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ANALYSIS OF LARGE SCALE WIRELESS SENSOR NETWORK FOR ENERGY EFFICIENCY

Dr. S.R.Boselin Prabhu
Assistant Professor, Department of Electronics and Communication Engineering,
SVS College of Engineering, Coimbatore, India. E-mail: eben4uever@gmail.com

M.Pradeep
Assistant Professor, Department of Electronics and Communication Engineering,
Sasurie Academy of Engineering, Coimbatore, Tamilnadu, India.
Email: saepradeep@gmail.com

Dr. E.Gajendran
Professor, Department of Information Technology,
St.Martin‟s Engineering College, Hyderabad. E-Mail: gajendrane@gmail.com

Abstract*:*

The major advantages of these networks are self-organization, fault tolerance characteristics, energy efficiency, avoiding wiring problems and can be accessed through a centralized control. In order to decrease the data transmission time and energy consumption, the sensor nodes are grouped into multiple clusters. The grouping of sensor nodes is known as clustering. In cluster formation, every cluster has a leader which is known as cluster head. A cluster head is one of the sensor nodes which have advanced capabilities than other sensor nodes. The cluster head is selected by the sensor nodes in the relevant cluster and may also possible by the user to pre-assign the cluster heads. The cluster head is used to transmit the aggregated data to the sink or base station. In this paper, a model of distributed layer-based clustering algorithm is proposed based on three concepts. First, the aggregated data is forwarded from cluster head to the base station through cluster head of the next higher layer with shortest distance between the cluster heads. Second, cluster head is elected based on the clustering factor, which is the combination of residual energy and the number of neighbors of a particular node within a cluster. Third, each cluster has a crisis hindrance node, which does the function of cluster head when the cluster head fails to carry out its work in some critical conditions. The key aim of the proposed algorithm is to accomplish energy efficiency and to prolong the network lifetime.

Keywords. Wireless sensor network (WSN), distributed clustering algorithm, cluster head, residual energy, energy efficiency, network lifetime.

1. INTRODUCTION

Wireless sensor network is gifted for accessing real-world information about the physical environments. Few deployments of wireless static sensor network are done using Berkley smart dust, µ-Adaptive multi-domain power aware sensors and wireless integrated sensor networks. In static wireless sensor network, few parameters like mobility is not considered thereby mobility becomes the next evolutionary criterion to be carefully considered. The dynamic environment of wireless sensor network introduces exclusive confronts like data management, accuracy, coverage, security and software configuration. One of the vital contemplations in wireless sensor nodes is the route maintenance when the node moves. The conservative protocols for static sensor network are to be optimized carefully when mobility is introduced. To learn the performance of these protocols, the mobility patterns and mobility metrics have to be subjectively considered. Since WSNs has many advantages like self-organization, infrastructure-free, fault-tolerance and locality, they have a wide variety of potential applications like border security and surveillance, environmental monitoring and forecasting, wildlife animal protection and home automation, disaster management and control. Considering that sensor nodes are usually deployed in remote locations, it is impossible to recharge their batteries. Therefore, ways to utilize the limited energy resource wisely to extend the lifetime of sensor networks is a very demanding research issue for these sensor networks.

