Eradicate Energy Inefficiencies That Reduce The Lifetime Using Clustering Approach For WSN

Kush Bhushanwar[#1], Praveen Bhanodia[#2], Makrand Samvatsar[#3]

[#1, 2, 3]Department of Computer Science & Engineering

Patel College of Science & Techonlogy, Indore (PCST)

***Abstract*- The wireless sensor network technology is a enter constituent for everywhere. A wireless sensor network consists of a huge number of sensor nodes. Every sensor node senses ecological circumstances such as temperature, force and light and sends the sensed data to a base station which is a long way off in general. Since the sensor nodes are powered by limited power batteries, in order to prolong the life time of the network, low energy consumption is important for sensor nodes. In universal, radio communication consumes the majority amount of energy, which is proportional to the data size and proportional to the square or the fourth power of the distance. We organized to reduce the energy consumption. In this paper, we studied classic clustering algorithms in wireless sensor networks and find two main reasons causing unnecessary energy consumption, which are fixed operation periods and too much information exchanged in cluster-heads selection. We proposed two types of clustering methods with less communication overhead for clustering. Based on federal management in k-means algorithm effective clustering and distributed approach.**

Index Terms — adaptive period, residual energy, clustering algorithm, wireless sensor network.

I. INTRODUCTION

In this paper addresses the problem of energy conservation in clustering algorithm for wireless sensor network. Since the major source of energy consumption in the sensor node is the wireless interface, considerable energy can be saved if the transceivers are completely shut down for a period of time. of course, these sleeping times must be carefully scheduled, or network functionality could be compromised. A clustering strategy is a distributed protocol that maintains a (minimal) connected backbone of active nodes, and turns into sleeping state the transceivers of non-backbone nodes. Periodically, the set of active nodes is changed to achieve more uniform energy consumption in the network.

We have studied many clustering algorithms and found that three basic techniques Hierarchical (clustering) architecture, which are respectively presented in LEACH [1], HEED [2], GAF [3] and P. Santi's algorithm [4]:

1) Selecting cluster-heads periodically. Cluster-heads are selected periodically to evenly distribute the energy load among all the nodes.

2) Virtual grids method. Each node use location information to associate itself with a “virtual grid”, in which only one node is active and responsible for processing signals.

3) Consideration of nodes' residual energy. Since cluster heads consume the most energy, residual energy is used to determine whether node can be cluster-head to

II. RELATED WORK

Throughout the previous few years, a lot of clustering algorithms have been proposed as an efficient method to organize communication and data processing in a sensor network. The problem of clustering network organization consists of several aspects that depend on the structure of the sensor network and the particular application’s demands. We mention some of the most relevant papers related to clustering.
Jin-Shyan Lee, at al [1] in this research, a fuzzy-logic-based clustering approach with an extension to the energy predication has been proposed to prolong the lifetime of WSNs by evenly distributing the workload. It is believed that the technique presented in this research could be further applied to large-scale wireless sensor networks.

