



Dynamic Clustering Technique for Energy Efficiency in Wireless Sensor Networks

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Abstract: Dynamic clustering technique is adapted with the sensor network for organizing the sensor nodes in an effective manner to form network and it spends less energy expenditure for data transmission. Effective communication is achieved by applying maximum distance method to form cluster between nodes in a wireless sensor network. This approach is essential for the workload balance among the nodes, updating new nodes in the network, increasing the network lifetime and effective resource utilization in wireless sensor network. Dynamic clustering technique is suitable for streaming of data, scalable to large size networks, partitions the sensor nodes in to reasonable sets faster and significantly speeds up the communication among nodes compared to the K-Means cluster algorithm. Simulation results show that the performance of dynamic clustering technique provides higher throughput and energy consumption.

Keywords: Cluster Head, Energy Expenditure, Scalability, Aggregation, Resource Utilization.

I. INTRODUCTION

Minimizing energy expenditure and scalability are very important issues in sensor networks because of limited battery resource. Energy efficiency is a major issue in a wireless sensor network due to the capacity of battery and always active in observation, gathering and processing of data. Several approaches are introduced for energy efficiency such as scheduling the data packets in the sub layer of data link layer called medium access control layer, sending and receiving of data packets in the network layer and clustering and multiparty processing. Many sensing tasks require a sensor network system to process data cooperatively and to gather data and control packets from various sources. Various clustering mechanisms such as K-Means, Ordering Points To Identify The Clustering Structure (OPTICS) with Ant Colony Optimization, Density Based Segmentation were introduced for wireless sensor networks. In order to balance the energy, cluster head must be selected appropriately. In order to outline the cluster, various parameters are to be considered such as distance between the sensor node and cluster head, control message and data packets transmission range, list of nearby nodes and so on. Cluster head transmits the control message called group head periodically. If this message is received by the nearby nodes, the nearby nodes will transmit the reply message called bond. Cluster is formed by sharing these control messages such as group head and bond.

II. LITERATURE REVIEW

Various protocols have been introduced for energy efficiency such as Sensor-Medium Access Control Protocol, Power Efficient and Delay Aware Medium Access Protocol for Sensor Networks, Adaptive Power Resourceful and Energy Conscious Protocol, Distributed Clustering algorithm, Weighted Clustering Algorithm. Heinzelman [2] proposes a centralized version of Low Energy Adaptive Clustering Hierarchy is purely task oriented and cluster based protocol. It is mainly designed for longer network lifetime. In case of Online Data Gathering, each sensor node broadcasts its control information such as its present position and energy level to cluster head. In order to keep away from inactive listening S-MAC introduces sleep mode. In this scheduling algorithm, the node which is not involved in transmit/receive be in sleep mode. Whenever any wants to transmit or receive data packets can be in active mode. Additionally control signals such as Request To Send (RTS) and Clear To Send (CTS) are used for energy efficiency. In case of Power Controlled Multiple Access Protocol, User Busy tone is used instead of Request To Send and Clear To Send signals. An adaptive Power Resourceful and Energy Conscious Protocol consists of four phases such as understanding the identifying the nearby nodes, collecting various information for scheduling from various sensor nodes, and reschedule whenever it is needed [3]. In case of CSHC, Cluster is formed by constructing Breadth First Search Tree with various parameters like the distance between nodes, transmission range of nodes. It is possible to reduce energy consumption in the network layer also by allowing some nodes for routing and keeping other nodes with no participation. Tabu search uses intra node search ie, within small coverage area and it follows the step by step process for moving from one solution to other until the condition is satisfied. K-Means algorithm uses linear method for the construction of cluster. In this method, nodes which are closer to the cluster head forms a cluster by using mean value and it continues the process until no other nodes are pending within the coverage area.



III. PROPOSED METHOD

The main aim of this proposal is to form dynamic cluster with continuous flow of control signals and data packets to the nodes which are available within the transmission range of cluster head. It can be adapted with large size networks by adding more nodes in a cluster. In some situation the network size can be reduced by partitioning the sensor nodes in to reasonable sets faster, and significantly speeds up the communication. In order to form the cluster non linear data structures and linear growth are used. Since the non linear data structure represents the hierarchical relationship among various nodes and linear growth uses the technique of adding nodes one by one in a network. In this proposal cluster head collects the data packets from various sensor nodes, aggregates them by using maximum distance clustering method. It uses the following formulae to form cluster.

