Research Journal of Computer and Information Technology Sciences _____ISSN 2320 – 6527
Vol. **5(4),** 1-5, June **(2017)** *Res. J. Computer and IT Sci.*

Comparative analysis of centralized and distributed clustering algorithm for energy- efficient wireless sensor network

Swati Dewangan[1*] and S.D. Mishra[2]
[1]Bhilai Institute of Technology, Durg (CG), India
[2]Department of Computer Science and Engineering, Bhilai Institute of Technology, Durg (CG), India
swatidwngn789@gmail.com

Available online at: www.isca.in
Received 10th April 2017, revised 15th June 2017, accepted 20th June 2017

Abstract

There has been an enormous growth in the wireless communication systems involving real time applications of sensor enabled devices. For developing an energy-efficient, reliable and scalable Wireless Sensor Networks, clustering is adopted as an optimal solution. Clustering mechanism is broadly classified into two categories i.e. centralized and distributed manner. In this paper, we investigate the performance of both centralized and distributed clustering algorithm. The energy consumption is considered as key performance indicator to differentiate both of them. Simulation results shows that distributed clustering outperforms over centralized clustering.

Keywords: Centralized clustering, Distributed clustering, Energy-efficient, Network lifetime, Residual Energy, Wireless Sensor Network.

Introduction

Wireless Sensor Network (WSN) involves deployment of multiple small, low powered sensing units called sensor nodes and a Base Station (BS). The sensor nodes have sensing, mobilizing, computing and data communication capabilities. These are the devices that are capable of sensing any physical parameters such as pressure, weight, temperature, electrical radiations etc. from the surroundings in which they are deployed in[1]. Then they communicate the sensed information either directly or indirectly to the BS. The BS in turn forwards the data to the end user to serve numerous applications.

Constraints in WSN include energy consumption, mobilization, load balancing, cluster maintenance and many others. Of these, effective utilization of energy is the major issue[2]. Each sensor node depends on its battery for power supply which gets depleted with each network task they perform. The nodes are irreplaceable once deployed in the sensing field. Therefore, it is necessary that very less amount of energy should be consumed by them while performing the network operations.

Also, the data communication task which is more energy consuming process should be well controlled and the redundant operations should be cancelled out[3]. The main goal of WSN is to collect raw data from the field by employing efficient use of constraint resources and prolonging network lifetime. To fulfil these goals different protocols have been proposed by researchers. Majority resulted with Clustering technique as an effective approach.

This paper focuses on the two major forms of clustering i.e. centralized and distributed clustering and analysing their performance from the graphical results. For comparison of both clustering techniques more emphasis is given on finding the number of nodes that may remain alive and the remaining energy levels of those node on simulating both for same interval of time.

This paper is structured as follows: Section II explains types of Clustering Techniques. Section III presents a brief literature survey. Section IV discusses the proposed work. Section V explains the simulation results. Section VI gives conclusion of the work.

Clustering techniques

It involves the division of nodes of the network into groups called clusters and from each cluster a node is selected as Cluster Head (CH) as the cluster representative. There are two categories for clustering: centralized and distributed[4].

Centralized clustering: Centralized clustering involves selection of the CH in each cluster by the central BS. The BS selects the CH on the basis of varying parameters such as hop count, node type, remaining energy, and minimum distance from the BS, etc. This CH is static for the complete network lifetime. Thus, for every cluster there is pre-defined CHs that performs data aggregation and forwarding tasks[5].

Distributed clustering: Distributed Clustering involves the selection of CH in each cluster independent of any other nodes in the network. The node that matches higher to the specified parameters becomes the CH. After certain interval of time when another member node in a cluster becomes more eligible to form

CH, it forms the CH on its own. And the previously elected CH acts as normal member node. There is dynamic CH election and thus each node gets an equal chance to become the CH[6].

Literature Review

Here the brief emphasis on some of the research related to our proposed work is given.

Shubhi et al.[7] presented LEACH-C and LEACH algorithms that are centralized and distributed respectively. Each has its own advantages and disadvantages. Centralized technique is energy-efficient since the number of CHs are known. Distributed approach is mainly adopted while designing large scale WSN. Performance of LEACH-C and LEACH varies on the basis of placement of BS at locations far or near to the sensor nodes.