In Sampath Priyankara at al [2], we proposed a clustering method for WSN with heterogeneous node types, which select cluster heads considering not only transmission power and residual energy of each node but also those of its adjacent nodes. Brief introduction for our clustering method is as follows.
Kyuhong Lee at al[3] In this research, they proposed an energy efficient clustering and routing method for wireless sensor networks by exploiting energy state information of neighbor sensor nodes for selection of cluster heads. They compared the performance of the proposed method with that of a well known clustering and routing protocol. They computational experiments demonstrate that the lifetime and distribution of energy consumptions of the proposed method are better than those of the compared method.
LEACH [4] which is a clustering protocol, proposes a Two-phase mechanism based on single-hop communication. The plain node transmits the data to the corresponding cluster head and the cluster head transmits the aggregated data to the BS. The authors in [5] analyze the problem of prolonging the lifetime of a network by determining the optimal cluster size.
For a general clustering model, they find the optimal sizes of the cells by which maximum lifetime or minimum energy consumption can be achieved. Based on this result, they propose a location aware hybrid transmission scheme that can further prolong network lifetime. So far several methods have been offered for clustering of sensor networks, the most important goal of which is maximizing the network lifetime by adopting a network architecture based on clustering, such as: distributed algorithm [6], weighted clustering algorithm [7], rapid clustering algorithm [8], voting based algorithm [9], hierarchical algorithm [10], HEED Hybrid Energy Efficient Distributed algorithm [11] and Adaptive clustering algorithm [12]. The most famous clustering protocol is *LEACH*, which has been introduced in [14]. *Leach* is a distributed clustering method based m rotation of CH role. Optimized *LEACH* that is known as *LEACH-C* has been proposed in [3]. In this algorithm, figuring of the clusters at the start of each round using centralized algorithm is perfonned by the BS. In *lEACH-CE* [13], a prediction technique for reducing number of the connections in the setup phase of *LEACH-C* is suggested.
Sajjanhar et al. [15] proposed a Distributive Energy Efficient Adaptive Clustering (DEEAC) Protocol, which is having spatio-temporal variations in data reporting rates across different regions. DEEAC selects a node to be a cluster head depending upon its hotness value and residual energy. B. Elbhiri et al [16], proposed SDEEC (Stochastic Distributed Energy-Efficient Clustering (SDEEC) SDEEC introduces a balanced and dynamic method where the cluster head election probability is more efficient. Moreover, it uses a stochastic scheme detection to extend the network lifetime. Simulation results show that this protocol performs better than SEP and DEEC in terms of network lifetime. Inbo Sim, et.al [17] proposed Energy efficient Cluster header Selection (ECS) algorithm which selects CH by utilizing only its information to extend network lifetime and minimize additional overheads in energy limited sensor networks.

III. WIRELESS SENSOR NETWORK REPLICA

This section describes the wireless sensor network replica considered in this paper [18, 19, 20]. The WSN model consists of *N* sensor nodes and one base station (BS) node as shown in Fig.1. All sensor nodes are identical and are assumed to have the following functions and features:

- sensing environmental factors such as temperature, pressure, and light,
- data processing by low-power micro-controller,
- radio communication, and
- powered by a limited life battery.

In Fig. 1, The Base Station node is assumed to have an unlimited power source, processing power, and storage capacity. The data sensed by sensor nodes are sent to the Base Station node over the radio, and a user can access the data via the Base Station node. In this WSN application, the clock synchronization of sensor nodes is an important issue. Because the time at which a data was sensed is important, which requires low clock skew among all the sensor nodes? We assume that the low clock skew requirement is guaranteed by using a clock synchronization method [5].

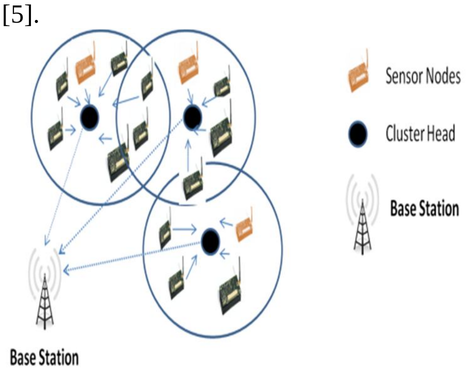

Fig. 1 Topology

The radio communication consumes more energy than the data processing on a sensor node. We assume the following energy consumption model for radio communication. The transmission of a *k*-bit message with transmission range *d* meters consumes *E*T(*k, d*) of energy.

$$E_T(k,d) = \begin{cases} k(E_{elec} + \varepsilon_{fs}d^2) & \text{for } d \le d_0 \\ k(E_{elec} + \varepsilon_{mp}d^4) & \text{for } d > d_0, \end{cases}$$

$$E_R(k) = k \cdot E_{elec}$$

Where *E*elec is the electronics energy, and *ε*fs and *ε*mp are the amplifier energy factors for free space and multipath fading channel models, respectively. The reception of a *k*-bit message consumes *E*R (*k*) of energy.

