



Cluster Head Election with Node Heterogeneity in WSN: A Survey

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Abstract- In the wireless sensor network the entire sensor nodes having the limited resources that's why wireless sensor network is known as resource driving network. In which to save the resources and energy data must be assemble to overcome the amount of traffic in the network. Assembling of data may also be done with the help of clustering scheme. Clusters overcome the local traffic to group the sensor nodes and bind the data together and then transmit the compressed data to the base station. Therefore the important part is to elect the best cluster head to increase the lifetime of the network by applying limited energy in adequate manner. Numbers of algorithms are advised for election of cluster head for increase the life time of network. Such algorithms are the attention of this survey.

Keywords- cluster, Traffic, cluster head election, energy factor, resources.

I. INTRODUCTION

To supervise the physical and economical conditions such as temperature, sound, pressure etc. Wireless Sensor Network [1], [2], [3] (WSN) consists of self-governing sensors and depart the data through the network to the chief location. The advancement of wireless sensor network was driven by military applications such as battlefield supervision; today such networks are used in many manufacturing and consumer applications, like process observation and determination, health monitoring [4], etc. Sensor nodes are like small computers that is very basic in their parts and there interfaces. They are basically consists of limited memory, limited computational power and limited processing unit. Every sensor node having the battery which is usually worked as power source. The base stations may have one or more components of the WSN with infinite gauge energy and communication assets. They act as a entrance between sensor nodes and the end user as they typically forward data from the WSN on to a server.

II. CLUSTERING IN WIRELESS SENSOR NETWORK

Hierarchical clustering is the efficient way [5] to use the energy in the best manner. The group of clusters performs the same task is known as the clusters. Clusters head, regular nodes and base station are the main components of the hierarchal cluster. When the cluster head is elected it collects the data from all its member nodes and combines it in order to remove the repetition. Thus it limits the amount of data transmission to Base Station, hence remaining energy level is increased and network lifetime is also increased. There are several key attributes [6] which must be carefully considered, while designing the clusters in WSN:

A. Clustering Specifications

- 1). *Number of Clusters:* Number of clusters may be changes according to the CH election algorithm.
- 2). *Intra-Cluster Communication:* Conversation between the regular node and CH may be one-hop communication or multi-hop communication.
- 3). *Nodes and CH Mobility:* Architecture of cluster is dynamically changed in the case of sensor nodes are in mobility.
- 4). *Types of Nodes and its Role:* The nature of the node may be homogeneous or heterogeneous. In homogeneous, all sensor nodes have same abilities such as same energy level, configurations. In heterogeneous, nodes are changes in configurations.
- 5). *Cluster Head Election:* Based on the criteria such as connectivity, cost of communication, remaining energy mobility CH is selected from the distributed nodes. CH election may be in deterministic or ambiguous way.
- 6). *Multiple Levels:* Multi level clustering approach is used to achieve better energy distribution, in very large networks.
- 7). *Overlaying:* Overlaying of different clusters in not supported by most of the protocols.

B. Matter of contention in clustering

To create a managerial structure between sensor nodes in WSN, it has the capabilities to distribute them in an ad hoc manner. Because it is not possible to maintain these nodes into groups, pre distribution. To achieve the managerial structure there has been a large amount of researches are in the progress. The clustering paradox, play an important role not just in maintains the network, but can dramatically affects the network performance. There are several drawbacks that clustering scheme must consider.

- 1). *Confined Energy*: Wireless Sensor Nodes having limited energy storage and the able use of this energy will be required in determining the rang of suitable application for this network. The confined energy in the sensor nodes must be considered as proper clustering that can overcame the complete energy usage in a network.
- 2). *Network life-spam*: The energy limitations of the nodes resulting in confined network lifespan for the nodes in the network. Proper clustering should attempt to reduce the use of energy, and hereby increase network lifespan.
- 3). *Confined Abilities*: The limited physical size and limited amount of stored energy in sensor node confined many abilities of nodes in the term of processing and communicational abilities. A good clustering algorithm should make use of shared resources within a managerial structure, while taking into account the limitation on individual node abilities.
- 4). *Application Dependency*: Often a given application will densely depends on cluster organization When designing a clustering algorithm, application strength must be considered as a good clustering algorithm should be able to adapt to a variety of application requirements.