Shigei et al.[8] proposed centralized and distributed clustering algorithms for WSNs. Of them, the first uses quantization method to enhance energy consumption. The network is divided into small vector sets from which the CH is chosen by the BS. Second approach is based on remaining energy and density of nodes for selection of CH independent of the other nodes. The lifetime of these algorithms is better than that of LEACH and HEED algorithms.

Waraich et al.[9] presented a survey on various clustering algorithms for WSN developed to improve the network lifetime. It is found that asynchronous clustering algorithms involves use of residual energy for periodic selection of CH. On the other hand, synchronous centralized clustering algorithms uses distance and connectivity as a primary parameter for fixed CH selection by the central BS. The synchronous algorithm has more time complexity than that of asynchronous clustering protocols.

K. Wankhede et al.[10] presented the differences between centralized and distributed clustering methodologies. The basic functioning of both the algorithm is discussed. And the advantages and limitations of each considered algorithms are tabulated. The study of these algorithms directs in designing a less complex energy-efficient routing algorithm.

Simulation of centralized and distributed clustering

The aim is to compare the centralized and distributed clustering and examine among the two the more stable and effective approach to develop an energy-efficient routing algorithms. On simulating the two clustering methods and then for both the methods, we compute the graph of the residual energy of each node and the number of nodes alive after the simulation time-out. Based on the simulation results and the graphical outputs we compare the two clustering approaches.

The network forms the clusters such that there is a single hop distance between the cluster members. Each node is moving randomly across the field. The simultaneous CH selection process is done using both the two approaches given below. The selected CH will transmit the collected data to the BS.

CH selection using Centralized approach: For each cluster, the BS selects the CH based on the node that has the maximum residual energy and the minimum distance from it. All the member nodes will forward the sensed data to this CH. This CH remains static for complete network lifetime.

CH selection using Distributed approach: In each cluster, a member node of a cluster that has the maximum residual energy becomes the Cluster Head independent of the decision of the BS. Also, within discrete time interval the residual energy of all the nodes is computed and the node that has maximum remaining energy value is selected as new CH for that cluster. This process is repeated periodically.

Results and discussion

We simulated the proposed model in NS2 network simulator. Initially each node has the same amount of energy. Simulation parameters used are:

Table-1: Simulation Parameters.

Parameters	Value
Total number of nodes	40
Area (Network size)	800x400
Initial energy of node	100 J
Simulation Time	30s

In Figure-1 centralized CH selection is shown. At time t =5s, node 9, 17, 21 and 23 serves as CHs in four clusters respectively. All the member nodes transmit the data packets to its CHs.

The simulation results in Figure-2 shows that same nodes act as the CH even at time t = 25s of centralized clustering. It is observed that very few nodes (coloured in yellow and green, with green representing node having more energy than other) are active with reasonable amount of energy and all other nodes (coloured in red) has very low energy or are dead.

Figure-3 shows the Distributed clustering at time t = 5s. Nodes selected as CHs are 11, 6, 16 and 1 in four clusters respectively.

From Figure-4, it is observed that at time t = 15s new CHs are elected and all other member nodes transmit data to the newly elected CHs. Also, more number of nodes are alive (coloured in green) as compared to centralized clustering.

