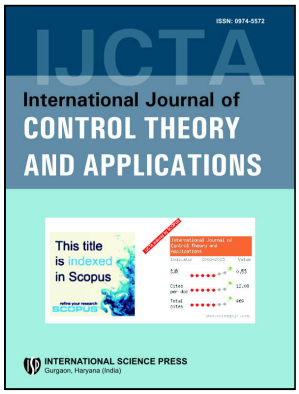

International Journal of Control Theory and Applications

ISSN : 0974-5572

Volume 10 • Number 13 • 2017

Enduring Energy Based Clustering Algorithm for Wireless Sensor Network

Sachi Pandey[1], Rajendra Prasad Mahapatra[1] and Vishal Goar[2]

[1] Department of Computer Science and Engineering SRM University, Modinagar, Uttar Pradesh, India, Emails: sachipandey.231@gmail.com, mahapatra.rp@gmail.com
[2] Department of Computer Application Government Engineering College, Bikaner, Rajasthan, India, Email: dr.vishalgoar@gmail.com

Abstract: Reducing the energy consumption of the nodes in the network is one of the most important issues for routing the packets in wireless sensor networks because there is limitation of batteries in the sensors. This manuscript presents an energy efficient base clustering algorithm called EERP to achieve optimum value of energy consumption, reliability, network lifetime and reach-ability. The focus is on cluster head selection phase where Cluster Head (CH) plays a very important role in clustering algorithm. This algorithm first selects the CH depending upon its energy level as well as its degree. If the cluster head has the high energy level, then network reach-ability and life time will be increased. For sending data from CH to sink node, we are routing the packets through the nodes which has the enough energy to transmit the complete packets. Thus it results that the network reach-ability and life-time will be increased. Finally, mobile and static wireless sensor network environment was evaluated with respect to the quality parameters of the packet delivery fraction, packets drop and throughput. By analyzing the results, we can prove that our proposed algorithm EERP performs successfully when compared to other traditional energy efficient algorithms.

Keywords: Wireless Sensor Network (WSN), Cluster Head (CH), Energy Efficient Based Clustering Algorithm (EERP)

1. INTRODUCTION

Wireless sensor network is generally used in military areas, health monitoring and in mines etc. The key features of these application systems are that the mobile nodes in each group may move together or separately by turn. Members within a group are under the control of a CH and have similar move patterns in terms of velocity and moving direction. By considering many energy conditions of large number of deployed sensor nodes, it needs a proper network protocols for employing network control and management functions [13]. The conventional routing protocols have many disadvantages when it is implemented in mobile WSNs, which is due to energy constrains nature of such networks. The flat protocols may be an ideal solution for a small network with stable nodes. However, in a large network they become infeasible because of link and processing overhead. So, the location based protocols is helpful for dynamic networks as there is no need of information about the state in

routers, in packet header. And it will not create the flood in the search. To calculate the distance between the nodes, they need the location information. Thus it will minimize the energy consumption and increase the lifetime of the network [14].Existing cluster-based mobile routing protocols consider only the energy efficiency of the sensor nodes. So in all the cluster based protocols, some delay and high energy consumption occurs while selecting the alternate Cluster Head (CH) or the re-clustering , thus results in the minimal lifetime of the network [3].

Further in most of the protocols the node mobility and proper location management scheme are not considered properly for the re-clustering which results in high energy consumption and extra delay. Some of the existing protocols are location-aware, energy efficient and reliable. But they do not consider other features such as variable timeslots duration for nodes at different clusters to reduce the end-to-end delay and they consider that once a node with the least mobility factor is selected as a CH, then the CH will not move out of the cluster in the current round. The main objective of this research paper is to design an energy efficient based clustering algorithm for mobile wireless sensor network. EERP is used to achieve optimum value of following parameters energy consumption, Reliability and reach-ability. Mobile and static wireless sensor network environment was compared with respect to the quality parameters of the packet delivery fraction, packets drop and throughput. All parameters in mobile wireless sensor networks have better performance than static wireless sensor networks using EERP algorithm in the considered scenarios.

