



International Journal of Emerging Technologies in Computational and Applied Sciences (IJETCAS)

(Open Access, Double Blind Peer-reviewed, Refereed and Indexed Journal)

www.iasir.net

Gateway Based Adaptive Routing in WSN

Raginee Chauhan¹, Dr. Vikas Thada², Dr. Khusboo Tripathi³

¹Research Scholar, ²Associate Professor, ³Assistant Professor
ASET, AUH Gurgaon
Haryana, India

Abstract: The Efficient designing and deployment of wireless sensor networks is booming area for researchers in the recent years, due to vast potential of the sensor network to enable the applications that connect the physical world to the virtual world. The major applications for such large-scale wireless sensor networks exists in a variety of fields, such as military applications, medical observation, environmental monitoring, security surveillance, home security and industrial machine monitoring and observation. By creating a network of large numbers of small-sized sensor nodes, it is possible to get the data about physical phenomenon which otherwise was difficult or impossible to obtain using more conventional ways. In the upcoming years, due to advances in fabrication technologies or micro embedded devices, the cost of manufacturing of the sensor nodes is expected to drop, leading to an increased deployments of wireless sensor networks, with the networks eventually growing to hundreds of nodes. Some of the common applications areas of the Wireless Sensor Networks are biometrics, weather monitoring, military applications etc. In this research, a gateway based routing protocol has been proposed and implemented in various scenarios.

Keywords: Wireless sensor Networks, Routing, Clustering, network lifetime, energy efficiency.

I. Introduction

Wireless sensor networks (WSNs) are increasingly used in many applications, for sensing ,collecting data and forwarding it to the control center which can be a base station having almost the same circuitry but more powerful. Typical uses of Wireless Sensor Networks include areas such as volcano and fire monitoring, urban sensing, and perimeter surveillance. Sensor nodes can aggregate the sensed data over a period of time and can relay it to the nearest base station themselves. This is called direct delivery. Though this is the most common approach but using this method generally leads to heavy traffic in the network and as the nodes have limitation with energy, this decreases the lifetime of the network. The sensor network comprises of sensor field, where the sensor devices or nodes are scattered in this field. With the help of multi-hop techniques and router based infrastructure, a significant amount of energy can be conserved in the long run of the network. The dynamic parameters which are present in this type of network are constrained following are few parameters which change dynamically depending on the application:

- Power Considerations.
- Position of the nodes.
- Reachability.
- Usage based on tasks.

In this paper we suggest a modified approach of dividing the network area into a number of intelligent sectors, and decentralization of the communication over network by employing a router node at the center of the network.

All manuscripts must be in English. These guidelines include complete descriptions of the fonts, spacing, and related information for producing your proceedings manuscripts.

II. Related Work

Clustering based techniques have been developed to deal with energy issues in Wireless Sensor Networks. Low Energy Adaptive Clustering Hierarchy (LEACH) [8] is the first credible work in this respect. LEACH, a clustering-based protocol, uses randomized election and rotation of local cluster base station (also called as 'cluster-heads' for transferring data to the sink (base station) node) so as to equally preserve the energy among the sensor nodes in network. This rotation of cluster heads also serves as a means of fault tolerance [1]. The sensors organize themselves into clusters using a probabilistic method to randomly elect themselves as heads in an epoch. However, one shortcoming of the LEACH protocol is that it is not suitable for heterogeneous environment, i.e. when there is a difference in energy to some threshold between these nodes in the network, the sensor nodes, die out faster than in a more uniform energy setting [12]. In DEEC (Distributed Energy- Efficient Clustering algorithm) [10], similar to LEACH, a probability based node clustering algorithm has been proposed. DEEC elects cluster heads on the basis of the information of the ratio between residual energy remaining of each nodes after each round and the average energy of the network. This knowledge however requires some additional information like energy consumption to

be shared among the sensor nodes. Stable Election Protocol (SEP) [12] is a heterogeneity aware clustering protocol. SEP does not require nodes to sharing energy knowledge but it works on the basis of assigning weighted election probabilities of every node to be elected cluster head, as per their respective energy. This approach ensures that the election of cluster head is randomly done and is distributed on the basis of fraction of energy of every node thereby ensuring a uniform use of the nodes energy. H-DEEC and MH-DEEC [17] are routing protocols which have been proposed as energy aware adaptive clustering protocols for heterogeneous networks. In H-DEEC protocol, the division of network takes place on the basis of initial energy and residual energy. Normal nodes elect themselves as cluster heads and beta nodes collect data from cluster heads and send it to Base station using multi-hopping. H-DEEC and MH-DEEC are found to perform better in a heterogeneous wireless sensor network as compared SEP and DEEC. Moreover, it also considers the problem of locating base station outside the network.

