

Survey on Clustering in Wireless Sensor Network

P. Divya

Department of Computer Science
Pondicherry University
Puducherry, India

E-mail: divyapalanisamy281993@gmail.com

M. Sathya

Department of Computer Science
Pondicherry University
Puducherry, India

E-mail: satsubithra@gmail.com

Abstract: Running a large number of nodes requires an efficient mechanism to bring them all together in order to form a multi-hop wireless network that can accomplish specific tasks. Clustering allows the nodes to increase the ability of a sensor network. It transmits traffic in a scheduled manner by means of aggregation which provides the transmission delay and reduces the network life time. By addressing these problems to use cluster head for group of sensor nodes (SN) communication to derive appropriate clusters size and increase network lifetime. In this paper, the survey on WSN under Clustering with its classification are discussed briefly.

Keywords: Wireless sensor network, Clustering, Sensor nodes, Network lifetime

I. INTRODUCTION

Wireless sensor network has the number of data streams or connectivity of each device is limited by multiple access control (MAC) [25] or physical layer. Sensors are tiny devices that sense physical quantities and convert them into electrical signals and also have certain controls with energy, computation and storage. Network signifies that these sensor nodes in figure 1 can communicate among themselves. Wireless denotes that the communication takes place through a wireless medium. Thus Figure 1 shows that the WSN which consists of hundreds of sensor nodes that can sense their vicinity and communicate either among themselves or to the external base station.

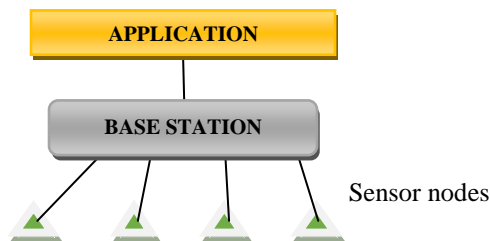


Figure 1. Wireless Sensor network

Sensor nodes contain battery powered and sometimes it is not possible to recharge or replace so that the battery power must be used effectively. Energy efficiency is one of the major design issue in wireless sensor networks. Other design issues are follows (i) Sensor nodes have routing capability (ii) architecture is not scalable because sensor nodes which place nearby to the sink, (iii) WSN be widespread, traffic of such nodes will increase and (iv) energy will be waste, consumed and finished so they go out of the WSN in fast. Clustering is grouping of objects which is from the same cluster or more similar to each other than objects from different clusters. Clustering is a technique employed in wireless sensor networks to provide balance in the network. Clusters are formed among the nodes and we have three different types of

nodes are ordinary node, cluster head and gateway. Cluster heads act as relays between the ordinary sensor nodes and base station. It also perform the task of data aggregation. Gateway nodes are those which are responsible for inter cluster communication. Major advantages of clustering are: (i) it reduces the distance which data has to travel sent by the ordinary node. Thus saves the lot of energy of ordinary nodes. (ii) it limits the amount of redundant data in the network as data aggregation is performed at the cluster heads. Clustering process takes place in two steps- first cluster heads are chosen and then clusters are formed. Clustering increases the network scalability and life. Nodes which are having highest energy are allocated more loads thus increasing the lifetime of the network [1] in the field. The clustering [1, 2, 3] is done in such a way that data has to travel minimum distance and Only cluster heads [5] communicates with the other cluster head which is near to that thus reducing the data redundancy which usually happens when each nodes in figure 1 perform its own data aggregation and transmission function separately. Some benefits are (i) Scalability of routing protocols, easier channel allocation and better intra-cluster coordination, (ii) To provide stable cooperative relationships, hence the objective is to favor data aggregation, (iii) Clustering also has its own costs and (iv) The interference avoidance obtained from a better channel allocation.

There are several key limitations in WSNs which is shown in figure 1, the limited energy in sensor nodes must be considered as proper clustering [1, 2, 3, 4] can reduce the overall energy usage in a network. The energy limitation on nodes results in a limited network lifetime [4] for nodes in a network. Proper clustering should attempt to reduce the energy usage, and hereby increase network lifetime [4, 5]. The two basic approaches for the co-ordination of entire clustering process are distributed and centralized are shown in figure 2. In distributed clustering, where each sensor nodes in figure 1 can run their own algorithm and takes the decision of

becoming cluster head [1, 3, 6]. In centralized clustering in figure 2, a centralized authority groups the nodes to form clusters and cluster heads. Sometimes hybrid scheme can also be implemented.