2. CLUSTER BASED ROUTING IN WSN

To maintain data aggregation with efficient network organization, nodes can be divided into number of small groups called clusters. This trend of grouping sensor nodes into clusters is known to be clustering. Every cluster will have a leader, commonly referred to as Cluster Head (CH). The selection of CH is done by the sensor nodes in the cluster or pre-allocated by the network designer [7][4]. The CH is nothing but a sensor in the network which has high resource. The members in the cluster either fixed or variable [8]. However, clustering in WSNs presents several challenges, as described below.

i. It is necessary to alternate the responsibility of CH among them in the cluster, to equalize the energy consumption of the sensors.

ii. The number of clusters must be adjusted according to several factors, including the current network topology and the enduring energy of the sensors.

iii. Sensors should not expend excessive energy on intra cluster communications [9].

Merits of Clustering Phenomenon:

- Clustering can pin point the route setup within the cluster and supports network scalability [10].
- Clustering can also conserve communication bandwidth.
- The network topology will become stable at the level of sensors due to clustering.
- CH can also be used to optimize the management approach to prolong the battery life and to increase the lifetime of network.
- In the cluster, the CH will accumulate the data collected by the sensors [8].

Almost in all the hierarchical or cluster based protocols in the literature, some delay and high energy consumption occurs while selecting the alternate Cluster Head (CH) or the re-clustering .thus results in the minimal lifetime of the network [3]. Further in most of the protocols the node mobility and proper location management scheme are not considered properly for the re-clustering which results in high energy consumption and extra delay. Some of the existing protocols are location-aware, energy efficient and reliable[7].

3. PROPOSED ALGORITHM

The clusters are formed based upon two parameters

1. Degree of node
2. Energy of node

Degree of a node is defined as the total no of nodes in the range of a node. Suppose node 0, 1, 2 are in the range of node 3 then degree of node 3 will be 3.

3.1. ALGORITHM

This Energy efficient based clustering algorithm has three phases.

1. Network Formation
2. Cluster Formation
3. Re-Clustering

3.2. Network Formation phase

The formation of complete wireless sensor network is done in this phase by the following steps.

1. By deciding what will be the area of network according to no. of nodes, Create the layout of network.
2. Create sensor nodes.
3. Set the initial positions of nodes. i.e. X and Y co-ordinates of the node, So that network will be uniformly distributed.
4. Set the initial energy of each node.
5. Node Enable (NE) is the variable attached to each node. Set NE of each node to 1. If NE of a node is 1 it means that node is eligible for clustering and if NE of a node is 0 it means that node is already a part of any cluster, so that node will not be considered in clustering.

3.3. Cluster Formation phase

In this phase, we need to carry on **CH selection, Member node selection and time allocation to member nodes.**

1. Calculate distance between each node to the all other nodes. Suppose there are 50 nodes in the network then node 1 will calculate its distance from all other nodes i.e. (2 to 50 nodes), like-wise node 2 will calculate its distance from all other nodes in the network.

   For calculating the distance we have used Pythagoras theorem.

   Let assume

   the co-ordinates of node 1 is (x1, y1)

   node 2 is (x2, y2)

   then distance between these two nodes will be.

   $$\text{Distance} = \text{sqrt}\ (\ (x1-x2)\text{^}2 + (y1-y2)\text{^}2\ )$$

2. If the calculated distance is less than 250 meters and Node_Enable of that node is 1 then degree of node will be incremented by 1. This same is to be performed for entire network.

3. The node having maximum energy, degree greater than 1 and remaining energy is greater than 100Joules i.e. threshold, will become CH.
4. Set Node_Enable of that CH as 0.
5. All nodes which are in the range of above CH will become their member node, and their corresponding Node_Enable will be 0.
6. CH will allocate time slots to each of its member to send their data to CH.
7. Step 1 to 6 will be repeated till all clusters are formed in network.
8. After the formation of cluster, all member nodes will start transmitting their sensed data to their corresponding CH in the given time slot.

3.4. Re-Clustering Phase

1. If energy of any cluster head (CH) is below the threshold value i.e. 100Joules.
2. Then that cluster will be destroyed.
3. Now all member nodes will check for the nearest cluster.
4. If that node is in the range of another cluster then it will join the cluster.
5. And remaining node that is not in the range of any cluster, they will form clusters among themselves.