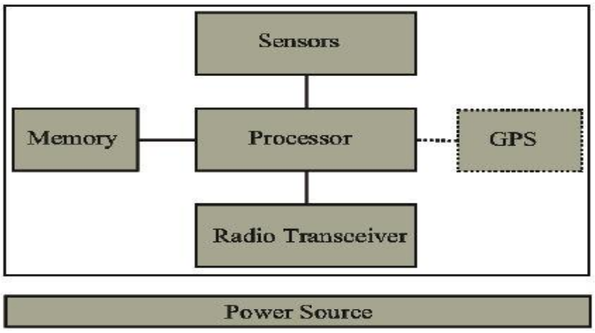

Figure 1: Different components of a wireless sensor node

Clustering [2-7] is an effectual topology control approach, which can prolong the lifetime and increase scalability for these sensor networks. The popular criterion for clustering technique (figure 2) is to select a cluster head (CH) with more residual energy and to spin them periodically. The basic idea of clustering algorithms is to use the data aggregation[8-11] mechanism in the cluster head to lessen the amount of data transmission. Clustering goes behind some advantages like network scalability, localizing route setup, uses communication bandwidth [17] efficiently and takes advantage of network lifetime[12-16]. By the data aggregation process, unnecessary communication betweensensor nodes, cluster head and the base station is evaded. In this paper, a well-defined model of distributed layer-based clustering algorithm is proposed based of three concepts: the aggregated datais forwarded from the cluster head to the base station through cluster head of the next higher layer with shortest distance between the cluster heads, cluster head is elected based on the clustering factor and the crisis hindrance node does the function of cluster head when the cluster head fails to carry out its work. The prime aim of the proposed algorithm is to attain energy efficiency and increased network lifetime.

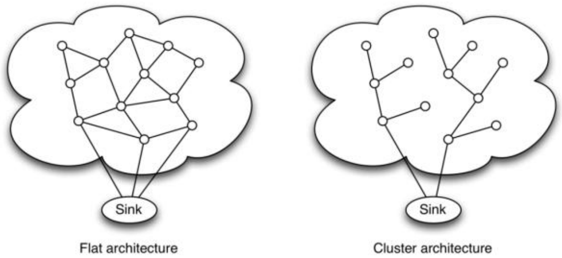

Figure 2: Cluster formation in a wireless sensor network

The rest of this paper is structured as follows. A literature review of existing distributed clustering algorithms, talking about their projected advantages and shortcomings is profoundlyconversed in Section 2. An evaluation of the existing clustering algorithm LEACH (Low Energy Adaptive Clustering Hierarchy) and the basic concept behind this algorithm is briefed in Section 3. Section 4 sketches a precise model of the proposed distributed layer-based clustering algorithm, enumerating the precious hiding concepts behind it. Finally, the last section gives the conclusioncreatively.

2. EXISTING CLUSTERING ALGORITHMS

Nagpal and Coore proposed CLUBS [18-20], which is executed with an idea to form overlapping clusters with maximum cluster diameter of two hops. The clusters are created by local broadcasting and its convergence depends on the local density of the wireless sensor nodes. This algorithm can be implemented in asynchronous environment without droppingefficiency. The main difficulty is the overlapping of clusters, clusters having their CHs within one hop range of each other, thereby both the clusters will collapse and CH election process will get restarted.Demirbas, Arora and Mittal brought out FLOC [21], which shows double-band nature of wireless radio-model for communication. The nodes can commune reliably with the nodes in the inner-band and unreliably with the nodes that are in the outer-band. The chief disadvantage of the algorithm is, the communication between the nodes in the outer band is unreliable and the messages have maximum probability of getting lost during communication.

Ye, Li, Chen and Wu proposed EECS [22-26], which is based on asupposition that all CHs can communicate directly with the BS. The clusters have variable size, those closer to the CH are larger in size and those farther from CH are smaller in size. It is really energy efficient in intra-cluster communication and shows an excellent improvement in network lifetime. EEUC is anticipated for uniform energy consumption within the sensor network. It forms dissimilar clusters, with a guessing that each cluster can have variable sizes. Probabilistic selection of CH is the focal shortcoming of this algorithm. Few nodes will be gone without being part of any cluster.

Yu, Li and Levy proposed DECA, which selects CH based on residual energy, connectivity and a node identifier. It is greatly energy efficient, as it uses lesser messages for CH selection. The main trouble with this algorithm is that high risk of wrong CH selection which leads to the discarding of every packets sent by the wireless sensor node.Ding, Holliday and Celik proposed DWEHC, which elects CH on the basis of weight, a combination of nodes' residual energy and its distance to the neighboring nodes. It produces well balanced clusters, independent of network topology. A node possessing largest weight in a cluster is designated as CH. The algorithm constructs multilevel clusters and the nodes in every cluster reach CH by relaying through other intermediate nodes. The foremost problem occurs due to much energy utilization by several iterations until the nodes settle in most energy efficient topology.