III. Mathematical Model

The first order radio model is used in many researches on wireless sensors networks. Energy dissipation takes place, while transmitting and receiving the data and energy consumption for short distance communication is ' d^2 ' when propagation is done in line of sight and ' d^4 ' when transmission is done for the long distance due to multipath fading propagation. It works on the route measurements and sensing takes place constantly resulting in steady volume of data being transmitted to the sink. The following assumptions are considered in an analytical implementation:

- 1) Base station remains fixed: Wireless sensors are densely populated in the network area and are static. Number of clusters according to the network is predetermined for the network. The nodes will pass the data on the predefined paths, in which clusters and the cluster heads are numbered according to the distance based on received signal strength.
- 2) Some sensors are located farther away from the base station due to which, the cluster head will consume the ' d^4 ' energy for transmitting 1 bit data for direct transmission. Thus, data is transmitted through multiple hops and finally reach the base station by clusters very near to the base station
- 3) Links in the path are symmetric i.e. same power is required for the communication between any two nodes. No changes in the topologies and the loads are considered.

Thus, to transmit a message of length to a distance d , the energy is given as:

$$d_0 = \sqrt{E_{mp}/E_{fs}} \quad (1)$$

if $d < d_0$

$$E_{tx}(k,d) = E_{elec} * k + E_{mp} * k * d^4 \quad (2)$$

if $d \geq d_0$

$$E_{tx}(k,d) = E_{elec} * k + E_{mp} * k * d^4 \quad (3)$$

Reception Energy:

$$E_{rx}(k) = E_{elec} * k \quad (4)$$

where E_{elec} is the energy dissipated in transmission and reception, E_{fs} and E_{mp} are free space and amplifier energy respectively.

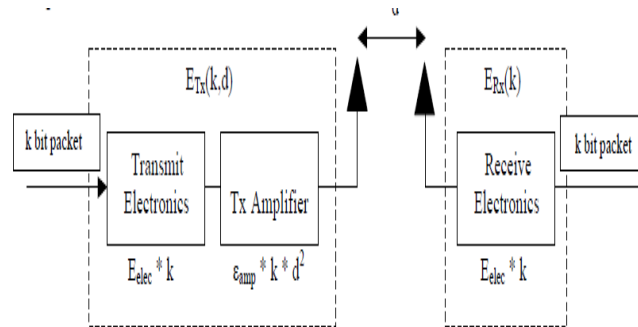


Figure 1: First Order Radio Model

The above diagram shown in figure 1 shows a pictorial representation of a first order radio model. The transmitter and receiver use the same kind of electronic circuitry and thus their energies are accumulated as E_{elec} , for each data bit transmitted. The sensor nodes are thus symmetric to each other.

IV. Proposed Work

The proposed work is based on the geographical knowledge of the network area. The network area consists of homogenous sensor nodes are used that are distributed randomly in the network area. After employment of nodes, every node forwards its location to the base station. The base station calculates the distance of each node and save all information of the sensor nodes into the node data table. The node data table consists of distinctive node ID, Residual energy of node, and its distance to the BS and gateway node. The same topology is being used in this proposed work. The below sections gives a detailed description of various phases in the deployment of the network and its operational characteristics.

Set Random Position of nodes:

- Set Position of gateway node:
At the center of Network area.
X-co-ordinate- $M/2$, Y-Co-ordinate- $M/2$;
- Set Position of Base Station:
X-Co-ordinate- $M/2$; Y-Co-ordinate- $M+M/10$;
- Calculate Distances of each nodes from base station and gateway node.

Set up Phase:

Network Division:

- Set Threshold Distance for selection of nodes in a particular zone:
 $d_0=87$;
- Define the four zones:

Zone1	$nz1=(d_{BS} \leq d_0). *id$
Zone2	$nz2=(d_{GS} \leq d_0). *id$
Zone3	$nz3=(y \geq y_g \ \& \ d_{BS} > d_0). *id$;
Zone4	$nz4=(y < y_g \ \& \ d_{GS} > d_0). *id$

Define fringe Nodes:

- If node is in zone 2 and node dist in zone1=nodedist in zone2 and not zero
Then node dist=0;
- If node is in zone 3 and node dist in zone1=nodedist in zone3 and not zero
Then node dist=0;
- If node is in zone 3 and node dist in zone2=nodedist in zone3 and not zero
Then nodedist=0;
- If node is in zone 4 and node dist in zone4=nodedist in zone2 and not zero
Then nodedist=0;

Running Phase:

- Initially every node has probability to be elected has cluster head.
- Initialize the rounds. Simulation is carried out for 7000 rounds.
- The selection Probability is given as:
- $T=p/(1-p*\text{mod}(r,1/p))$
- where T is threshold probability, p = the desired percentage of CHs and r = the current round, C = set of nodes not elected as CH in current round.
- Calculate node distance to cluster head.
- For every round calculate energy and threshold for cluster head selection.