4. NETWORK METRICS FOR PROPOSED ALGORITHM PERFORMANCE

4.1. Packets Delivery Fraction

Packet delivery fraction is the ratio of total number of data packets delivered successfully to intended destinations to the total number of data packets generated.

Formula:
PDR = Total no. of packets received / Total no. of packets sent

4.2. Packets Drop

Amount of packets dropped between the nodes due to traffic congestion and overloading in the network.

Formula:
Packet Drop = No. of packets sent - No. of packets received

4.3. Network Throughput

It is used to calculate the average throughput of the application traffic between the nodes. The time taken for a packet to travel from source to destination, when it reaches the destination that particular time is said to be throughput.

Formula:
Network Throughput = Total no. of bites received / Time duration

5. EXPERIMENT AND RESULT

The mannasim Framework is the element for WSN simulation based on the network simulator (NS-2). Mannasim extends NS-2 by introducing some of the new modules for design, development and analysis of different WSN

applications. Its objective is to develop a detailed simulation framework, which can model different sensor nodes and applications by providing a versatile testbed for the protocols.

MWSN Simulator proved that the proposed algorithm is more effective. During the simulation, the simulated network consisted of varies number of nodes that are randomly scattered in a given area.

Table 1
Simulation Parameters

Parameters	*Values*
Number Of Sensor Nodes	50,60,70,80,90,100
Area Size	3400* 2000
Radio Propagation Model	Two Ray Ground
Transmit Power	1 Watt
Receiver Power	1Watt
Idle Power	0.01J
Initial Energy	1000 J
Communication System	MAC/802_11
Routing Protocols	NOAH

Table 1 shows the simulation parameters for analyzing the protocol using EERP algorithm. The result is obtained by using the NS-2 simulation tool.

In figure 1, figure 2 and figure 3 the simulation results reveal that mobile wireless sensor networks is better than static wireless sensor networks.

In mobile wireless sensor network, the ratio of total no of data packets that delivered successfully to the intended destination so the Packet delivery fraction in the mobile wireless sensor networks is high when compared to static wireless sensor networks using EERP in the considered scenarios. PDF increases with an increase in the number of nodes for both static and dynamic EERP. As far as throughput is concerned, large no of bites are