HEED is a well distributed clustering algorithm in which CH selection is done by taking into account the residual energy of the nodes and intra-cluster communication cost leading to prolonged network lifetime. It is clear that it can have variable cluster count and supports heterogeneous sensors. The problems with

HEED are its application narrowed only to static networks, the employment of complex methods and multiple clustering messages per node for CH selection even though it prevents random selection of CH.

3. LEACH ALGORITHM

LEACH [1] is one of the most well-liked clustering mechanisms for WSNs and it is considered as the representative energy efficient protocol. In this protocol, sensor nodes are unified together to form a cluster. In each cluster, one sensor node is chosenarbitrarily to act as a cluster head (CH), which collects data from its member nodes, aggregates them and then forwards to the base station. It disperses the operation unit into many rounds and each round consists of two phases: the set-up phase and the steady phase. During the set-up phase, initial clusters are fashioned and cluster heads are selected. All the wireless sensor nodesproduce a random number between 0 and 1. If the number is lesser than the threshold, then the node selects itself as the cluster head for the present round. The threshold for cluster head selectionin LEACH for a particular round is given in equation 1.Gone selecting itself as a CH, the sensor node broadcasts an advertisement message which has its own ID. The non-cluster head nodes can formulate an assessment, which cluster to join based on the strength of the received advertisement signal. After the decision is made, every non-cluster head node should transmit a join- request message to the chosen cluster head to specify that it will be a member of the cluster.

Therefore, it can receive every data from the nodes within their own clusters. On receiving the data from the cluster, the cluster head carries out data aggregation mechanism and onwards it to the base station directly. This is the entiremechanism of the steady state phase. After a certain predefined time, the network will step into the next round. LEACH is the basic clustering protocol which processes cluster approach and it can prolong the network lifetime in comparison with other multi-hop routing and static routing. However, there are still some hiding problems that should be considered.

LEACH does not take into account the residual energy to elect cluster heads and to construct the clusters. As a result, nodes with lesser energy may be elected as cluster heads and then die much earlier. Moreover, since a node selects itself as a cluster head only according to the value of the calculated probability, it is hard to guarantee the number of cluster heads and their distribution. Also in LEACH clustering algorithm, the cluster heads are selected randomly and hence the weaker nodes drain easily. To rise above these shortcomings in LEACH, a model of distributed layer-based clustering algorithm is proposed, where clusters are arranged in to hierarchical layers. Instead of cluster heads directly sending the aggregated data to the base station, sends them to their next layer nearer cluster heads. These cluster heads send their data along with that received from lower level cluster heads to the next layer nearer cluster heads. The cumulative process gets repeated and finally the data from all the layers reach the base station. The proposed model is dedicated with some expensive designs, focusing on reduced energy utilization and improved network lifetime of the sensor network.

4. THE PROPOSED ALGORITHM

The proposed clustering algorithm is well distributed, where the sensor nodes are deployed randomly to sense the target environment. The nodes are divided into clusters with each cluster having a CH. The nodes throw the information during their TDMA timeslot to their respective CH which fuses the data to avoid redundant information by the process of data aggregation. The aggregated data is forwarded to the BS. Compared to the existing algorithms, the proposed algorithm has three distinguishing features.First, the aggregated data is forwarded from the cluster head to the base station through cluster head of the next higher layer with shortest distance between the cluster heads. Second, cluster head is elected based on the clustering factor, which is the combination of residual energy and the number of neighbors of a particular node within a cluster. Third, each cluster has a crisis hindrance node, which does the function of cluster head when the cluster head fails to carry out its work in some conditions.