Maximum Distance $\Rightarrow \|a-b\|_{\text{infinity}} = \max_i |a_i - b_i|$

Cluster heads are equally scattered in the entire region, then only it is possible to get proper communication among the sensor network. Otherwise some cluster heads are overhead compared to other cluster heads. Some additional effort is needed for the formation of meaningful cluster. Cluster head performs various activities such as coordination, collection, filters redundant information and sends responses to node collector.

3.1 Formation of Cluster

Step 1: choose cluster head CH_1 uniformly at random from region R

Step 2: $CH = \{CH_1\}$

Step 3: for $i= 2$ to n

Step 4: choose the next cluster head with the probability. CH_{prob}

Step 5: $CH = CH \cup \{CH_i\}$

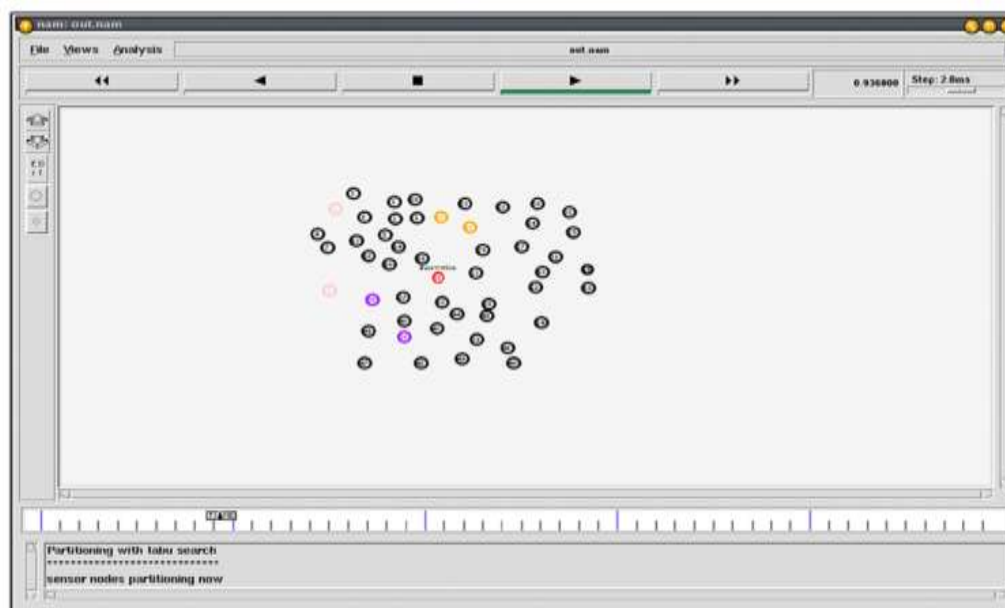


Fig. 3.1 Initial Stage of Cluster Formation

Fig. 3.1 shows the initial stage of cluster formation of adaptive distributive clustering. Node is discovered by using the power level of cluster head and the distance measure either close to or far. Partitioning the entire region R in to two sets called $R_{\text{close to}}$ and R_{far} . Initially, cluster head sends the control message which carries various fields such as its ID may be CH_i , power level of the cluster head, cost or transmission range, type of transmission such as broadcast or multicast. Based on the region cluster head may choose the node from $R_{\text{close to}}$ from the region R, if any node is not available in that region, else some other cluster head will choose the node.

Figure 3.2 and 3.3 represents grouping of cluster head with different regions and dendrogram approach for the cluster head selection. Dynamic Clustering is used instead of K-Means clustering algorithm. The entire process can be implemented by two pass methods. The first pass solves the main issue of scalability by adding huge set of nodes beyond called shelter wherein each node is a member of at least one shelter. It can be evaluated as one pass. In the second pass, data stream is formed by using Merge-and-reduce technique, it collects data packets from various nodes and prepares.

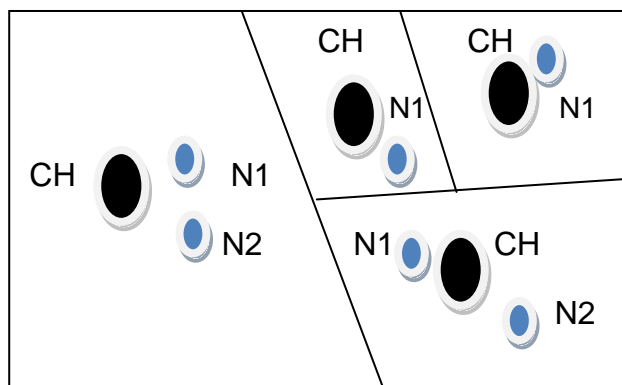


Fig. 3.2 Grouping Cluster Head with Region

This approach overcomes the drawback of K-Means clustering algorithm and also it greatly reduces the amount of computation involved by adding the nodes in a linear form. Let CH be the cluster head with n elements. The maximum

number of subsets in an incomparable collection of subsets is $\binom{n}{n/2}$.