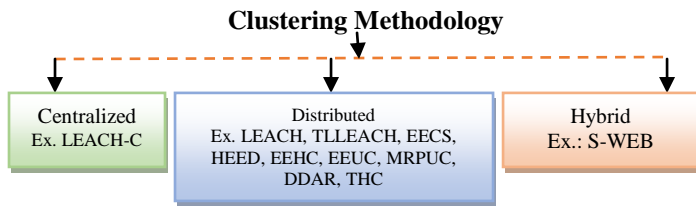


Figure 2. Clustering Methodology with different protocols

In centralized clustering, the clusters and cluster heads are made by an authority. Following are the algorithms of the centralized methodology. LEACHs [28] distributed algorithm, this protocol does not offer guarantee about the number of cluster head nodes. Since the clusters are adaptive, obtaining a poor clustering during a given round won't greatly affect overall performance. Two-Level LEACH (TL-LEACH) proposed extension of LEACH [28] algorithm which uses two levels of cluster heads in addition to the other simple sensing nodes. Energy Efficient Clustering Scheme (EECS) [16] is a clustering algorithm in which cluster head candidates compete for the ability to elevate to cluster head for a given round. Hybrid Energy Efficient Distributed Clustering (HEED) [22] is a multi-hop clustering algorithm for Wireless Sensor Networks. Energy-efficient unequal clustering (EEUC) [9] is multi-hop WSNs, there exists a hot-spot problem that CHs closer to the base station tend to die faster, because they relay much more traffic than remote nodes. EEUC [9] proposed to balance the energy consumption among clusters, in which the cluster sizes near the sink node are much smaller than the clusters far away from the sink node [10, 12] in order to save more energy in intra-cluster communications [1, 2, 3, 5] and inter-cluster communications. Energy Efficient Hierarchical Clustering (EEHC) [9] is a distributed, randomized clustering algorithm in which CHs collect data from the non-cluster head node in different clusters and send an aggregated report to the base-station. Multi-hop routing protocol [1, 5] with unequal clustering (MRPUC) [5, 16] is a distributed clustering scheme which operates in rounds, and each round is separated into three phases: cluster setup, inter-cluster [4, 5] multi-hop routing formation and data transmission [15]. Dynamic clustering and distance aware routing protocol (DDAR) [11] takes into account node distance for selecting CH, dynamic approach of selecting the CH nodes, and two level hierarchy of clustering with super cluster head (SCH) node near to the BS. It consumes about 15.5% less energy than conventional LEACH [28] protocol. Two Hop Clustering Protocol (THC)

[3] is proposed to increase the energy saving in sensor nodes. CH selection is based on remaining energy and node degree.

Clustering technique algorithms are supports an energy efficient path for data transmission. In this paper we have studied various clustering methodologies such as centralized, distributed and hybrid. Also we find out many advantages and some limitations of clustering techniques which is objective of this paper. The study of different clustering techniques will helpful to design new clustering approach which will reduce energy so as to improve network lifetime.

II. RELATED WORK

In cluster formation process the cluster heads will broadcast request packet to the sensor nodes come in radio range to form cluster. In single hop nodes transmits to the cluster head directly and in multi hop all sensor node will send their data through neighbor node. Figure.3 summarizes the classification of different attributes of clustering in wireless sensor networks. This process is repeated periodically with the aim so that every node in the network becomes cluster head and all nodes can equally share the responsibility of message transmission, ensuring longer life for all the nodes. Although LEACH [28] is one of the most elegant protocols that is extensively studied by many researchers [10, 11, 13, 17, 18] the randomized nature of its cluster head selection has some limitations. There are ample scopes for improvement as far as the network lifetime and energy efficiency is concerned as described in [10, 11]. An extension of LEACH [28] which is based on the local density of sensors. However in a low density area, the probability that a sensor becomes a cluster head is high. The results show that the proposed method increases the network efficiency in terms of energy consumption and lifetime comparing to LEACH [28].

