 ISSN : 2230-7109(Online) | ISSN : 2230-9543(Print)

Energy Efficient Data Collection Algorithm in Wireless Sensor Network

[1]Dr. K.K Paliwal, [2]Rohit Anand, [3]Priyanka Garg
[1,2,3]Dept. of ECE, N.C College of Engineering, Israna Panipat, Haryana, India

Abstract

Wireless sensor networks are self organized, low cost and low power utilizing network. It can sense, calculate and communicate the data. Collection of data at sensor nodes consumes a lot of energy and sensor nodes have limited energy. In this paper, we proposed a minimum number of full transmission based clustering technique. We compare our results with LEACH which is cluster based protocol. Results will show that proposed technique is more energy efficient and network will have prolonged lifetime.

Keywords

WSN, Data Collection Algorithms, LEACH

I. Introduction

A Wireless Sensor Network (WSN) consists of autonomous, self-organizing, lightweight sensor nodes, which can monitor physical or environmental conditions. Wireless sensor nodes are the nodes, whichcan sense, compute and communicate the data. It is possible only due to the miniaturization of various components, which is made possible by MEMS technology. A sensor node consists of microcontroller, battery, analog to digital converter, sensing device. All these components have their own function. There is some features of WSN which makes it more reliable for various applications, these factors include fault tolerance, scalability, production cost, hardware constraint, sensor network topology, environment, transmission media and power consumption [1].WSN have various applications like military, environmental, health and home applications. The main challenge for WSN is energy consumption. There is lot of energy consumes while transmitting the data but sensor nodes have limited energy. Various techniques had been proposed to make network more energy efficient. In this paper, we propose a technique which is minimum number of full transmission based clustering technique. In this we proposed that only the cluster heads will transmits their data and all other nodes compute the difference between their own sensed data and received data from their respective cluster-head. After that we use the double hierarchy technique for multi-hop transmission of data. We compared our results with LEACH having a modified cluster head selection parameter.

The rest of the paper is organized as follow. In section II we present some related work. In section III we provide some details of our proposed technique followed by simulation results and comparison with LEACH in section IV. Conclusion and possible future work is presented in section V.

II. Related Work

In [2] whole network is divided into several sub-regions with each covered by a cluster of sensor nodes. It can effectively save energy without losing observation fidelity. In [3] cluster based routing driven compression is proposed, which organizes the nodes into clusters, and within each cluster each sensor's data is routed to a cluster head where redundant data is suppressed. There were also a number of full transmissions. In [4] a method of staggered sampling for data collection is introduced. Staggered sampling means that at each sampling moment (epoch) only a small percentage of sensors collect (sample) data. The effectiveness of the model and approach for energy savings are evaluated on real-life data traces. In [5] a coalition-based cooperative data transmission mechanism for energy saving it is more energy efficient than routing algorithms. In [6] scheme proposed an improvement in LEACH in selection of cluster head as in LEACH cluster head chose randomly, this technique chooses a function which relates relative distance between nodes and base station and the round number as its parameters. Thus distribution of cluster head becomes symmetrical through changing parameters of the function and with the increase of running time, every node in the network has the chance to be a cluster head, that is, the energy consumption could be balance.