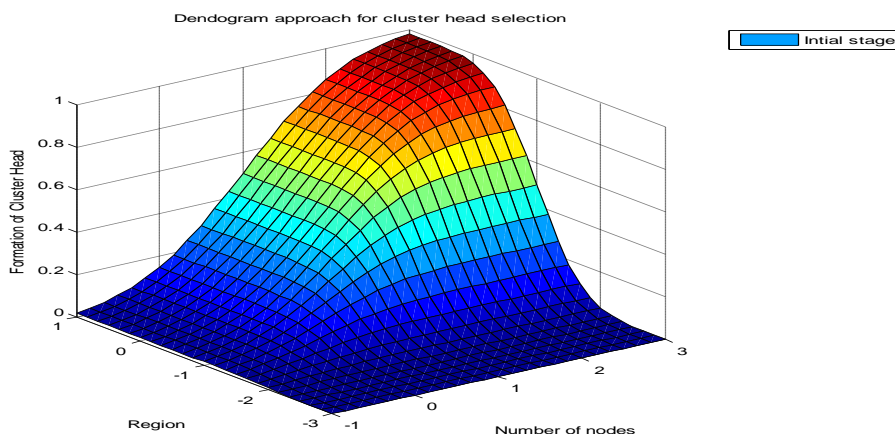


Fig. 3.3 Dendrogram approach for Cluster Head Selection

IV. RESULTS AND DISCUSSION

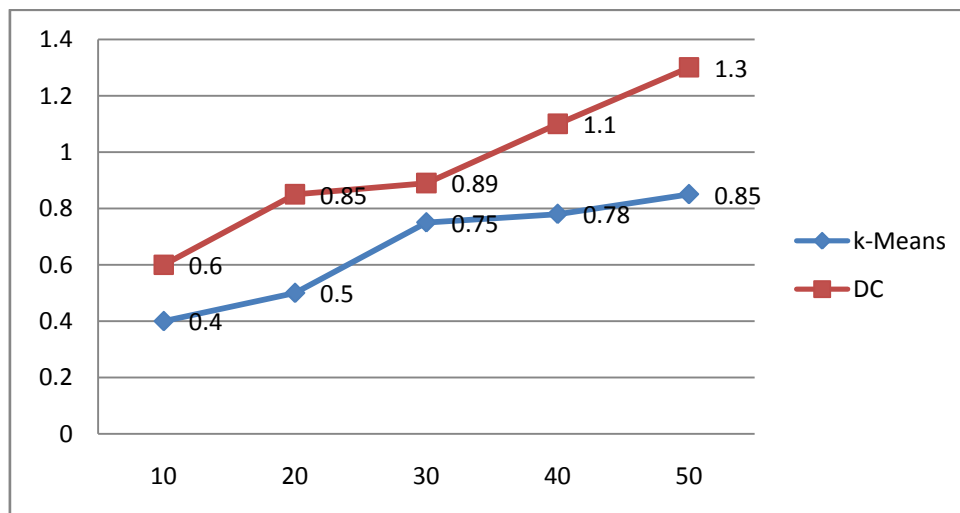


Fig. 4.1 No. of Nodes vs Throughput



The evaluation performance of the adaptive and optimal distributed clustering was implemented using TCL language utilizing NAM editor and XGraph in NS2 with sensor networks of different sizes and topologies. Performance of dynamic clustering was compared with K-Means clustering for the factors like throughput & energy consumption and the graph (4.1 – 4.2) shows that the performance of dynamic clustering is comparatively better than the performance of K-Means clustering.