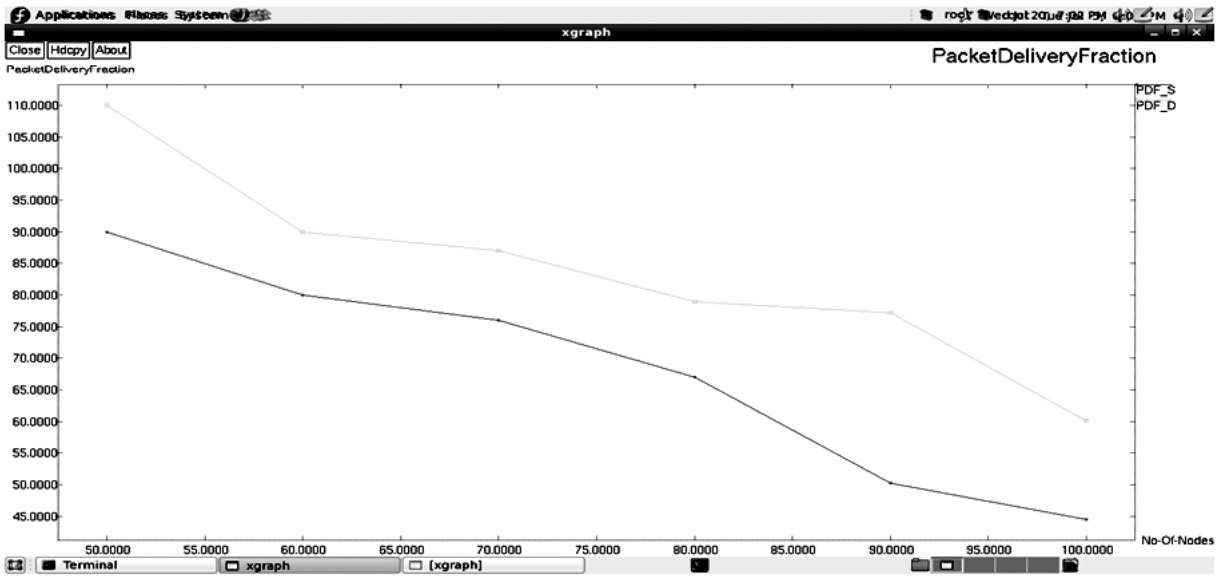

Figure 1: Comparison of Packets Delivery Fraction versus no. of nodes between Static and Mobile wireless sensor network.

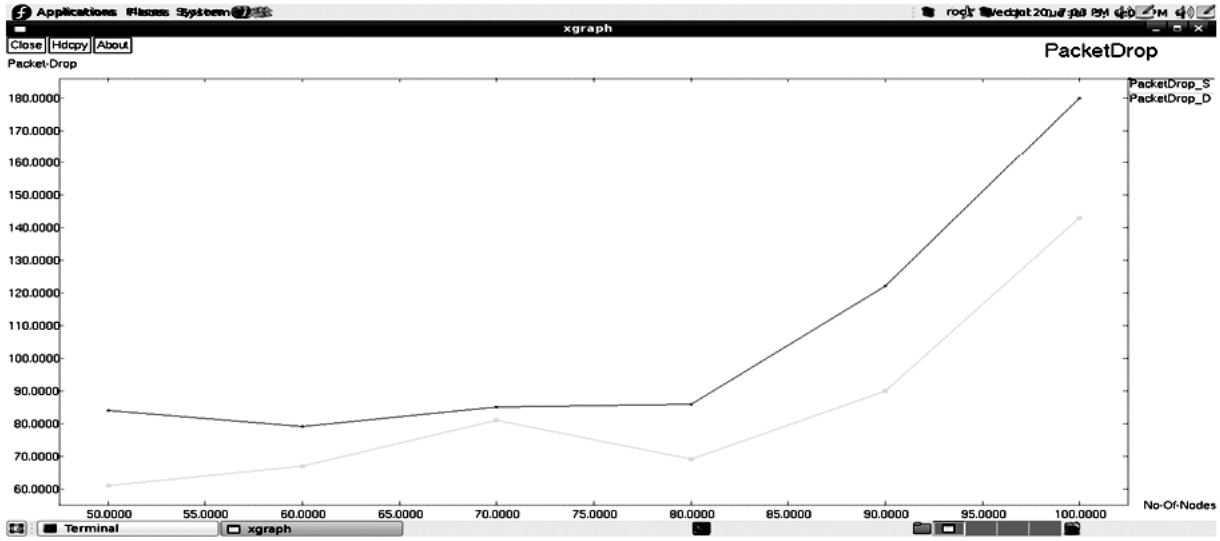

Figure 2: Comparison of Packets Drop versus no. of nodes between Static and Mobile wireless sensor network.