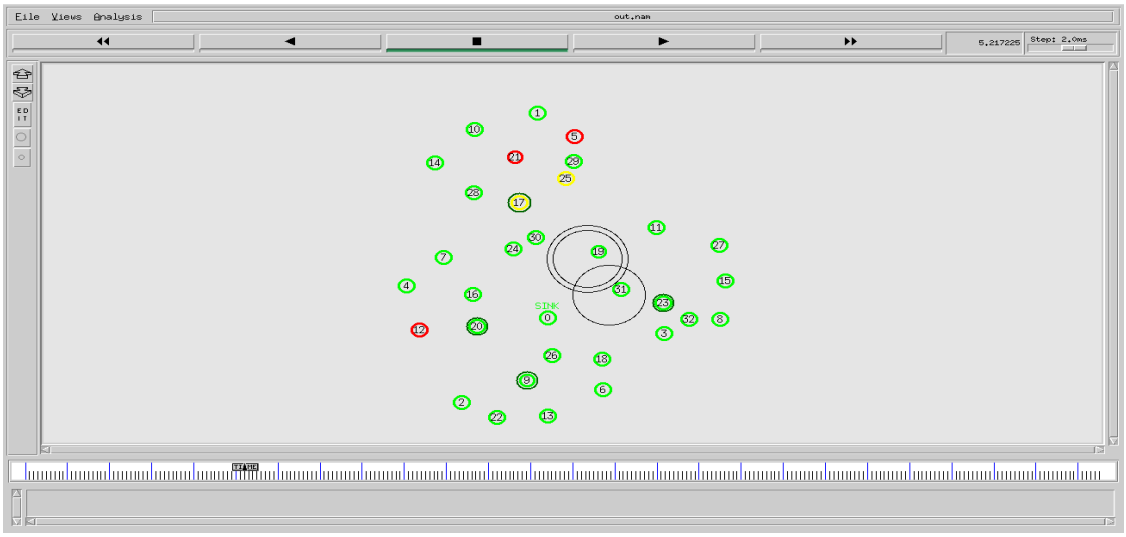

Figure-1: Centralized clustering at t = 5s.

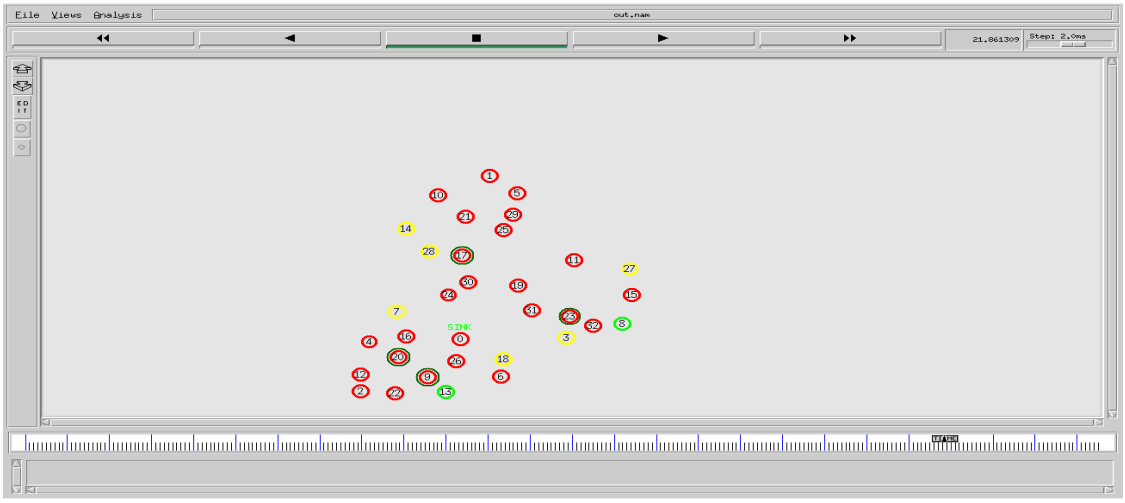

Figure-2: Centralized Clustering at t = 25s.

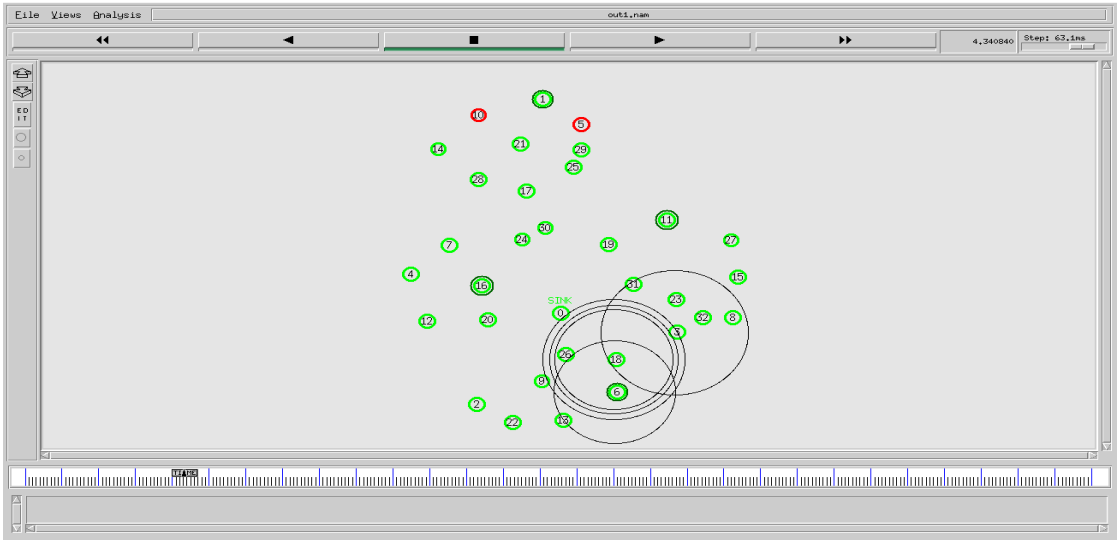

Figure-3: Distributed Clustering at t = 5s

The remaining energy values of all the nodes in both centralized and distributed clustering is shown in graph in Figure-5. It can be seen that the residual energy of nodes in distributed clustering is much higher than that of residual energy of nodes in centralized clustering. Thus, more number of nodes are alive in distributed clustering.