A. Radio Energy Consumption Model

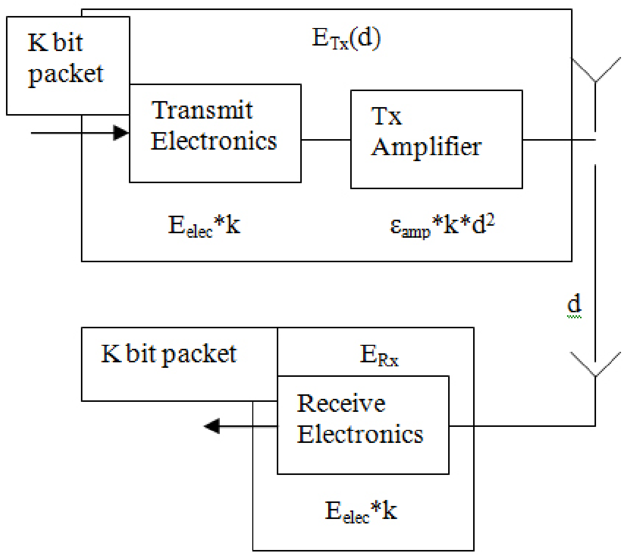

Fig. 1: Energy Consumption model

Due to all these constraints, we are proposing a scheme to balance energy in the whole sensor network as the capacity of individual sensor can't be increased but we will optimize the whole network so that energy consumption is less. Our scheme is based on the fact that energy consumption in transmission of data is more as compare in calculation. So we are proposing a scheme which can minimize the number of reference data transmission and reduce the number of bits required to transmit the data. A sensor consumes Eelec = 50nJ/bit to run the transmitter or receiver circuitry and

Eamp = 100pJ/bit/m2 for the transmitter amplifier [2-7]. Thus, the energy consumed by a sensor i in receiving a k-bit data packet is given by,

Rxi = Eelec* k (1)

While the energy consumed in transmitting a data packet to sensor j is given by,

Txij = Eelec* k + Eamp* d2ij * k (2)

Where dij is the distance between nodes i and j. So main requirement is to minimize the transmission of data, for this it is thought that if redundant data is not transmitted then a lot of energy saving is possible [3-8]. As computation of data consumes lesser energy, so we compute the data at every sensor node and transfer only that data which is actually required. For the calculation of data at each node there is requirement of reference data.

B. Cluster-head Selection Parameter

Each sensor node chooses a random number, temp, between 0 and 1 and this number is then compared with threshold value, T (n), which depends on various parameters given below [9]. If this random number is less than threshold value, then that node becomes the cluster-head for current round. The role of cluster is dynamic which means it rotates to other nodes also in continuous round and each node must be elected as cluster-head at-least once in their lifetime.

$$T(n) = \frac{p}{1 - p(r \bmod \frac{1}{p})}\left[\frac{En\_current}{En\_\max} + (rs * p)\left(1 - \frac{En\_current}{En\_\max}\right)\right]$$

Where rs represent the number of successive rounds in that a node has not been cluster-head. When rs attains the value 1/p, the threshold T(n) is changed to the value it had previous to the addition of the left out energy into the threshold equation.

III. Proposed Work

To achieve this, we reduce the number of full transmission by proposing that each cluster-head will transmit its data in its respective cluster and then all the cluster members will compute the difference between its own sensed data and received data. After this we use the hierarchy technique, in which we divide the cluster-heads into three levels. Firstly we find the cluster-head nearest to the base station called the first level node. After that we find the next two cluster-heads nearer to the base station called the second level nodes. Now the farthest two cluster-heads transmit their data to the second level nodes which aggregate this data and then they transmit aggregated data to the first level node. Finally at this level cluster-head aggregates the whole data and transmits to the base station. Since energy consumption is less in computation as compared to transmission, proposed technique will save energy by reducing the number of full transmissions without affecting the integrity of data collection at base station.
The various steps for the process have been followed:

STEP 1: Nodes are randomly deployed in square field.
STEP 2: Co-ordinates of Base Station are defined
STEP 3: Initial energy of each node is defined.
STEP 4: Compute the threshold value.
STEP 5: A random number between 0 and 1 is given to each node.
STEP 6: Compare the value of each node with the threshold value.
STEP 7: A node will declare itself as cluster-head if its value is less than threshold value.
STEP 8: Count the number of cluster heads. If number is less than 5 then move to step 6 other wise move to next step
STEP 9: Calculate the distance of each node from the cluster heads
STEP 10: Nodes will join their nearby cluster-head and declare themselves as cluster member.
STEP 11: After the formation of clusters, each cluster head will transmit its data to its cluster members.
STEP 12: Cluster members compute the difference between their own sensed data and received data.
STEP 13: Cluster member nodes will transmit difference data to their respective cluster-head. It is the main difference between LEACH and proposed technique as there is transmission of completely sensed data but in this only difference data is being transmitted
STEP 14: After that we divide our cluster-heads into three levels. First we find the cluster-head nearest to the Base station and called as first level node.
STEP 15: Then find the next two cluster-heads nearer to the base station and called them as second level node.
STEP 16: Now the farthest cluster-heads called third level cluster-heads will transmit their data to the second level cluster-heads, which, then aggregate the received data.
STEP 17: Second level cluster-heads will transmit the aggregated data to the first level cluster-head, which then aggregate the received data.
STEP 18: Cluster-head at first level will transmit the aggregated data to the base station.
STEP 19: As the first round is completed it will check for alive nodes. If there is alive node then it moves to the next round following from step 4.
STEP 20: If there is no alive node it shows that communication will not be possible and it becomes the end of network

IV. Simulation and Results

A. Simulation Parameters

We take a 100*100 m field area and we deploy 100 nodes. Base station is located at outside the field and its coordinate are (x = 50, y = 200) and can vary. According to optimum number of cluster head theory it is verified that for our network maximum 5% of nodes can be the cluster-heads in one round. Energy of Base Station is infinite and each node has initial energy lying between 0.25 and 1 Joule.

B. Results

For the results we have taken the average.
LEACH will take 1171.933 rounds for the Ist node becoming dead and in our algorithm it will take 1874.333 rounds. There is improvement of 59.93517%. For 25 nodes LEACH will take 1526.1 rounds as compared to our algorithm which will take 2418.8 rounds, So improvement is of 58.49551%.

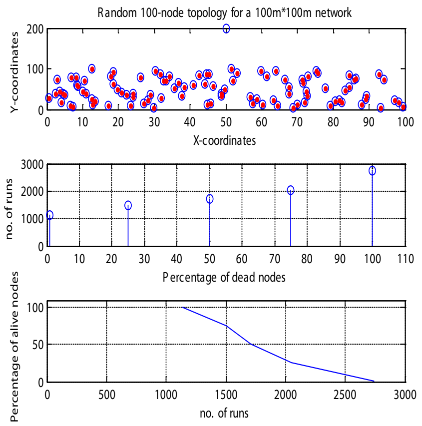

Fig. 2: Simulation Results for LEACH

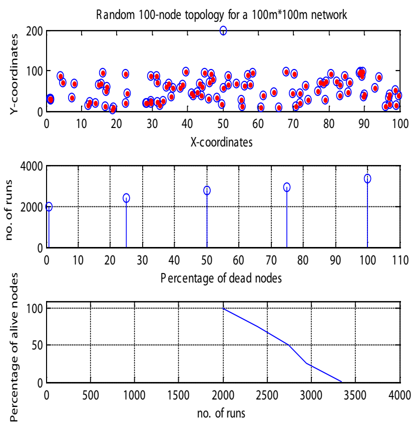

Fig. 3: Simulation Results for Proposed Method

For 50 nodes to become dead LEACH will take 1762.733 rounds and our algorithm will take 2696.467 rounds. So, percentage improvement of 52.97081% is there. For 75 nodes LEACH will take 2076.233 rounds and our algorithm will run till 2914.333 rounds, So there is percentage improvement of 40.36638%. For all the nodes to become dead LEACH will run till 2818.7 rounds and our algorithm will take 3315.267 rounds. So, percentage improvement of 17.61688% is there.

The average lifetime of network in LEACH and Proposed technique, as shown in fig. 5, which shows that lifetime of network is more in proposed technique.