III. CLUSTERING ALGORITHMS

A). LEACH Protocol (Low Energy Adaptive Clustering Hierarchy)

LEACH collects the data from distributed sensor nodes and transmits it to the base station. Some of the nodes choose themselves as a cluster heads. The chosen cluster heads collect sensor data from other nodes in the local area and transfer the collected data to the base station. The process of transferring data to the base station is very energy consuming. In LEACH [7] cluster head election based on the chosen percentage of CHs for the network. Each node elects a random number between the interval 0 & 1. If the produced random number is less than the threshold then the node become a CH for the current round. A round is a process of electing cluster head, Cluster formulation, and data communication at the same time. Each round consisting of two phases: - (a) Set-up phase (b) Steady state phase.

(a). Set-up phase: In the set-up phase cluster head make a proclamation of its selection by sending message to all other nodes in order to form a cluster.

(b). Steady state phase: - cluster head creates a TDMA schedule for their member to transfer their data and acknowledges when it to transmit, nodes send data in the given period. Transmission of the regular nodes is switched off until their schedule is reached, to save the energy. Finally CH aggregates the collected data and sends to base station.

Problems in LEACH:

(i). selection of cluster head is random and also not cares about the energy consumption of nodes. Because of this cluster head may die, if the CH dies the cluster became invaluable, (ii). Most of the time it fails to cover large area and not consistent in the distribution of CHs, (iii). It is unable to address the schedulability and predictability measures.

B). ACW (adaptive contention Window)

To select the cluster head, an Adaptive Contention Window (ACW) is proposed in this section. The main aim behind the propose ACW-based head selection mechanism is that all sensor nodes randomly pick a retreat value from the contention window based on the uniform distribution and then the sensor node with minimal retreat can be cluster head in its communication rang. ACW can rotatively select a cluster head.

System model: in our system model we assume that all the sensor nodes are synchronized by a certain synchronization mechanism [3]. In the starting of each round the entire sensor node make use of an existing contention based medium access control (MAC) protocol to compete the channel. If the channel contention is successful sensor node become a cluster head. Next the cluster head regularly transmit a signal to initiate other sensor nodes to be its member in order to form a cluster. If the circumstances between the request node and response node are comfort with certain parameters such as distance or receiving power, the respond node confirm the request node and become a member of this request node.

The ACW algorithm can achieve four major goals in cluster head election for WSNs.

(i). High probability of successful cluster head election, (ii). Suitable number of cluster heads, (iii). ACW is able to uniformly distribution of cluster heads, (iv). For each sensor time is equal to be a cluster head, concurrently.

C). CIPRA (Clustering and In-Network Processing Routing Algorithm)

CIPRA is energy efficient data gathering technique which engages a hierarchical clustering algorithm and In-network processing. CIPRA increases the life time of the network by distributing energy consumption. CIPRA divide the energy load of the cluster head to the member sensor so that energy of each sensor coequally diminishing over all network. In CIPRA when sensor senses the data every node sends the data to its nearby node instead of cluster head. Nearby nodes aggregate data to overcame the amount of data and transfer the aggregated data to their nearby nodes, which may be their cluster head. By using the local information of each sensor CIPRA is capable to self organize a data routing tree. Sensor should vigorously adjust radio transmission energy to adapt the change in the network topology due to vanishing of nodes. The nearby nodes lessen the communication distance by using the local communication between the nodes. In network processing at each member node distributes the energy load of cluster head for the member nodes. The main focus of CIPRA to distribute the energy load to each node to avoid the intensive energy consumption of the cluster head.

IV. CLUSTERING ALGORITHMS BASED ON ENERGY CONSIDERATION

A. Energy Residue Aware (ERA) Algorithm

Cluster head selection in this algorithm is same as in the LEACH. But it different in the formation of cluster that is relation between the cluster head and other nodes. When CH is selected as in the LEACH CH estimated their residual

energy [10] and sends this information to all other nodes. The residual energy is calculated by subtracting the remaining energy of CH in the current round from energy requirement for transferring data to base station. Similarly all other regular nodes calculate their residual energy by subtracting their remaining energy in the current round. After this process they collaborate with one CH according to the sum of maximum energy residual path. Thus it increases network life time by balancing the energy consumption of the network. In LEACH, shortest distance is selected by the regular nodes to choose the cluster head. That's why there will be a chance that CH dies earlier. As compared to LEACH, ERA extends the network life time by equalizing the energy consumption of nodes. ERA guarantees for optimal CH selection by extending network lifetime, but it not focus on network monotony.

B. LEACH – C Algorithm [LEACH – Centralized]

LEACH-Centralized Cluster Head Election depends upon the current location of the node and residual energy [11]. In initial phase every node sends it current location and residual energy to the base station. Base station approximates the average energy from the gathered energy information. It then finds which nodes energy level is higher than average energy level and those nodes will be selected as cluster head. After the selection of cluster head base station broadcast the message with selected cluster head's ID to all nodes. Nodes whose ID is matched with the ID containing in the message become cluster head. Because of LEACH-C based on location and residual energy CHs are scattered throughout the network. Here the difficulty is, base station is responsible for calculating average energy level. In this case if any node fails to communicate with base station due to the distance from base station the favorable probability of cluster head selection is less. LEACH-C focus on the energy level of the network but not on the predictability of the network.