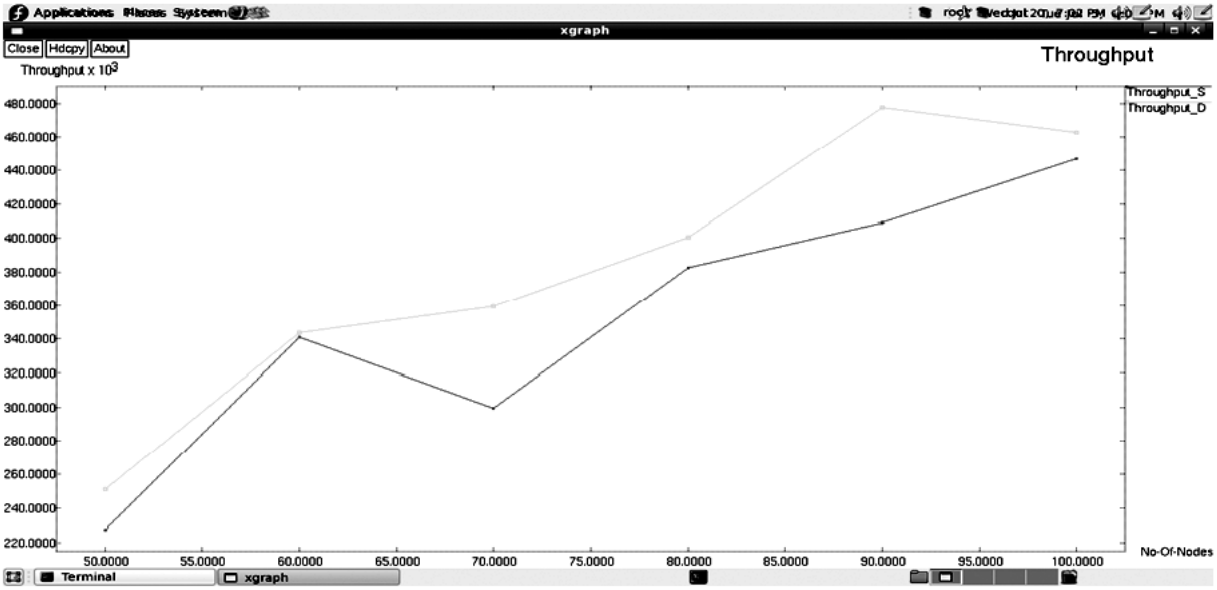

Figure 3: Comparison of Throughput versus no. of nodes between Static and Mobile wireless sensor network.

received in the destination within the given time. And when the no of nodes in the network is increased is also increased. So mobile wireless sensor networks performs far better when compared to static wireless sensor networks using EERP. Also in packet loss, mobile wireless sensor networks using EERP has better performance that it will loss only few number of packets when node is increased in comparison to static wireless sensor networks using EERP in the considered scenarios.

6. CONCLUSION

EERP is used to achieve optimum value for energy consumption, network life-time, Reliability and reach-ability. Mobile and static wireless sensor network environment was compared with respect to the quality parameters such as packet delivery fraction, packets drop and throughput. All parameters in mobile wireless sensor networks have better performance than static wireless sensor networks using EERP in the considered scenarios. By analyzing

the results, we can prove that our proposed algorithm EERP performs successfully when compared to other traditional energy efficient algorithm. Reducing the energy consumption of the nodes in the network is one of the most important issue for routing the packets in Wireless sensor networks because there is limitation of batteries in the sensors. In Future, we will propose a new GSA Algorithm based routing technique that uses special parameters in its capability function for reducing energy consumption of network nodes. We plan to extend the algorithm to increase the efficiency of the system, obtain fair transmission among the nodes and reduce the energy consumption of the routing, and extend the network lifetime.

REFERENCES

[1] Sachi Pandey and R.P Mahapatra, , "A Centralized comparison of Energy Efficient Routing Protocol For Mobile and Static Wireless sensor Network ", Proceedings published in International Conference on Intelligent Computing, Communication and Convergence (ICCC 2015), ELSEVIER, 2015.

[2] F. Xiao, X. Yang, L. Sun, R. Wang, and X. Tang, "Node selection approach for data compression in wireless multimedia sensor networks," J. Beijing Univ. Posts Telecommun., vol. 39, no. 2, pp. 15–19, Feb. 2016.

[3] P. Gope and T. Hwang , " A realistic lightweight anonymous authentication protocol for securing real-time application data access in wireless sensor networks ," IEEE Trans. Ind. Electron. , vol. 63 , no. 11 , pp. 7124 – 7132 , Nov. 2016 , doi: 10.1109/TIE.2585081 .

[4] A. Chatterjee and P. Venkateswaran , " An efficient statistical approach for time synchronization in wireless sensor networks," Int. J. Commun. Syst. , vol. 29 , no. 4 , pp. 722 – 733 , Mar. 2016 .

[5] S. Ulukus et al., "Energy harvesting wireless communications: A review of recent advances," IEEE J. Sel. Areas Commun., vol. 33, no. 3, pp. 360–381, Mar. 2015.

[6] Nikolaos A. Pantazis, Stefanos A. Nikolidakis and Dimitrios D. Vergados ,"Energy-Efficient Routing Protocols in Wireless Sensor Networks: A Survey", in IEEE COMMUNICATIONS SURVEYS & TUTORIALS, VOL. 15, NO. 2, SECOND QUARTER 2013.