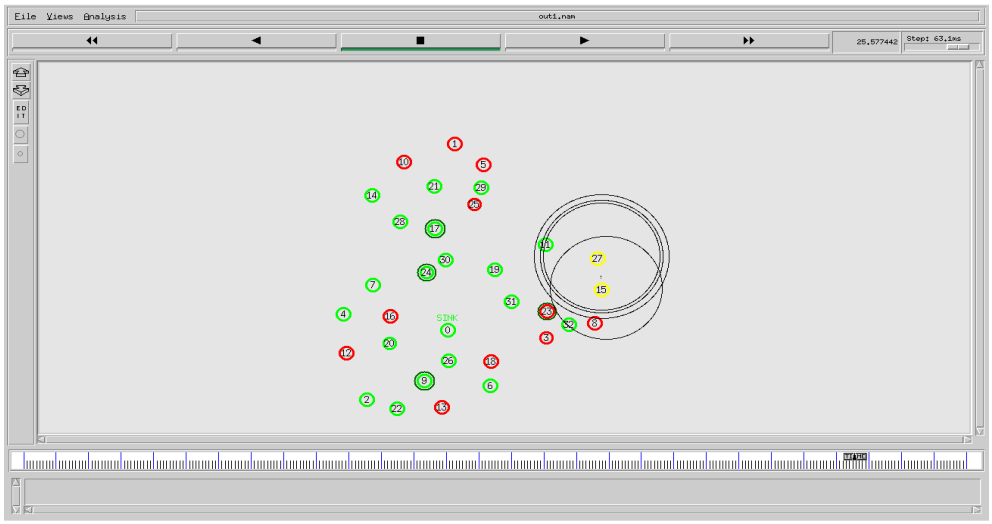

Figure-4: Distributed Clustering at t = 25s.

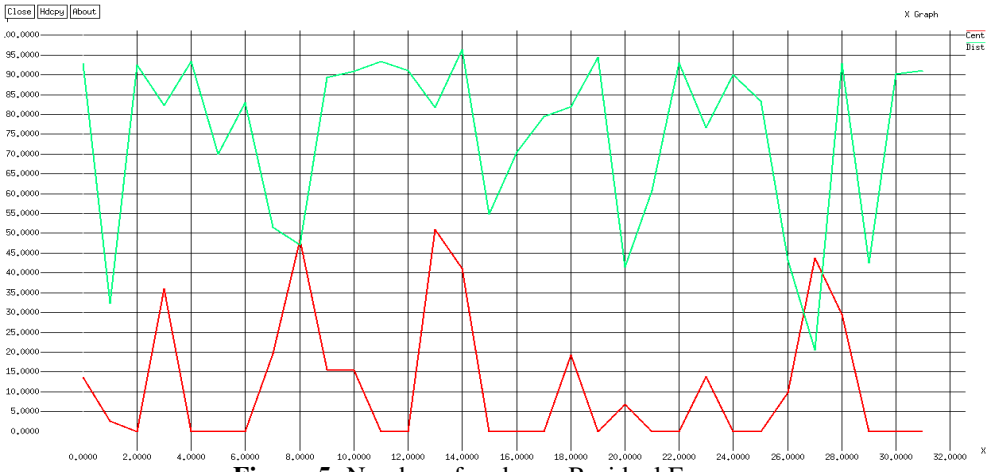

Figure-5: Number of nodes vs Residual Energy.