V. Simulation Results

The proposed work was implemented using the MATLAB R2010a software tool, using standard network parameters, as shown in Table 1. The various graphs related to network simulation are plotted.

The division of network area into various zones is as shown in the figure 2. The red colour circles show nodes in Zone1, the blue colour circles marks the nodes in Zone 2, the black colour circles denote the nodes in Zone 3, which can be further said as Zone 3a, which lies to the left of gateway node and Zone 3b, which lies to the right of the gateway node. Similarly, the green colour circles denote the nodes belonging to the Zone 4, and accordingly divided as Zone 4a and Zone 4b respectively based on the whether they lay to the left of the gateway node or to the right of

the gateway node. The base station is shown by the square box in figure 2, while the gateway node is demarcated by an asterisk '*'.

Table1: Simulation parameters

Parameters	Values
Network Area	200m
Threshold distance, d_0	$\sqrt{E_{fs}/E_{mp}}$
Energy consumed in the electronics circuit to transmit in or receive the signal, E_{elec}	50 nJ/bit
Energy consumed by the amplifier to transmit at a short distance, E_{fs}	10 pJ/bit/m ₂
Energy consumed by the amplifier to transmit at a longer distance, E_{mp}	0.0013 pJ/bit/m ₄
Data Aggregation Energy, EDA	5 nJ/bit/signal
Message Size	4000 bits
Initial Energy, E_0	0.5 J