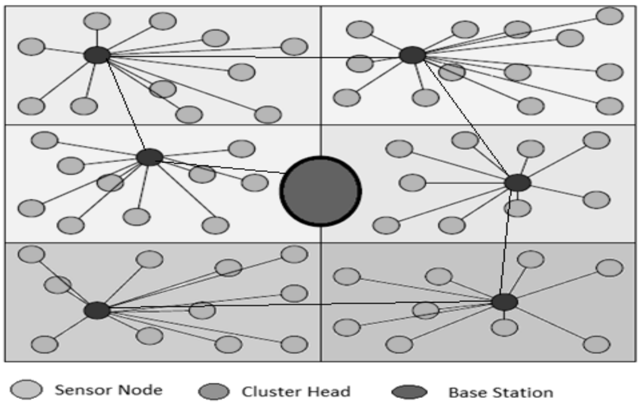

Figure 3: Aggregated data forwarding in the proposed algorithm

In a network of N nodes, each node is assigned with an exclusive Node Identity (NID). The NID just serves as a recognition of the nodes and has no relationship with location or clustering. The CH will be placed at the center and the nodes will be organized in to several layers around the CH. Every clusters are arranged into hierarchical layers and layer numbers are assigned to each clusters. The cluster that is far away from the base station is designated as the lowest layer and the cluster nearer to the base station is designated as the highest layer. The main characteristic feature of the proposed algorithm is that the lowest layer cluster head forwards only its own aggregated data to the next layer cluster head but the highest layer forwards all the aggregated data from the preceding cluster heads to the base station (figure 3). Thus lower workload is assigned to the lower layers but the higher layers is assigned with greater workload. The workload assigned to a particular cluster head is directly proportional to the energy utilization of the cluster head. In order to balance the energy utilization among the cluster head, the concept of variable transmission power is employed, where the transmission power reduces with increase in layer numbers. In LEACH, each cluster head forwards the aggregated data to the base station directly which uses much energy. The proposed algorithm uses a multi-hop fashion of data forwarding from cluster head to the base station resulting in reduced energy utilization.

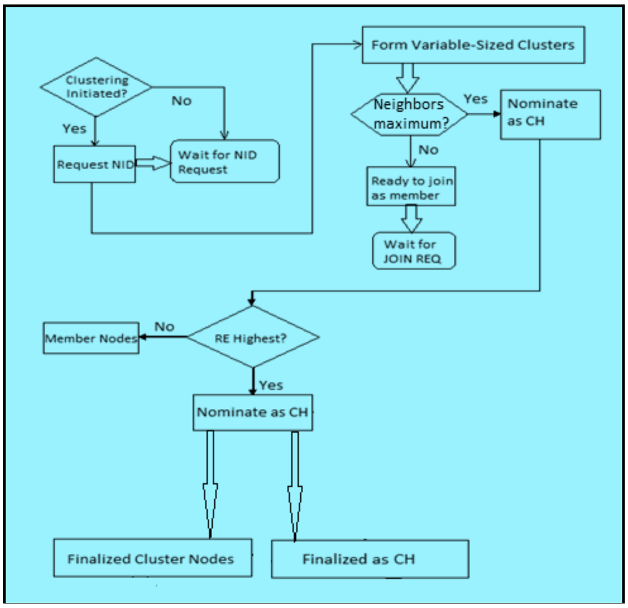

Figure 4: Mechanism of cluster head selection in the proposed algorithm

The cluster head is elected based on the clustering factor (figure 4), which is the combination of residual energy and the number of neighbors of a particular node within a cluster. Residual energy is defined as the energy remaining within a particular node after some number of rounds. This is generally believed as one of the main parameter for CH selection in the proposed algorithm. A neighboring node is a node that remains closer to a particular node within one hop distance. LEACH selects cluster head only based on residual energy, but in the proposed algorithm an additional parameter is included basically to elect the cluster head properly, thereby to reduce the node death rate. The main characteristic feature of the proposed algorithm compared to LEACH is that, the base station does not involve in clustering process directly or indirectly. A node with highest clustering factor is selected as cluster head for the current round. This is generally significant in mobile environment, when the sensor nodes move, the number of neighbors vary which should be taken into account but it is barely not concentrated in the LEACH clustering mechanism.

