DEVELOPMENTS OF CLUSTERING HIERARCHY FOR WIRELESS SENSOR NETWORKS

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Abstract

The esteemed criteria for clustering methodology are to select cluster heads with more residual energy and to rotate them periodically. Sensors at heavy traffic locations quickly deplete their energy resources and die much earlier, leaving behind energy hole and network partition. Clustering goes behind some advantages like network scalability, localizing route setup, uses communication bandwidth efficiently and takes advantage of network lifetime. By the data aggregation process, unnecessary communication between sensor nodes, cluster head and the base station is evaded. This paper gives a detailed description of Low Energy Adaptive Clustering Hierarchy and its further developments.

Keywords: Wireless sensor network (WSN), distributed clustering algorithm, coverage based clustering, energy efficiency, network lifetime.

1. INTRODUCTION`

Each of the distributed senor nodes typically consists of one or more sensing elements, a data processing unit, communicating components and a power source, which is usually a battery [1]. The sensed data is collected, processed and then routed to the desired end user through a designated sink point, referred as base station. Now it has become feasible to construct multifunctional sensor nodes with advanced capabilities. Such sensor nodes are relatively of smaller size, lower cost and lesser power consumption. WSNs are originally motivated for the use in military applications, such as border monitoring. Now a days it is mainly focused on civilian applications such as environment monitoring, object tracking and bio-medical applications [2] – [9].

II. RESEARCH WORKS IN CLUSTERING

WSNs consist of hundreds of even thousands of sensor nodes which may be sparsely distributed in remote locations. Thus, it becomes infeasible to recharge or replace the dead batteries of the nodes. As soon as, some of the sensor nodes in a WSN run out of energy, they stop functioning causing progressive deconstruction of the network. Therefore, one of the most stringent limitations that the development of a WSN faces is that of power consumption. Hence each and every protocol should be so designed, that minimum energy should be consumed during sensing, processing and communication [10].

Three layers are involved in the functioning of a WSN. Physical and data link layers, of the protocol stack deals with energy awareness, radio communication hardware, low duty cycle issues, system partitioning and energy aware MAC protocols. At the Network layer, of the protocol stack, the main aim is to find ways for energy efficient route setup and reliable data transmission from the sensor nodes to the base station in order to prolong the overall network lifetime as much as possible [11] – [17]. The

routing protocols proposed have is the Hierarchical routing protocols. The main idea is that, every sensor node with in a WSN is grouped along with some other of its neighboring nodes so as to constitute a specific cluster. Data collected by the sensor nodes are not directly transmitted to the Base station. Instead, a node of the cluster called Cluster head, collects these data and forwards them to the base station after possibly having performed appropriate data aggregation.

III. ENHANCEMENTS ON LEACH

Distributed clustering is the mechanism in which there is no fixed central cluster head and the cluster head keeps on changing from node to node based on some pre-assigned parameters [18] –[21].

LEACH is a clustering mechanism that distributes energy consumption all along its network, the network being divided into clusters and the CHs are purely distributed in manner, and the randomly selected CHs collect the information from the nodes which are coming under its cluster as proposed by (Heinzelman et al 2002). LEACH protocol involves four main steps for each round: Advertisement phase, Cluster set-up phase, Schedule creation and Data transmission. During the advertisement phase, the eligible CH nodes will be issuing a notification to the nodes coming under them to become a cluster member in its cluster. The nodes will be accepting the offer based on Received Signal Strength (RSS). In the cluster set-up phase, the nodes will be responding to their selected CHs. In schedule creation step, as the CH receives response from the nodes, it has to make a Time Division Multiple Access (TDMA) schedule and send back to its cluster members to intimate them when they have to pass the information to it. In the data transmission step, the data collected by the individual sensors will be given to the cluster head during their time intervals. The main constraint here is that, the cluster member nodes will be turned off to reduce energy consumption after the data transmission during particular time slot gets over.

A new version of LEACH called TL-LEACH is the clustering methodology in which the CH collects data from other cluster members as in original LEACH, but rather than transferring data to the base station directly, it uses one of the CH that lies between the CH and the base station as a relay station as worked out by (Zhixiang and Bensheng 2007). It has two levels of cluster heads (primary cluster head and secondary cluster head). The primary CH in each cluster communicates with the secondary CH, and the corresponding secondary CH communicates with their sub-cluster nodes. Data aggregation can be executed as in LEACH. Additionally, communication within a cluster is scheduled by means of TDMA time-slots. The association of a round comprises of first selecting the primary and secondary CHs using the same mechanism as in LEACH, with the probability of being elevated to a primary CH lesser than that of a secondary node. Transmission of data from source node to the base station is carried out in two steps, and the secondary nodes gather data from nodes in their own clusters. Data aggregation could be done at this level. Primary nodes gather data from their respective secondary clusters. Data aggregation can also be applied at the primary CH level. The two-level arrangement of this algorithm decreases the number of nodes that need to transmit the data to the base station, thereby successfully reducing the total energy usage [22-25].