C. Efficient Cluster Head Selection Scheme for Data Aggregation [EECHSSDA]

EECHSSDA [12] reduce the problem of LEACH-C. in this cluster head election is same as the LEACH-C. When the energy of the cluster head is decreases it elects a Associative Cluster Head (ACH). If the energy of the cluster head is going to drain ACH play a role of CH. For the selection of ACH the node having the higher energy level after the energy of cluster head is less than average energy act as an ACH. Due to the presence of ACH there is no need to elect the cluster head periodically. Hence it reduces the load overhead, use of energy and there is no need to elect cluster head periodically. EECHSSDA promises to obtain best cluster head energy efficiency but it is also not focus on predictability.

D. Hybrid Energy- Efficient Distributed Clustering [HEED]

In HEED cluster head selection depends on residual energy and intra cluster communication cost. HEED [13] is a hierarchal, distributed clustering scheme. There is a single hop communication within each cluster and multi hop communication between CHs and base station. Initial set of cluster head is maintained by using residual energy. Communication between the cluster is use to decide to join a cluster or not. This is based on the node's nearness or node's degree to adjacent nodes. Every sensor node approximate CH_{pb} values for become a cluster head as follows:

$$CH_{pb} = C_{pb} * E_{res} / E_{max}$$

This value of probability should not be beyond the threshold value P_{min} , P_{min} is inversely proportional to E_{max} . This algorithm is based on the fix number of repetition. Each node use these repetitions until it find a cluster head. CH will be the node with least communication cost. At the end of repetition each node doubles the CH_{pb} value. If this CH_{pb} value reaches to 1 repetition will end. There are two types of cluster head status that a sensor node broadcast to its adjacent. I) CH_{pb} less than 1 that is node become a experimental CH_{pb} . II) if CH_{pb} reaches to 1 node become permanently a CH. In the last final Cluster head consider a CH and experimental CH become a regular node. If two nodes are in the same transmission rang of each other then probability of electing cluster head will be small. In HEED synchronization is required and use of energy is significant if cluster head are at distance. It also needs feedback of complete network to determine the intra cluster communication cost. Communication cost is very difficult to calculate practically. So it is also very tough to obtain network life time bound to ensure predictability.

E. Probabilistic Clustering Algorithm

This algorithm is the enhanced version of HEED [14]. This algorithm is used to produce a small number of CH in relatively few rounds, especially in sparse networks. It consists of three phases: i) Core Head Selection ii) Cluster Head selection iii) Finalize CH. During Core Head Selection each node checks whether its cost is least among its adjacent. If it is true, then it will set itself as Core Head; otherwise select the adjacent node with least cost as Core Head. During Cluster Head Selection other than Core Heads are involved. Selection of cluster head is same as of HEED. In the final round, final CHs are considered as CHs, and temporary CH becomes regular nodes. In this, every regular node must have one neighboring final CH with the highest priority as its CH; otherwise it will be considered as an naked one. All naked nodes run the Core Head Selection procedure in order to select some added CHs. Here also access the predictability bounds of network is difficult.

F. High Energy First Algorithm [HEF]

HEF is used to access the excellent Cluster Head, increase the network life time & schedulability bounds also derived under IOCH [15]. Here the Cluster Head is selected based on maximum residual energy. After each round, energy consumption of CH and regular nodes are calculated. From this calculated value, those nodes contain higher residual energy will be selected as CH. Cluster formation is similar to LEACH. HEF algorithm is based on residual energy, at different rounds nodes have maximum energy will be selected as CH. So the sink rate of the nodes will be linear and

packet delivery rate is increased. At the end of each round, uses of energy is better and hence network lifetime is increased in higher level compared to other algorithms. It also supports for deriving life time bounds for performing schedulability test to ensure predictability of the nodes. This prediction is very much helpful for real time WSN.

VI. CONCLUSION

To expand the network life time excellent cluster head selection is important. As compare to all other nodes CHs need more energy because they perform processing, sensing, communication and aggregation. In case, the cluster head dies priory, then the entire network becomes useless; since the CH cannot communicate with Base Station. To obtain excellent cluster head, CH should be elected based on the residual energy of each and every node. Therefore energy efficiency is expands & network lifetime is also increased.

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