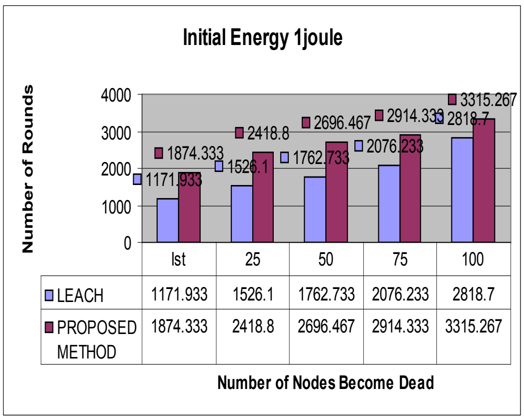

Fig. 4: Number of Rounds Comparison Between LEACH and Proposed Method

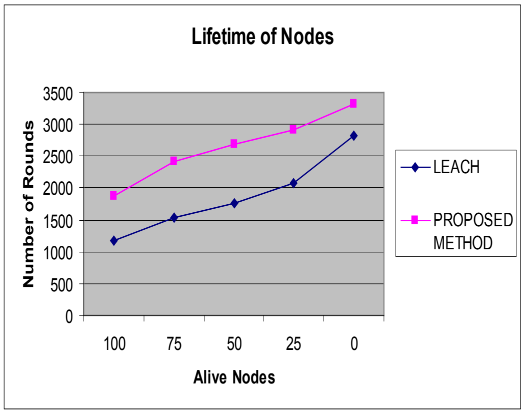

Fig. 5: Comparison of Lifetime of Network Between LEACH and Proposed Method

V. Conclusion

In our algorithm we have proposed to reduce the number of full transmissions. We achieve it by allowing only cluster heads to do the full transmission and rest of the nodes will compute the difference between their own sensed data and received data from their respective cluster head and retransmit the difference data by using the hierarchy technique. Since near by nodes sense the similar data thus the number of bits to be transmitted will reduce and the network becomes more energy efficient.

References

[1] "Information Processing and Routing in wireless sensor networks", World Scientific Publishing Co. Pte. Ltd. [Online] Available http://www.worldscibooks.com/compsci/6288.html.

[2] Chong Liu, Kui Wu, Jian Pei, "An energy Efficient Data Collection Framework for Wireless Sensor Networks by Exploiting Spatiotemporal Correlation"

[3] Sundeep Pattem, Bhaskar Krishnamachari, Ramesh Govindan, "The Impact of Spatial Correlation on Routing with Compression in Wireless Sensor networks", ACM Transactions on Sensor Networks (TOSN), vol. 4, no. 4, p. 24,2008.

[4] Jennifer L. Wong, Seaphan Megerian, Miodrag Potkonjak, "Staggered Sampling for Energy Efficient Data Collection," IEEE SENSORS 2006, EXCO, Daegu, Korea October 22-25, 2006

[5] Na Xia, Mei Tang, Jian-guo Jiang, Dun Li, and Hao-wei Qian, "Energy Efficient Data Transmission Mechanism in Wireless Sensor Networks," 2008 IEEE

[6] Li Xunbo, Li Na, Chen Liang, Shen Yan, Wang Zhenlin, Zhu Zhibin , "An Improved LEACH for Clustering Protocols",2010,International conference on Measuring Technology and Mechatronics and Automation.

[7] Konstantinos Kalpakis, Koustuv Dasgupta, Parag Namjoshi, "Maximum Lifetime Data Gathering and Aggregation in Wireless Sensor Networks". 2002 TR CS-02-12

[8] Sarah Sharafkandi, David H.C Du, Alireza Razavi," DECOR: Distributed and Energy Efficient Collection of Raw Data in Sensor Networks" University of Minnesota, Tech. Rep., 2010.

[9] M.Sheik Dawood, S.Sadasivam, G.Athisha, "Energy Efficient Wireless Sensor Networks based on QoS Enhanced Base Station controlled Dynamic Clustering Protocol,"

International Journal of Computer Applications (0975 – 8887) Volume 13– No.4, January 2011.