III. CLASSIFICATION OF CLUSTERING PROTOCOLS

In recent years, various clustering-based routing techniques have been proposed which are distinguished by how the CHs would be selected. In this section, discuss the set of attributes can be used to differentiate clustering protocols [21] for wireless sensor networks under clustering techniques. Selection of the appropriate CHs can significantly minimize the overall energy consumption of nodes, and enhance the network lifetime. The most existing researchers choose cluster heads in accordance with various metrics such as residual energy, distance, locations and node densities. Anker_et al proposed hierarchial [21] model requires two main methods are periodic selection of cluster heads (CHs) and assignment of each node to one or multiple clusters It provides network reliability, data collection quality, transmission cost and better

aggregation. HEED [22] performs more because nodes die, so this difference significantly decreases.

Dali Wei et al proposed the method cluster head selection and Traffic hot spots are used to save the travel time between the nodes. It provides less load with cluster-based routing algorithms comes from a variety of circumstance such as greater scalability, less energy consumption and more robustness. Malathi et al was proposed the method data forwarding, chain construction and Cluster setup are used to provide the good distribution of clusters. Simple compression algorithm which also improves lifetime without using complex algorithm and also to reduce redundant data transmission. But it has more energy consumption. Pei et al proposed the uneven clustering method, determination of CHs, and Clusters establishment which are provides the density of nodes and the distance between CHs and sink. LEACH [28] have less delay relative to clustering routing protocols at almost same time delay. Peng et al proposed the energy neutral clustering and Sensor energy consumption models has to provide energy efficiency and scalability. Energy Neutral Clustering protocol is used to group the network into several clusters with the goal of endless network operation. The background works are look closely for based on attributes in clustering under WSN which includes some parameter such as energy efficiency and load balancing are shown above table. From this the contribution of survey is under the LEACH [28] protocol in distributed manner of clustering method.

Clustering algorithms are diverse and oriented to different scenarios. Hence, it is hard to determine which algorithm is best, but it is possible to say which algorithm is more suitable for a certain scenario. Energy-Efficient Communication Protocol for Wireless Micro sensor Network (LEACH) [28] sensors are organized into clusters and randomly select a few nodes as cluster head with a certain probability of becoming a cluster heads per round. The task of being a cluster head is rotated between nodes. The rotation role balances the energy dissipation of the nodes in the networks. LEACH [28] is a distributed algorithm but cluster count (cluster head) is not fixed in each round per epoch. Due to distributed algorithm each node is capable to select itself as a cluster head by choosing random number. There is possibility that each node choose same number for cluster head selection [1, 2, 3, 4, 5] due to randomness property of random number generator. So cluster head count is varying in each round. An application-specific protocol architecture for wireless micro sensor networks (LEACH-C) [30] uses a centralized approach where the information of node location and energy level was communicated to base station. The base station decides about the cluster head selection and cluster formation. In this

protocol the selection of cluster heads is random and the cluster head number is limited. The base station sure those nodes have less energy than it cannot become a cluster head. It increases the latency and delay.

Hybrid Energy-Efficient Distributed Clustering (HEED) [22] improves the LEACH protocol by using residual energy, node degree or density as a main parameters for cluster formation to achieve power balancing. The first primary parameter is the residual energy [10,15] of each node; second parameter is the intra-cluster communication [1, 2, 3, 4, 5] cast as a function of cluster density or node degree. The primary parameter selects initial set of cluster heads [2, 5, 6] probabilistically which secondary parameter is breaking ties. HEED [22] is not able to fix the cluster count in each round and it is also not aware of heterogeneity. Distributed Cluster Head Election Scheme for Improving Lifetime of Heterogeneous Sensor Network and Applications (DCHE) [8] has distributed cluster head election scheme for heterogeneous WSNs. The election of cluster heads [1, 2, 9, 4] is based on different weighted [5] probability. The weight assigned to each node will decide the selection of cluster head [2, 5, 9] for each type. Simulation results show that the DCHE [8] scheme offers a better performance in terms of lifetime and stability than LEACH, DEEC [17] and direct Transmission. Energy Efficient Scheme for Clustering Protocol Prolonging Lifetime of Heterogeneous Wireless Sensor Networks (TDEEC) [24] is an energy efficient cluster head election scheme for heterogeneous WSNs. It requires the average network energy for cluster head selection [1, 5, 6, 8], which is more energy consumable. Energy Efficient Cluster Based Data Aggregation for Wireless Sensor Networks (ECBDA) [29] has data aggregation method to enhance the network lifetime.