[7] Xiao Chen, Zanxun Dai, Wenzhong Li, And Hongchi Shi,"Performance Guaranteed Routing Protocolsfor Asymmetric Sensor Networks", in IEEE TRANSACTIONS ON EMERGING TOPICS IN COMPUTING, 1 April 2013; revised 25 June 2013; accepted 29 June 2013. Date of publication 18 July 2013.

[8] E.Ever, R. Luchmun, L. Mostarda, A. Navarra and P. Shah," UHEED - An Unequal Clustering Algorithm for Wireless Sensor Networks", In Proceedings of the 1st International conference on sensor networks (SENSORNETS 2012). Rome, Italy February 24-26 2012.

[9] Alejandro Ribeiro, Ioannis D. Schizas, Stergios I. Roumeliotis and Georgios B. Giannakis, "Kalman Filtering in Wireless Sensor Networks Reducing Communication Cost in State-Estimation Problems', IEEE Control Systems Magazine, April 2010.

[10] G.Suresh Kumar and V.Rajamani, "Energy efficient Multi-Target Tracking in Wireless Sensor Networks with accuracy", Proceedings published in International Journal of Computer Applications (IJCA), National Conference on Advances in Computer Science and Applications with International Journal of Computer Applications (NCACSA 2012) , 2012.

[11] S. Liu, A. Vempaty, M. Fardad, E. Masazade, and P. K. Varshney, "Energy-aware sensor selection in field reconstruction," IEEE Signal Process. Lett., vol. 21, no. 12, pp. 1476–1480, Dec. 2014.

[12] Bin Zan, K.K. Kashyap, Zhenhua Feng, Fei Hu and Sunil Kumar, "An energy-aware and intelligent cluster-based event detection scheme in wireless sensor networks", 2nd IEEE Upstate NY Workshop on Communications and Networking, Rochester, NY, November 18, 2005.

[13] http://www.isi.edu/nsnam/ns/

[14] Daisuke Takaishi , Hiroki Nishiyama, Nei Kato, and Ryu Miura," Towards Energy Efficient Big Data Gathering in Densely Distributed Sensor Networks", in IEEE Transactions on Emerging Topics in Computing, DOI 10.1109/TETC.2014.2318177.

[15] Shivashankar, Suresh H.N,, Varaprasad Golla, , Jayanthi G ," Designing Energy Routing Protocol with Power Consumption Optimization in MANET ", in IEEE Transactions on Emerging Topics in Computing, DOI 10.1109/TETC.2013.2287177

[16] Huang Lu, Jie Li, and Hisao Kameda, "A Secure Routing Protocol for Cluster-based Wireless Sensor Networks Using ID-based Digital Signature", IEEE Global Telecommunications Conference (GLOBECOM 2010), 6-10, Dec. 2010.

[17] Pu-Tai Yang and Seokcheon Lee, "A Distributed Re-clustering Hierarchy Routing Protocol Using Social Welfare in Wireless Sensor Networks", International Journal of Distributed Sensor Networks, Hindawi Publishing Corporation, Volume 2012, Article ID 681026, 2012.

[18] Shio Kumar Singh, M. P Singh and D. K Singh, "A Survey of Energy-Efficient Hierarchical Cluster-Based Routing in Wireless Sensor Networks", International Journal of Advanced Networking and Applications, Volume: 02, 2010.

[19] Qiang Gao, Yi Zuo, Jun Zhang, and Xiao-Hong Peng, "Improving Energy Efficiency in a Wireless Sensor Network by Combining Cooperative MIMO With Data Aggregation", IEEE Transactions On Vehicular Technology, Vol. 59, No. 8, October 2010.

[20] Chakib Bekara, Maryline Laurent Maknavicius and Kheira Bekara, "SAPC: A Secure Aggregation Protocol for Cluster-Based Wireless Sensor Networks", Proceedings of the 3rd international conference on Mobile ad-hoc and sensor networks (MSN'07), Springer-Verlag Berlin, Heidelberg, 2007.