In a cluster with large number of nodes, cluster crisis does not affect the overall performance of the wireless sensor system. But in the case of network with less number of nodes, cluster crisis greatly affects the wireless sensor system. Care should be done when cluster head selection process by applying alternate recovery mechanisms. In addition to the regular cluster head, additional cluster node is assigned the task of secondary cluster head, and the particular node is called as crisis hindrance node. Generally the cluster collapses when the cluster head fails. In such situations, crisis hindrance node act as cluster head and recovers the cluster. The main characteristic feature of the proposed algorithm is that, the crisis hindrance node solely performs the function of recovery mechanism and does not involve in sensing process. In case of LEACH, the distribution and the loading of CHs to all nodes in the networks is not uniform by switching the cluster heads periodically. Hence, there is a maximum probability of a cluster to be collapsed easily, but it can be avoided in the proposed algorithm with the help of crisis hindrance node.

5. CONCLUSION

The key aim of this work is to design an energy efficient clustering algorithm for mobile wireless sensor network that operates in unattended and sometimes in hostile environments. As the sensor nodes are resource constrained (specially limited energy and limited on-board storage), the algorithm should consume low power and should not burden the nodes with storage overhead. This paper gives a brief introduction on clustering process in wireless sensor networks. A study on the well evaluated distributed clustering algorithm Low Energy Adaptive Clustering Hierarchy (LEACH) is described artistically. To overcome the drawbacks of the existing LEACH algorithm, a model of distributed layer-based clustering algorithm is proposedfor clustering the wireless sensor nodes. The proposed distributed clustering algorithm is based on the aggregated data being forwarded from the cluster head to the base station through cluster head of the next higher layer with shortest distance between the cluster heads. The selection of cluster head is based on the clustering factor, which is the combination of residual energy and the number of neighbors of a particular node within a cluster. Also each cluster has a crisis hindrance node.

REFERENCES

[1]W.B.Heinzelman, A.P.Chandrakasan, H.Balakrishnan, (2002), “An application specific protocol architecture for wireless microsensor networks”, IEEE Transactions on Wireless Communication Volume 1, Number 4, Pages 660-670.

[2] O.Younis, S.Fahmy, (2004), “HEED: A hybrid energy-efficient distributed clustering approach for adhoc sensor networks”, IEEE Transactions on Mobile Computing, Volume 3, Number 4, Pages 366-379.

[3] S.Zairi, B.Zouari, E.Niel, E.Dumitrescu, (2012),

"Nodes self-scheduling approach for maximizing wireless sensor network lifetime based on remaining energy" IET Wireless Sensor Systems, Volume 2, Number 1, Pages 52-62.

[4] I.Akyildiz, W.Su, Y.Sankarasubramaniam, E.Cayirci, (2002), "A Survey on sensor networks", IEEE Communications Magazine, Pages 102-114.

[5] Hamid Ali Abed Al-Asadi, "Energy Efficient Hierarchical Clustering Mechanism for Wireless Sensor Network Fields", International Journal of Computer Applications, Vol. 153, Issue 8, PP 42-46, 2016.

[6] Boselin Prabhu S.R. and Sophia S., 'A review of energy efficient clustering algorithm for connecting wireless sensor network fields', International Journal of Engineering Research and Technology, 2(4), 2013.

[7] Boselin Prabhu S.R. and Sophia S., 'Real-world applications of distributed clustering mechanism in dense wireless sensor networks', International Journal of Computing Communications and Networking, 2(4), 2013.

[8] Hamid Ali Abed Al-Asadi, "Evaluating Iraqi universities websites based on fuzzy expert system using multiple quality criteria's", Universities ICT Research and Development conference, Basra, Iraq, 2016.

[9] Hamid Ali Abed Al-Asadi, "Development of Tacit Knowledge Measurement Model for Academic Staff Activities", American Journal of Computer Science and Information Engineering, Vol.3 , No. 6, Nov. 8, 2016, Page: 37-44, 2016.