IV. THE PROPOSED METHODS

Extra effective clustering approaches than LEACH has been proposed such as HEED, HIDCA [3, 4, 6]. Though, they require additional inter-node communications for clustering. In this section, we proposed two types of methods with less inter-node communication for clustering. The primary approach is a federal approach, and the second is a distributed approach. The federal approach - In this method, the Base Station node supervise the clustering by exploit a k-means algorithm, specified the energy as well as other resource constraints in wireless sensor networks the proposed k-Means Based clustering approach In this energy efficient protocol we make the following assumptions. A large scale network with a large number of nodes exists where the sensors are grouped into clusters. Each cluster has a cluster-head which communicates with the base station and the nodes in its cluster. In a densely deployed large scale sensor network, there is a higher degree of spatial correlation between the data sensed by the sensors in a cluster. Data aggregation is thus used to eliminate redundancy and minimize the number of transmissions in a cluster in order to save energy. The clusters of sensors are formed in such a way that in a cluster no two sensors are more than some constant distance (d) apart which is specified according to the type of application. This assumption is made in order to ensure a higher degree of correlation between the data sensed by the sensors in a cluster. Our protocol uses the k-Means algorithm with certain medications for in-network data processing and aggregation. The k-Means algorithm is a well known partition based algorithm for clustering of data sets. We next give a brief description of k-Means algorithm. K-Means is a partition based clustering algorithm for large scale data analysis. In partition based cluster analysis of large data sets, optimal solution is obtained by computationally intensive extensive enumeration of all possible partitions of the data set. For practical purposes, hence, two

We describe our protocol as well as the distributed algorithms that are executed at the sensor nodes and the cluster-head. We define the following terms: k Denotes the number of partitions or groups of a set containing n data values at each sensor obtained by executing k-Means algorithm on the sensed data set at that sensor. K: Denotes the number of partitions or groups of a set data values at each cluster-head obtained by executing the k-Means algorithm at the cluster-head. In this protocol every sensor operates in two phases: Sensing Phase and k Means Phase. Sensing Phase: The sensing phase is the time interval during which the sensor collects data. As soon as a sensor has sensed substantial amounts of data values it goes into the next phase. K Means Phase: In this phase k-Means algorithm is executed over the data values collected during the sensing phase as shown Fig. 2-4. As a result we get a reduced set of k (k n) data items which give a good representation of the n data items sensed by the sensor. Now we present our algorithm in flow chart format. Our algorithm is a federal algorithm which executes independently at the sensor nodes and the cluster-heads. The algorithm for sensor nodes and cluster-heads and so we present them as follows. For simplicity, we assume that K is equal to k here. The LEACH allows only single-hop clusters to be constructed. On the other hand, in [2] authors proposed the similar clustering algorithms where sensors communicate with their cluster-heads in multi-hop mode. However, in these homogeneous sensor networks, the requirement that every node is capable of aggregating data leads to the extra hardware cost for all the nodes. Instead of using homogeneous sensor nodes and the cluster reconguration scheme, the authors of [17] focus on the heterogeneous sensor networks in which there are two types of nodes: super nodes and ordinary sensor nodes. The super nodes act as the cluster- heads. The ordinary sensor nodes communicate with their closest cluster-heads via multi-hop mode [21].. The major objective of federal approach is to use the sensor networks, like authors used in [17]. Federal approaches an interconnected set of clusters covering the entire node population. Namely, the system topology is divided into small partitions (clusters) with independent control. Using a clustering approach, sensors can be managed locally by a cluster head, a node elected to manage the cluster and responsible for relaying data to other cluster heads or the sink. In addition, clustering provides inherent optimization capabilities at cluster-heads, such as data pre-processing. Federal approach is a simpler, but sub-optimal scheme where the nodes employ the mixed communication modes: single-hop mode and multi-hop mode periodically. This mixed communication modes can better balance the energy load efficiently over WSNs and have already used in [16]. In addition federal approach will tend to preserve its structure when a few nodes are moving and the topology is slowly changing. Otherwise, high processing and communication overheads will be paid to reconstruct clusters. Within a cluster, it is easy to schedule packet transmissions and to allocate the bandwidth to data traffic. From an energy standpoint, the advantages of our proposed protocol federal approach are as follows: First, by routing all data through the local cluster heads, the nodes avoid high power long distance wireless transmission to the base stations. Only the cluster heads (which are the powerful nodes) have to do it. A cluster head can reduce the transmission energy expenditure by aggregating the collected data from its cluster before relaying them to the base stations. This reduces the overall network-wide transmission energy expenditure. Since the monitoring applications are often interested only in geographically aggregated data rather than per-node data, aggregation at cluster heads is highly desirable for extending the lifetime of sensor networks [13].