In Cluster Head election process, one node is selected as cluster head from each cluster by using its residual energy and the communication cost factor. Once a node is elected as a cluster head, it broadcasts the cluster head message to its cluster members. The proposed protocol leads to small sized cluster which lead to more amount of data transfer from cluster head [1, 2, 3, 5] to base station it is energy consumable. An Energy Efficient Clustering Method for WSN (EDBC) [19] has a protocol which considers the residual energy and distance from the base station of each node in the cluster head selection process. The cluster head election probability [17, 29] in closer segments is more than distant segments and the number of cluster heads [1,5] in these segments is more. Distributed Clustering Algorithms with Load Balancing in Wireless Sensor Network (DCLB) [12] evaluate distributed clustering with load balancing for forming cluster efficiently and balancing load in inter cluster communication cluster. Size

is important in terms of energy in multi hop communication of cluster heads. Since it determine data volume in every step of clustering to avoid energy inefficiency [3, 6] and balanced load of cluster [12].

shown above table. From this the contribution of survey is under the LEACH [28] protocol in distributed manner of clustering method. The suggestion of ns2 with the clustering framework in or MatLab with the framework to undergo detailed simulations on clustering algorithms [1, 2, 3, 4, 5, 6, 7, 8, 9] and also suggest to evaluate clustering performance [15, 22] in a square-based scenario [14] with random mobility, since it is the most commonly adopted clustering benchmark and it is easier to model analytically and distributed.

