.