Figure 2: Logical division of Network Area

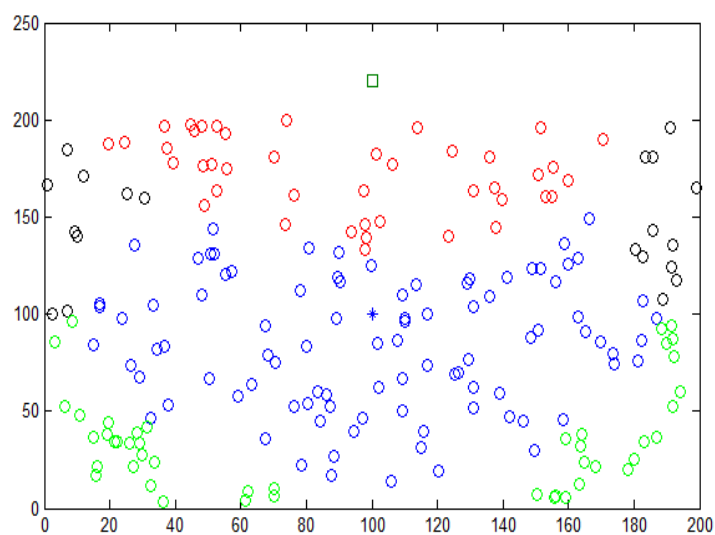


Figure 3: Number of Alive Nodes vs Rounds

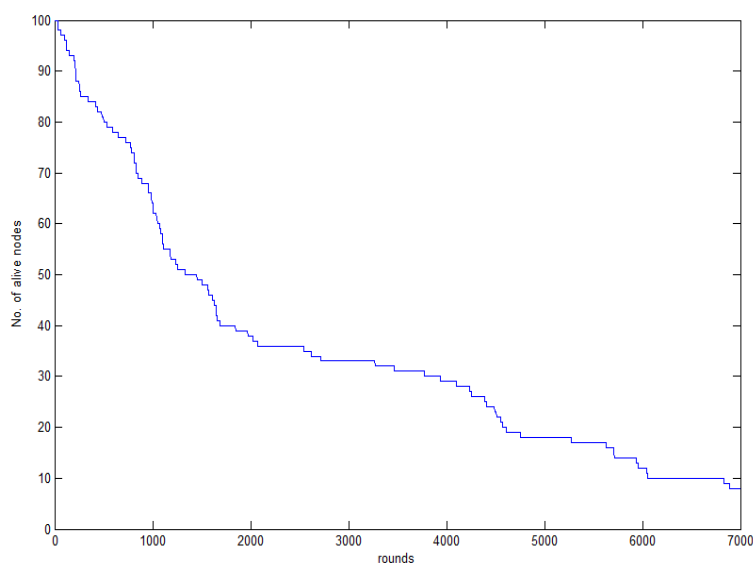
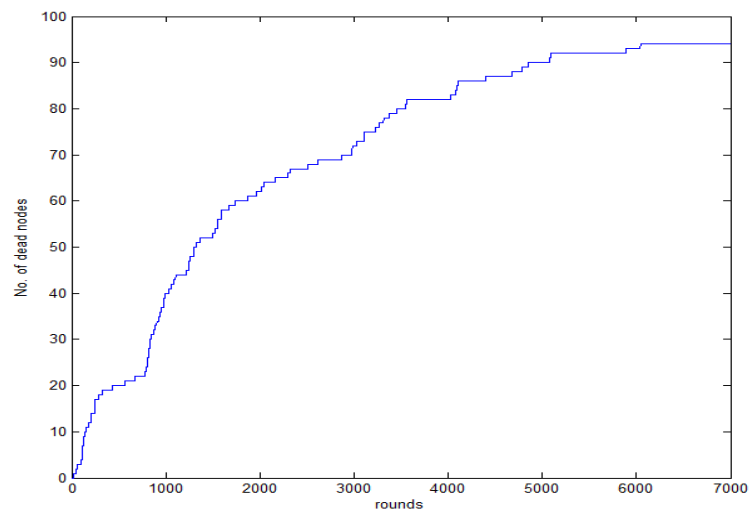


Figure 4: Number of Dead Nodes vs Rounds



The above Figure 3 and Figure 4 shows the various simulation results for 7000 rounds. As shown from the figure 3 and figure 4, the method shows a considerable improvement in the network lifetime. The figure 5 and figure 6 shows an indication of packets of data transmitted between Cluster head by nodes and cluster heads to base station respectively. There are a sufficient number of alive nodes and dead nodes are fewer, after simulating to 7000 rounds which proves for the energy efficiency of the proposed method.

Figure 5: Packets sent to Cluster Head by Nodes vs Rounds

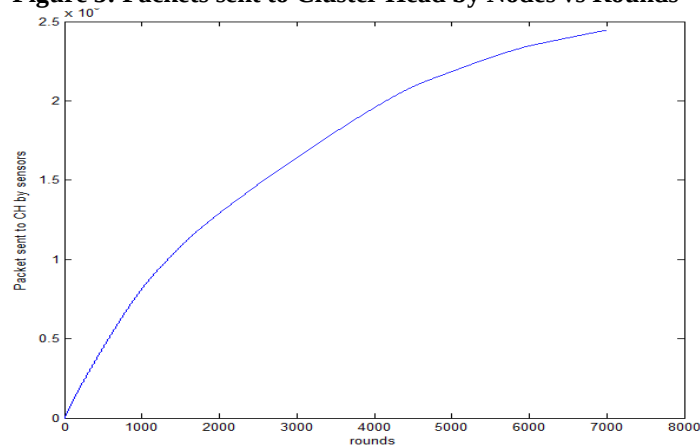
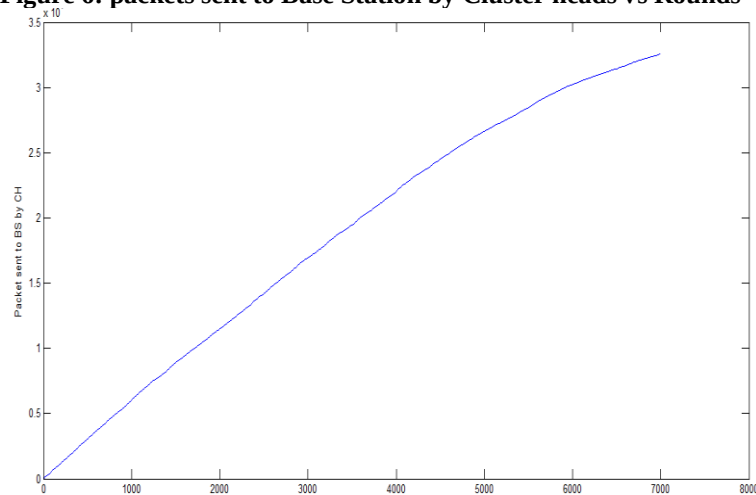


Figure 6: packets sent to Base Station by Cluster heads vs Rounds



V. Conclusion

This research work focusses on implementing a gateway based routing protocol which is an improvement over recent clustering based protocols. LEACH which stands for Low Energy Adaptive Cluster Head protocol has been proposed by Hienzelmann in 2002. It has shown considerable improvement in terms of network lifetime and energy efficiency as compared to other methods and protocols being used in Wireless Sensor Networks having fixed power sensor nodes. In this research work, a novel algorithm which takes inheritance from gateway based protocol has been used in which apart from base station, an additional gateway node is present. Further, the network area is logically divided into several zones, on the basis of their relative positioning from the gateway node. The protocol has been implemented in MATLAB software with standard network parameters and simulation shows improved results in terms of number of dead nodes, number of alive nodes and the packets transferred. The simulation has been carried out to 7000 iterations and still the some of the nodes show activity. Even after 7000 thousands rounds out of total of initial 100 nodes 10 remain (i.e. almost 90 dead nodes). Thus, network lifetime has increased appreciably.