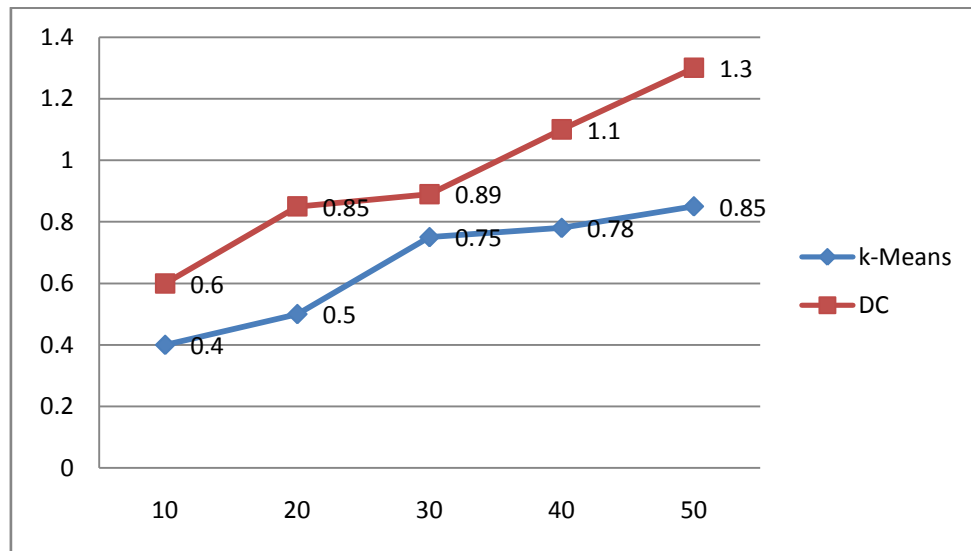


Fig. 4.2 No. of nodes vs Energy Consumption

V. CONCLUSION

Dynamic clustering uses linear growth technique for adding the sensor nodes in to reasonable sets faster and significantly speeds up the communication among nodes compared to the K-Means cluster algorithm. Simulation results show that the performance of dynamic clustering provides higher throughput and energy consumption and it is suitable for large scale networks.

REFERENCES

- [1] Renita Machado, Wensheng Zhang, Guling Wang and Simi Tekinay, "Coverage Properties of Clustered Wireless Sensor Networks", ACM Transactions on Sensor Networks. (August 2010) 13-21.
- [2] W. Heinzelman, A. Chandrakasan, H. Balakrishnan, "An Application Specific Protocol Architecture for Wireless Micro sensor Networks", IEEE Trans. Wireless Comm. 1 (2002) 660-670.
- [3] M. Senthil Kumaran, and R. Rangarajan, " An Adaptive Power Resourceful and Energy Conscious Protocol for Multi channel Medium Access Control layer in Wireless sensor Networks", International Journal of Computer and Network Security, vol. 2, no. 7, pp. 32-36, July 2010.
- [4] S.R. Madden, M.J. Franklin, J.M. Hellerstein, W. Hong, "TAG: Tiny AGgregation Service for ad hoc sensor networks, Proc. Fifth Symp. Operating Systems Design and Implementation (OSDI '02). (2002) 131-146.
- [5] Jing Wang, Younge Liu and Sajal K. Das, "Energy- Efficient Data Gathering in Wireless Sensor Networks with Asynchronous Sampling", ACM Transactions on Sensor Networks. (June 2010) 22-37.
- [6] P. Gupta, P.R. Kumar, The Capacity of wireless networks, IEEE Trans. on Information Theory. 46 (2000) 388-404.
- [7] S. Ghiasi, A. Srivastava, X. Yang, M. Sarrafzadeh, "Optimal Energy Aware Clustering in Sensor Networks", Sensors. (2002) 258- 269.
- [8] J.J. Lee, B. Krishnamachari, C.C.J. Kuo, "Impact of Heterogeneous Deployment on Lifetime Sensing Coverage in Sensor Networks", Proc. IEEE Sensor and Ad Hoc Comm. and Networks Conf. (SECON '04), (2004) 367-376.
- [9] P.K. Agarwal, C.M. Procopiuc, Exact and Approximation Algorithms for Clustering, Algorithmica. 33 (2002) 201- 226.

BIOGRAPHY



Dr. M. Senthil Kumaran is working as an Associate Professor in the department of Computer Science and Engineering of SCSVMV University, Kanchipuram. He has published 10 papers in International Journals, presented more than 20 papers in international and National Conferences and published 2 books. He is a reviewer of International Journal of Communication Systems, Journal of Computer Science and International Journal of Computer Science Issues. He is a member in various societies such as Computer Society of India, IAENG, ISTE, IBM my Developer works Community and senior member of IACST.