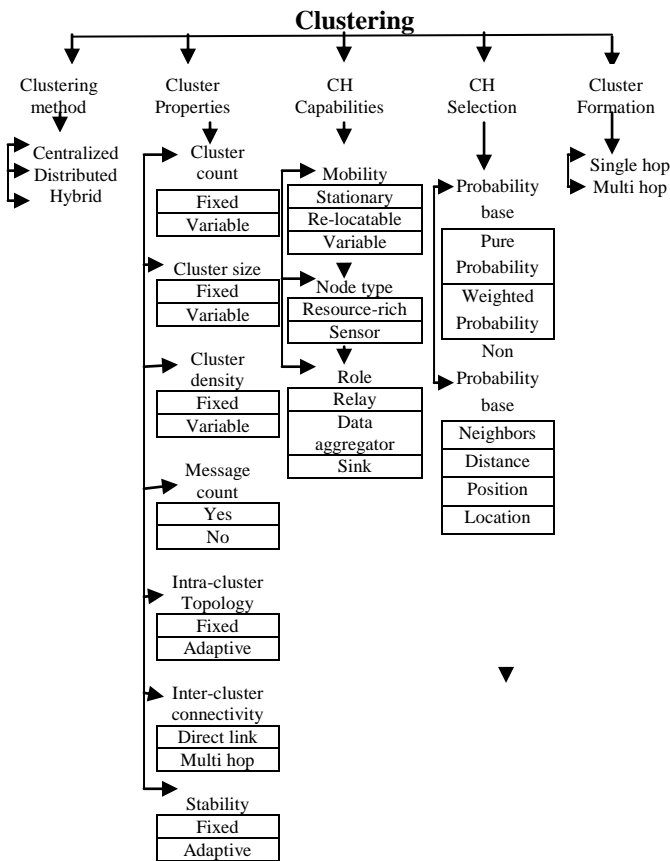


Figure 3. Classification of the different attributes of clustering in WSN

A Density and Distance Based Cluster Head Selection Algorithms in Sensor Networks (DDCHS) [15] has an algorithm to elect the cluster head based on density and distance of sensor nodes in the sensor network. This protocol shows better performance than LEACH [28] and HEED [22]. A location Based Clustering Algorithm for Wireless Sensor Networks (LBC) [3] has a protocol to prolong the lifetime of sensor network. The clusters are formed only once during the lifetime of sensor network. Cluster heads rotation depends on the residual energy of a cluster heads. The rotation frequency timing of cluster head is based on energy consumption of sensor nodes for various tasks performed by them during the lifetime of sensor network. This ensures balanced energy consumption of all sensor nodes present in a cluster, resulting in prolonged network lifetime. The proposed protocol is static in nature, cluster head selection procedure is not well in term of energy consumption. Load balancing [12] is unevenly distributed, so all these lead to poor stability period.

The background works are look closely for based on attributes in clustering under WSN which includes some parameter such as energy efficiency and load balancing are

Table 1. Comparison of protocols with the clustering attributes

Algorithm	Clustering method	CH Capability	Cluster Properties	CH Selection	Cluster Formation	Parameters	
	Control manner	Data aggregation	Scalability	CH election	CH Rotation	Energy Consumption	Network Lifetime
LEACH-C[30]	Centralized	No	Poor	Probabilistic	Yes	Low	Yes
DEBC[6]	Centralized	No	Poor	Probabilistic	Yes	M	Yes
DEEC[17]	Centralized	Yes	Poor	Probabilistic	Yes	High	Yes
LEACH[28]	Distributed	Yes	No	Probabilistic	Yes	Low	No
UCR[13]	Distributed	No	No	Id-based	Yes	Low	No
DDEEC[11]	Distributed	Yes	Yes	Probabilistic	Yes	High	No
SDEEC[4]	Distributed	Yes	Yes	Probabilistic	Yes	M	Yes
DWEHC[23]	Distributed	Yes	Yes	Weight based	Yes	High	No
LBC[3]	Distributed	No	Yes	Connectivity	No	Low	Yes
EDBC[19]	Hybrid	No	No	Weight based	No	High	Yes
HEED[22]	Distributed	Yes	Yes	Probabilistic	Yes	Yes	Yes
DDCHS[15]	Distributed	Yes	Yes	Probabilistic	Yes	High	Yes
PRODUCE[14]	Hybrid	Yes	Yes	Proximity	No	Yes	No
MNCP[5]	Distributed	No	Yes	Weight based	Yes	Yes	No
DCLB[12]	Distributed	Yes	No	Connectivity	No	M	Yes
SBDEEC[10]	Distributed	Yes	Yes	Weight based	Yes	High	No
DCHE[8]	Distributed	No	Yes	Weight based	Yes	M	No
TDEEC[24]	Distributed	Yes	Yes	Weight based	Yes	Yes	No
EECCIA[27]	Distributed	No	Yes	Weight based	Yes	Yes	No
EEHC[9]	Distributed	Yes	No	Weight based	Yes	M	No
EECS[16]	Distributed	Yes	Yes	Weight based	Yes	Yes	Yes
FEED[20]	Distributed	No	No	Weight based	Yes	Yes	No
ECBDA[29]	Distributed	Yes	No	Weight based	Yes	No	No
HSR[31]	Distributed	No	No	Distance based	Yes	Yes	Yes
WEP[21]	Distributed	Yes	Yes	Weight based	Yes	No	No

After the comparison of these clustering protocols with the parameter which develop the LEACH protocol under the Wireless Sensor Network in distributed manner. It have the data aggregation with the other nodes while communication without scalability. It has probabilistic form of cluster formation and energy consumption is low with more network lifetime.

IV. CONCLUSION

In Wireless Sensor Network, many approaches and techniques have been proposed for optimization of energy usage. In order to gather information more efficiently, wireless sensor networks are partitioned into clusters. To improve the network lifetime and energy efficiency investigate the hop count for required nodes are grouped and perform all the sensor

node give the exact information in a deployed manner in such case it can reduce the energy consumption and maximize the life time and also improve the performance while comparing metrics like Network lifetime, Packet delivery ratio. During survey under this aspects, energy consumption is more so it can be reduces by using life time and energy of clusters to save more energy while guaranteeing the packet

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