[10] Boselin Prabhu S. R. and Balakumar N., "Evaluation of Quality in Network and Interoperable Connectivity between IP Networks", International Journal of Current Engineering and Scientific Research, Volume 3, Issue 9, pp. 81-85.

[11] Boselin Prabhu S.R. and Sophia S., "Bio-Medical Application of Wireless Power Transmission System", International Journal of Research and Engineering, Volume 3, Number 7, July 2016.

[12] Hamid Ali Abed Al-Asadi, "Cuckoo Search Algorithm and Discrete Wavelet Transform for Iraqi Road Signs Recognition System", The ICSES Journal on Evolutionary and Metaheuristic Algorithms (IJEMA), 2016.

[13] Hamid Ali Abed Al-Asadi, "Fuzzy model for evaluation of selected Diabetes Medical Sites", IJRDO-Journal of Computer Science Engineering, Vol. 2 Issue 1, January 2016.

[14] Boselin Prabhu S.R. and Sophia S., 'Evaluation of clustering parameters in WSN fields using distributed zone-based approach', ASTM Journal of Testing and Evaluation, 43(6), 2015.

[15] Boselin Prabhu S. R. and Gajendran E., "An Investigation on Enlightening Performance in an Overburdened Highway System by Integrating Roadside Technologies", International Journal of Advances in Engineering Research (IJAER), Vol. No. 12, Issue No. V, November 2016, pp. 06-15.

[16] Hamid Ali Abed Al-Asadi, "The Internet of Things Software Architectural Solutions", Australian Journal of Basic and Applied Sciences (AJBAS), 2015.

[17] Hamid Ali Abed Al-Asadi, "A Proposed Risk Assessment Model For Decision Making In Software Management", Journal of Soft Computing and Decision Support Systems 3:5 (2015), 31-43.

[18] Boselin Prabhu S. R. and Balakumar N., "Methodology for Improving Security Issues and Reducing Vulnerability in Microprocessors", International Journal of Advances in Agricultural Science and Technology, Vol.3, Issue.6, November-2016, pp. 60-65.

[19] 1. Boselin Prabhu S. R. and Balakumar N., "Smart Antenna and RFID Technology Enabled Wireless Charger for Mobile Phone Batteries", International Journal of Current Engineering and Scientific Research, Vol. 3, Issue. 12, December 2016, pp. 66-70.

[20] Hamid Ali Abed Al-Asadi, "Object Recognition Using Artificial Fish Swarm Algorithm on Fourier Descriptors", American Journal of Engineering, Technology and Society; Volume 2, Issue 5: pp. 105-110, 2015.

[21] Boselin Prabhu S. R., "Reliable Security Approach for Wireless Embedded Systems", International Journal of Emerging Technology and Innovative Engineering, Vol. 2, Issue 11, November 2016, pp. 402-406.

[22] Boselin Prabhu S. R., and Pradeep M., "Implementation of Voice Recognition Wireless Home Automation System with Zigbee", International Journal of Research in Electrical Engineering, Vol. 3, Issue 4, December 2016, pp. 54-58.

[23] Hamid Ali Abed Al-Asadi, "A Hybrid Model of MFCC/MSFLA for Speaker Recognition, American Journal of Computer Science and Engineering, Vol. 2, No. 5. Pp: 32-37, 2015.

[24] Hamid Ali Abed Al-Asadi , "New Hybrid (SVMs-CSOA) Architecture for classifying Electrocardiograms Signals", International Journal of Advanced Research in Artificial Intelligence (IJARAI), Vol. 4, No. 5, 2015.

[25] Boselin Prabhu S. R. and Balakumar N., "Enhanced Clustering Methodology for Lifetime Maximization in Dense WSN Fields", International Journal for Technological Research in Engineering, Volume 4, Issue 2, pp.343-348, October-2016

[26] Haitao, Z, Shiwei, Z &Wenshao, B 2014, 'A clustering routing protocol for energy balance of wireless sensor network based on simulated annealing and genetic algorithm', International Journal of Hybrid Information Technology, vol. 7, no. 2, pp. 71-82.