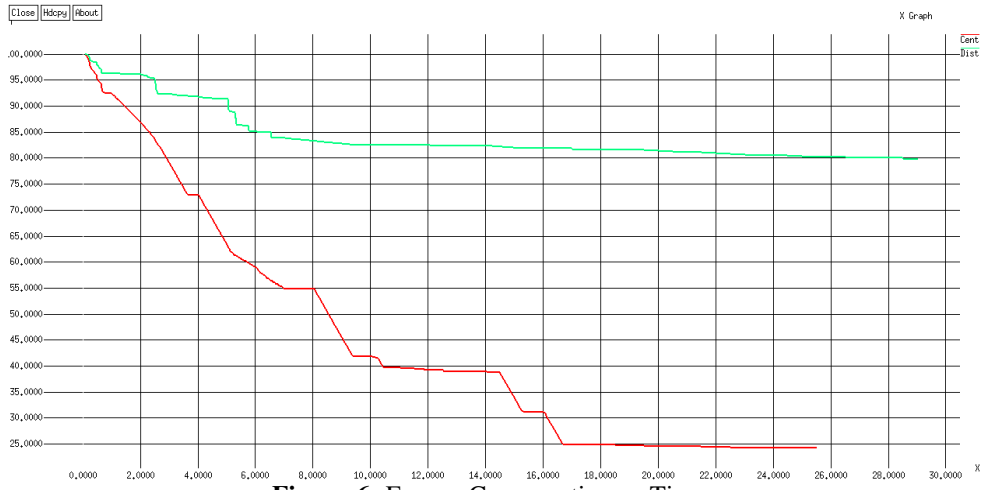

Figure-6: Energy Consumption vs Time.

As time increases the consumption of energy of each communicating node decreases. However, the rate of energy loss is more in case of centralized clustering than that of distributed clustering. This is observed from Figure-6. Since in centralized clustering the CH is same for entire network lifetime, the energy losses are more than that of the nodes in distributed one in which the role of the head node gets changed at different time period.

Conclusion

The WSN with centralized and distributed clustering techniques have been simulated. It can be concluded that the network is stable in distributed clustering since less number of nodes gets exhausted during the running time of network. On the other hand, in centralized clustering there is loss of sensor nodes due to energy depletion. Hence the clustering where the fixed node is involved in overall network task leads to network failure. Whereas, the distribution of the task among all nodes results in balancing the load across the network that in turn increases the network throughput.

But in case of small networks where the BS is located very near to the CHs, centralized approach dissipates less amount of energy. For developing an energy-efficient routing algorithms use of distributed clustering is an open area of research.

References

1. Heinzelman Rabiner W., Chandrakasan A. and Balakrishnan H. (2000). Energy-efficient communication protocol for wireless micro sensor networks. Proceedings of the 33rdannual Hawaii international conference on. IEEE System Science, 2, 1-10.

2. Pantazis Nikolaos A., Nikolidakis Stefanos A. and Vergados Dimitrios D. (2013). Energy-efficient routing protocols in wireless sensor networks: A survey. *IEEE Communications surveys & tutorials*, 15(2), 551-591.

3. Mishra P. and Sharma S. (2016). A Comparative Study of Existing Cluster-Based Routing Protocols in Wireless Sensor Networks. *International Journal of Future Generation Communication and Networking*, 9(7), 43-52.

4. Zanjireh Morteza M. and Larijani Hadi (2015). A survey on centralised and distributed clustering routing algorithms for wsns. Vehicular Technology Conference (VTC Spring), IEEE, 1-6.

5. Singh S.P. and Sharma S.C. (2015). A survey on cluster based routing protocols in wireless sensor networks. Proceeding computer science, 45, 687-695.

6. Bansal S. and Arora V.K. (2015). Distributed and Centralized Clustering Approaches: Leach vs. C-Leach. *HCTL Open International Journal of Technology Innovations and Research*, 14, 1-7.

7. Shigei Noritaka, Miyajima Hiromi, Morishita Hiroki and Maeda Michiharu (2009). Centralized and distributed clustering methods for energy efficient wireless sensor networks. *Proceedings of theInternational Multi Conference of Engineers and Computer Scientists*, 1, 18-20.

8. Kaur H., Kaur N. and Waraich S. (2015). Comparative Analysis of Clustering Protocols for Wireless Sensor Networks. *International Journal of Computer Applications*, 115(1).

9. Wankhede K. and Sirsikar S. (2014). Review of Clustering Algorithms in Wireless Sensor Networks. *International Journal of Advance Foundation and Research in Computer*, 1(11).

10. Dewangan S. and Mishra S.D. (2016). A survey on Energy Optimization in WSN using Distributed Clustering Approach. *International Journal of Innovative Research in Engineering and Computer Science*, 4(11), 19020-19023.