References

- [1] A. Haider, et. al,(2014), "REECH-ME: Regional Energy Efficient Cluster Heads based on Maximum Energy Routing Protocol with Sink Mobility in WSNs" , *J. Basic. Appl. Sci. Res.*, 4(1)200-216, 2014.
- [2] K. Sohrabi, et al, (October 2000) "Protocols for self-organization of a wireless sensor network," *IEEE Personal Communications*, Vol. 7, No. 5, pp. 16-27.
- [3] R. Min, et al., (January 2001), "Low Power Wireless Sensor Networks," *International Conference on VLSI Design, Bangalore, India*.
- [4] J.M. Rabaey, et al., (July 2000), "PicoRadio supports ad hoc ultra low power wireless networking," *IEEE Computer*, Vol. 33, pp. 42-48.
- [5] R. H. Katz, J. M. Kahn and K. S. J. Pister, (August 1999), "Mobile Networking for Smart Dust," *5th Annual ACM/IEEE International Conference on Mobile Computing and Networking (MobiCom '99)*, Seattle, WA.
- [6] F.Akyildiz,W.Su,Y.Sankarasubramaniam,E.Cayirci, (Dec 2002), "Wireless Sensor Networks:A survey", *Elsevier science B.V*.
- [7] Shio Kumar Singh, M P Singh and D K Singh, (August 2010), "A Survey of Energy-Efficient Hierarchical Cluster-Based Routing in wireless Sensor Network," *Int J. of Advanced Networking and Applications Volume:02, Issue:02, Pages:570-580*.
- [8] Abbasi, A.A.; Younis, M. A survey on clustering algorithms for wireless sensor networks. *Comput. Commun.* 2007, 30, 2826–2841.
- [9] Lindsey S. and Raghavendra C., "PEGASIS: Power-Efficient Gathering in Sensor Information Systems, in *Proceedings of IEEE Aerospace Conference*, vol. 3, pp. 1125- 1130, 2002.
- [10] N. Israr and I. Awan. Multihop clustering algorithm for load balancing in wireless sensor networks.University of Bradford, UK.
- [11] Arati Manjeshwar, Agrawal and D.P., "TEEN: A Routing Protocol for Enhanced Efficiency in Wireless Sensor Networks" *Proceedings 15th International on Parallel and Distributed Processing Symposium*, 2000.
- [12] Akshay, N.Kumar, M.P., Harish, B. and Dhonarkar and S., "An efficient approach for sensor deployments in wireless sensor network" *International Conference on in Robotics and Communication Technologies (INTERACT)*, 2010.
- [13] Z. Chaczko, R. Klempous, J. Nikodem and M. Nikodem, "Methods of Sensor Localization in Wireless Sensor Networks" *14th Annual IEEE International Conference and Workshops on the Engineering of Computer-Based Systems, ECBS '07*, 2007.
- [14] Javaid, N.Ullah, M.Djouani, K., "Identifying Design Requirements for Wireless Routing Link Metrics," *Global Telecommunications Conference (GLOBECOM 2011)*, 2011 IEEE , vol., no., pp.1,5, 5-9 Dec. 2011.
- [15] N. Javaid, A. BiBi, K. Latif and M. Ishfaq, "Investigating Quality Routing Link Metrics in Wireless Multihop Networks" *Springer's Annals of Telecommunications*, 2013
- [16] Javaid, N., Bibi, A. Khan, Z. A.,Djouani, K., "On using multiple quality link metrics with Destination Sequenced Distance Vector protocol for Wireless Multi-hop Networks," *Electrical & Computer Engineering (CCECE)*, 2012 25th IEEE Canadian Conference on , vol., no., pp.1,4, April 29 2012-May 2 2012.
- [17] M. Y. Khan, N. Javaid, M. A. Khan, A. Javaid, Z. A. Khan, U. Qasim, "Hybrid DEEC: Towards Efficient Energy Utilization in Wireless Sensor Networks", *World Applied Sciences Journal* 22 (1): 126-132, 2013.