Heinzelman et al (2002) proposed a distributed clustering methodology LEACH-F in which the number of clusters will be permanent all-through the network lifetime and the cluster heads are rotated within the respective clusters. Steady state phase of LEACH-F is analogous to that of LEACH. LEACH-F may or may not offer energy saving and does not offer flexibility to sensor node mobility.

Heinzelman et al (2002) carried out few modifications in the original LEACH protocol and was proposed as LEACH-C. The original LEACH cluster formation algorithm has the disadvantage of having no assurance about the number of cluster head nodes. As the clusters are adaptive, there is underprivileged clustering set-up during a round. Nevertheless, by using a central control mechanism to form clusters can create better clusters by distributing the cluster head nodes all-through the network, which forms the basic concept behind LEACH-C.

Depedri et al (2003) proposed a distributed clustering methodology LEACH-B which

functions in the following phases: cluster formation, cluster head selection and data transmission. Each sensor node decides its cluster head by assessing the energy dissipated in the path between the last receiver and the node itself. It offers enhanced energy efficiency in comparison with LEACH.

Lijun et al (2006) proposed a distributed clustering methodology LEACH-ET where the clusters will alter only when one of the following conditions are fulfilled: energy consumed by any one of the cluster heads attains the Energy Threshold (ET) in one round and every sensor node is supposed to have the idea of the energy threshold value.

LEACH-E offers enhancement in the selection of cluster heads when compared to the LEACH protocol as worked out by (Fan and Song 2007). It considers the residual energy of a node as the chief factor which decides whether these sensor nodes turn into cluster head or not in the subsequent round. LEACH-E assists a large in the cluster head election procedure.

Chen and Shen (2008) formulated ME-LEACH-L which is an energy-efficient multi-channel clustering-routing protocol for wireless sensor network. With the intention of controlling the size of every cluster and separating the cluster heads from backbone nodes, ME-LEACH-L supervises the channel assignment amid neighbouring clusters and co-operation among the CHs during data collection process [26-34].

Guo et al (2010) proposed ACHTH–LEACH to overcome few of the inadequacies of LEACH. The clusters are set up on the basis of Greedy k-means algorithm. The cluster heads are elected on the basis of residual energy of the sensor nodes, which might assume two hop transmissions to decrease the energy spent while forwarding the data to the base station. The performance of ACHTH-LEACH could be additionally enhanced if few parameters and the threshold values are optimized.

The frequently employed security solutions based on cryptography and other conventional methods cannot answer the related issues of internal attackers. To attain excellent security feature for wireless sensor network, the Trust-Based LEACH was proposed by (Song and Zhao 2008). This protocol ensures secure routing, while keeping the essential functionalities of the original LEACH protocol. The decision-making is based on the decision trust, which is evaluated separately and adaptively for dissimilar decisions by the fundamental situational trust.

Liu et al (2008) formulated LEACH-DCHS-CM for fulfilling the requirement of frequent formation of clusters. The algorithm mainly focuses on the energy balance when certain extent of sensor nodes fails.

TB-LEACH is an efficient protocol for cluster head selection based on time as formulated by (Junping et al 2008). The principal mechanism of TB-LEACH is the formation of constant number of clusters. This algorithm constructs clusters by using random-timer mechanism.

In O-LEACH, the infrastructure of the network is composed of a Distributed Fiber Sensor (DFS) link and two separated wireless sensor network fields as worked out by (Lianshan et al 2011). The DFS link is situated at the center of the sensor fields and can cover certain area. The two fields are filled with randomly scattered nodes and these nodes can or cannot communicate with each other depending on the required applications. This O-LEACH algorithm exhibits good energy efficiency, especially when two wireless sensor networks are not reachable to each other.

MS-LEACH mainly focuses on the problem of energy consumption during single-hop and multi-hop transmissions within a cluster as demonstrated by (Qiang et al 2009). A critical value of cluster area size is established. MS-LEACH is based on the critical value and this method outperforms LEACH protocol in terms of network lifetime.

MR-LEACH exhibits multi-hop routing with low energy dynamic cluster hierarchy to diminish the energy consumption of the wireless sensor nodes as formulated by (Farooq et al 2010). The performance assessment of MR-LEACH clearly reveals that MR-LEACH performs well when compared to analogous approaches, given that the network is partitioned into optimal number of layers.

Han (2010) proposed LEACH-HPR which is an energy efficient cluster head election technique, and uses the customized Prim's algorithm to build an inter-cluster routing in heterogeneous wireless sensor network. LEACH-HPR is more effective in reducing and balancing the energy

consumption, and hence demonstrates an enhanced network lifetime.

IV. CONCLUSION

LEACH protocol involves four main steps for each round: Advertisement phase, Cluster set-up phase, Schedule creation and Data transmission. During the advertisement phase, the eligible CH nodes will be issuing a notification to the nodes coming under them to become a cluster member in its cluster. This paper gives a detailed description of Low Energy Adaptive Clustering Hierarchy and its further developments. The sensed data is collected, processed and then routed to the desired end user through a designated sink point, referred as base station. Now it has become feasible to construct multifunctional sensor nodes with advanced capabilities. Such sensor nodes are relatively of smaller size, lower cost and lesser power consumption.

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