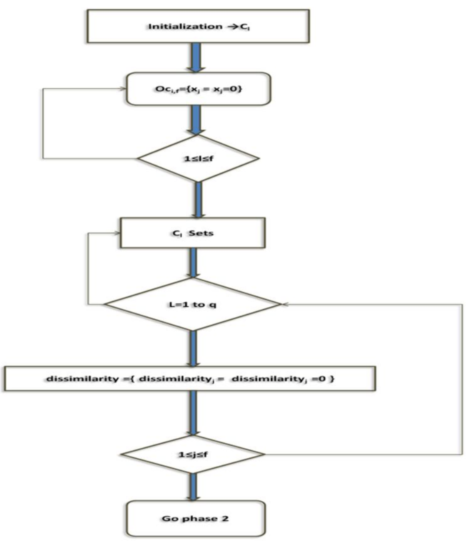

Fig. 1 Phase –I: K-means algorithms

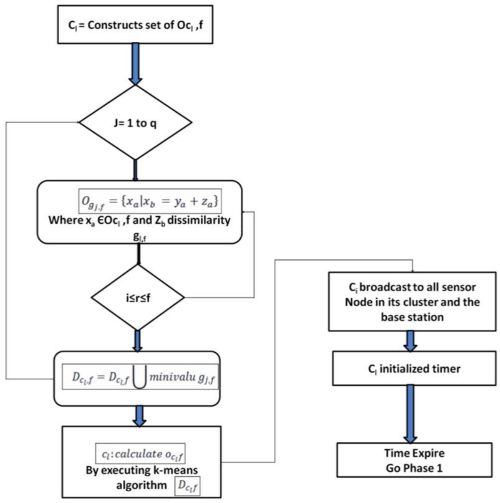

Fig. 3 Phase –II: K-means algorithms

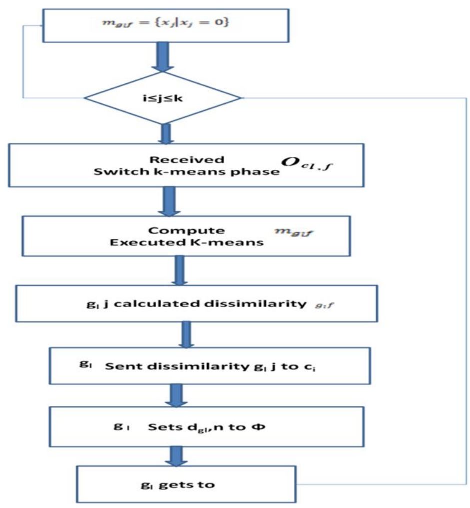

Fig. 4 Phase –III: K-means algorithms

Distributed approach: we study Distributed clustering protocols that have we performs IV phase in WSNs as shown in Fig. 5. The performance of two popular schemes, HEED and HIDCA protocols, Node clustering has been widely studied for WSNs and many clustering algorithms have been proposed in the literature, such as LEACH, HEED, and HIDCA. The Highest Identifier Clustering Algorithm (HIDCA), modified from [7], is a primitive clustering protocol. Initially, during the node discovery stage, each sensor node exchange information to determine its neighboring nodes. Then, each node compares its ID with those from its neighbors. If its own ID has the smallest number, the node will become the cluster head and all other nodes will request to join the cluster and hence become cluster members. After the cluster is formed, the cluster head, that is, the node with lowest ID, sends control packets to maintain the operation of the cluster. No cluster head rotation is considered in this protocol. The cluster head keeps serving for the cluster until its battery power is depleted, during which another round of clustering process will take place and the node with the second lowest ID will be selected as the cluster header. Similar step continues step I, step II, step III, step IV until all nodes in the network are out of service. The Low-Energy Adaptive Cluster Hierarchy (LEACH) combines the MAC (Medium Access Control) and routing functionalities. In LEACH, clusters are generated based on the optimal number of cluster heads, which is calculated using the prior knowledge of uniform node distribution.

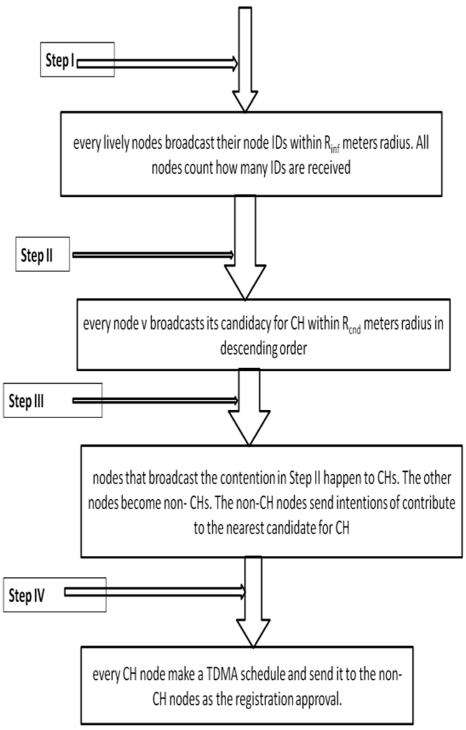

Fig. 5 Phase –IV: Distributed approach

The cluster head determines a TDMA schedule for each sensor nodes within its cluster. Global synchronization is usually required, which consumes significant amount of network resources. Moreover, the cluster diameter in LEACH is assumed to be unlimited, which may result in the generated cluster members being located far away from the cluster head and each other In HEED, clusters are generated without any assumption about node distribution. The cluster diameter is limited and fixed, and a cluster head rotation scheme is employed for load balancing. Although HEED can achieve a good load balance in a small area, the traffic loads in different areas are still unbalanced, thus leading to unbalanced energy consumption in the whole network. It should be pointed out that both LEACH and HEED are cluster head-centric algorithms, which first select cluster heads based on a selection policy, such as the node with the largest residual energy, and then adds each non-cluster-head node into the cluster of its nearest cluster head or the cluster head with some predefined property, such as the largest node degree.

IV. CONCLUSION

In this paper, we describe an energy-efficient clustering algorithm in wireless sensor network. We studied classic clustering algorithms in wireless sensor networks and find two main reasons causing unnecessary energy consumption, which are fixed operation periods and too much information exchanged in cluster-heads selection. We proposed clustering methods with less communication overhead for clustering. Based on federal management in k-means algorithm effective clustering and distributed algorithm.

REFERENCE

[1] Jin-Shyan Lee, Wei-Liang Cheng," Fuzzy-Logic-Based Clustering Approach for Wireless Sensor Networks Using Energy Predication" IEEE SENSORS JOURNAL, VOL. 12, NO. 9, SEPTEMBER 2012.

[2] Sampath Priyankara, Kazuhiko Kinoshita, Hideki Tode, and Koso Murakami, "A Clustering Method for Wireless Sensor Networks with Heterogeneous Node Types," 18th International Conference on Computer Communications and Networks (IEEE ICCCN 2009), Aug. 2009.

[3] Kyuhong Lee and Heesang Lee," EECR: Energy Efficient Clustering and Routing Approach for Wireless Sensor Networks" 978-1-4577-1088-9/11 IEEE-2011.

[4]Noritaka Shigei, Hiromi Miyajima, Hiroki Morishita, Michiharu Maeda," Centralized and Distributed Clustering Methods for Energy Efficient Wireless Sensor Networks" Proceedings of the International MultiConference of Engineers and Computer Scientists 2009 Vol IMECS 2009, March 18 - 20, 2009, Hong Kong.

[5] W. Heinzelman, et. al., An application-specific protocol architecture for wireless microsensor networks," IEEE Transactions on Wireless Communications, 1(4):660-669, 2002.

[6] Q. Xue, A. Ganz, "Maximizing Sensor Network Lifetime: Analysis and Design Guides", in Proceedings of MILCOM, October 2004.

[7] s. Basagni, "Distributed Clustering Algorithm for Ad-hoc Networks" ,Proceedings of International Symposium on Parallel Architectures,Algorithms, and Neworks(ISPAN), 1999.

[8]M. Chatterjee, S. K. Das and D. Turgut, "WCA: A Weighted Clustering Algorithm for Mobile Ad hocNetworks", Journal of Cluster Computing (Special Issue on Mobile Ad hoc Neworks), Vo1.5, No.2, pp.193-204, 2002.

[9] R. Krishnan and, D. Starobinski, "Efficient Clustering Algorithms for Self-organizing Wireless Sensor Networks", Ad Hoc Networks, vol. 4, pp. 36-59,2006.

[10]M. Qin and R. Zimmermann, "An Energy-efficient Voting-based Clustering Algorithm for Sensor Networks",Proceedings of the Sixth International Conference on Software Engineering, Artificial Intelligence, Neworking and ParalleliDistributed Computing and First ACIS International Workshop on Self-Assembling Wireless Networks (SNPD/SAVVN'05), pp. 444451, 2005.

[11] S. Banerjee and S. Khuller, "A Clustering Scheme for Hierarchical Control in Multi-hop Wireless Neworks", Proceedings of IEEE INFOCOM,2001.

[12] o. Younis and S. Fahmy, "Distributed Clustering in Ad-hoc Sensor Networks: A Hybrid, Energy-Efficient Approach",

[13] D. V. Paruchuri, "Adaptive Clustering Protocol for Sensor Networks", Aerospace, 2005 IEEE Conf.,pp. 1-8,2005

[14] Jin-Mookim ,Hayeon-Kyu JOO, Seong-Sik Hong, Woo-Hyun ahn,Hwang-Bin Ryuo," An Efficient Clustering Scheme through Estimate in Centralized Hierarchical Routing Protocol," 2006 International Conference on Hybrid Information Technology (ICHIT'06).

[15] W.R.Heinzelman A. Otandrakasan, and H.Balakrishnan, "Energy Efficient Communication Protocol for Wireless SensorNetworks," Proceedings of the 33rd Hawaii International Conference on System ScienceVolume 2, Jan 2000.

[16] U. Sajjanhar, P. Mitra,"Distributive Energy Efficient Adaptive Clustering Protocol for Wireless Sensor Networks", Proceedings of the 2007 International Conference on Mobile Data Management, pp. 326 - 330,2007

[17] Elbhiri Brahim,Saadane Rachid,Alba-Pages Zamora, Driss Aboutajdine,"Stochastic Distributed Energy-Efficient Clustering (SDEEC) for heterogeneous wireless sensor networks", ICGST-CNIR Journal, Volume 9, Issue 2, December 2009.

[18] Inbo Sim, KoungJin Choi, KoungJin Kwon and Jaiyong Lee, "Energy Efficient Cluster header Selection Algorithm in WSN", International Conference on Complex, Intelligent and Software Intensive Systems , IEEE, 2009.

[19] Linde, Y., Buzo, A., Gray, R.M., "An Algorithm for Vector Quantizer Design." IEEE Trans on Communications, V28, pp.84-95, 1980.

[20] Heinzelman, W.B., Chandrakasan, A.P., Balakrishnan, H., "An Application-Specific Protocol Architecture for Wireless Microsensor Networks," IEEE Trans on Wireless Communications, V1, N4, pp. 660-670, 2002.

[21] Younis, O., Fahmy, S., "HEED: A Hybrid, Energy- Efficient, Distributed Clustering Approach for Ad Hoc Sensor Networks," IEEE Trans on Mobile Computing, V3, N4, pp. 366-379, 2004.

[22] Chan, H., Perrig, A., "ACE: An Emergent Algorithm for Highly Uniform Cluster Formation," Proc. 1st Euro Workshop Sensor Networks, pp.154-71, 2004.