An Enhanced Distributed Clustering Methodology and Data Aggregation in Connecting Dissimilar Wireless Sensor Networks

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Abstract: One of the major advantages of wireless sensor network is their ability to operate in unattended, harsh environments in which existing human-in-the-loop monitoring schemes are uncertain, inefficient and sometimes impossible. Therefore, wireless sensors are expected to be deployed randomly in thepredetermined area of interest by a relatively uncontrolled manner. Given the huge area to be covered, the short lifespan of the battery-operated wireless sensors and the possibility of having damaged sensor nodes during deployment, large population of sensors are expected in the majority of wireless sensor applications. In centralized clustering, the cluster head isfixed. The rest of the nodes in the cluster act as member nodes. In distributed clustering, the cluster head is not fixed. The cluster head keeps onshiftingformnodetonodewithintheclusteronthebasisofsomeparameters.Hybridclusteringisthe combinationofbothcentralizedclusteringanddistributed clustering mechanisms. This paper gives a brief overview on clustering process in wireless sensor networks and an enhanced distributed clustering methodology and data aggregation in connecting dissimilar wireless sensor Networks. The proposed method is compared with LEACH and HEED Clustering methods.

Keywords:Distributed clustering algorithm, Energy efficiency, Delay, Throughput.

1. Introduction

One or more data storage devices are attached to the IP network to archive the sensor data from a number of edge sensor networks. One of the major advantages of wireless sensor network is their ability to operate in unattended, harsh environments in which existing human-in-the-loop monitoring schemes are uncertain, inefficient and sometimes impossible. Therefore, wireless sensors are expected to be deployed randomly in thepredetermined area of interest by a relatively uncontrolled manner. Given the huge area to be covered, the short life span of the battery-operated wireless sensors and the possibility of having damaged sensor nodes duringdeployment, large population of sensors are expected in the majority of wireless sensor applications. Figure 1 shows a typical militaryapplicationof WSN.

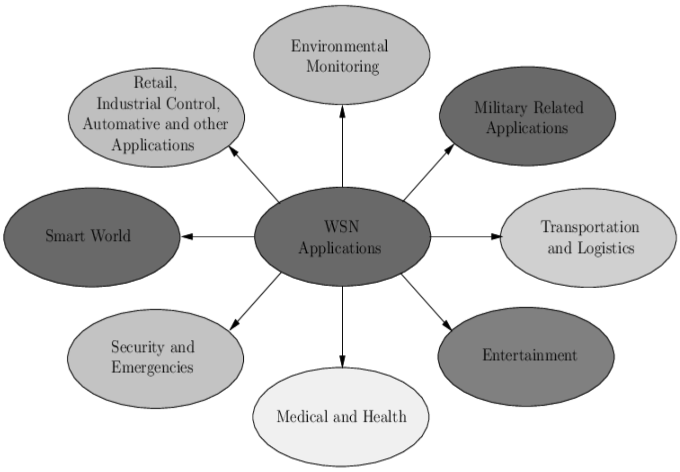

Figure 1. A typical Militaryapplicationof WSN

Generally awireless sensor node consists of low power processor, tiny memory, radio frequency module, various kinds of sensing devices and limited powered batteries which finds applicable in target tracking, environmental monitoring and oceanography. Much of energy consumption happens during wireless communications. The energy consumption when transmitting one bit of data equals to several thousands of cycles of CPU operations.

Hence the energy efficiency of a wireless communication protocol brutally affects the energy efficiency andlifetime of the network. Many researchers have projected several algorithms for WSNs to improve energyconsumption and network lifetime. Since these wireless sensor devices are power-constrained, long-distance communications are not encouraged [1].Thereby direct communication between the nodes and base station is generally avoided. A proficient way is to arrange the network into several clusters and each individual cluster has a cluster-head (CH) [2]. CH is one of the sensor nodes which are affluent in resources. Sensor nodes send their sensed information to the CH during their respective TDMA time-slots [3]-

[5].The CH performs data aggregation process and forwards the aggregated data to base station (BS). Figure 2 shows the articulation of TDMA time-slots in wireless sensor network

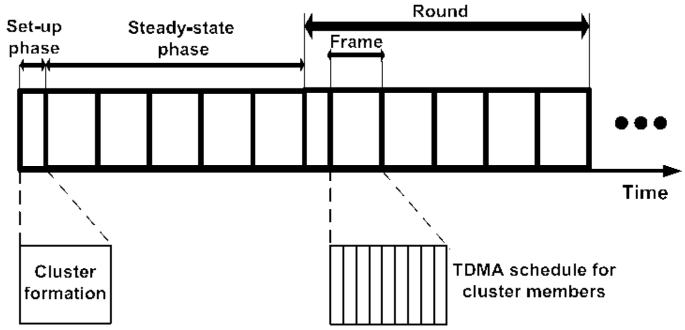

Figure 2.TDMA time-slots in wireless sensor network

Clustering follows some advantages like network scalability, localizing route setup within the cluster, uses communication bandwidth efficiently and makes best use of network lifetime. Since clustering uses the mechanism of data aggregation, unnecessary communication between the sensor nodes, CH and BS is avoided. Figure 3 shows the articulation of clustering mechanism.

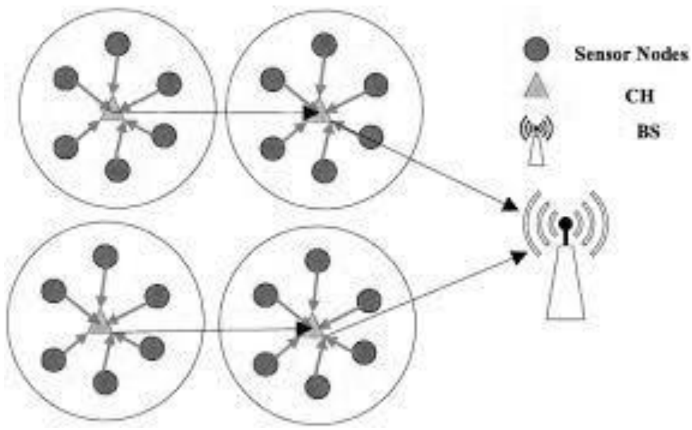

Figure 3. Atypical clustering mechanism

In this proposed work, thecriterion of a node is the combination of three parameters: the number of tasks assigned to a particular node, remaining energy and coverage with neighboring nodes. The node with highest criterion is selected as a CH for the current round. The primary objective of the proposed algorithm is to attain energy efficiency and extended network lifetime.

2. Review of Literature

One of the well-known clustering algorithms is Energy-Efficient Hierarchical Clustering (EEHC), a randomizedclustering algorithm organizing the sensor nodes into hierarchy of clusters with an idea of minimizing the totalenergy spent in the system to communicate the information gathered by the sensors to the information processing center.

Another clustering algorithm, Linked Cluster Algorithm (LCA) was mainly implemented to evade the communication collisions among the nodes by using a TDMA time-slot. It uses a single-hop scheme, attains highdegree of connectivity when CH is selected randomly. With an objective to figure overlapping clusters withmaximum cluster diameter of two hops, CLUBS was implemented in WSNs. The clusters are formed by localbroadcasting and its convergence depends on the local density of the sensor nodes. This algorithm can beimplemented in asynchronous environment without losing efficiency. The main hitch is the overlapping ofclusters, clusters having their CHs within one hop range of each other, thereby both clusters will collapse and CH election process will restart. Fast Local Clustering Service (FLOC) achieves re-clustering in constant time and in a confined manner in large scale networks, exhibits double-band nature of wireless radio-model for communication.

According to Energy Efficient Clustering Scheme (EECS), all CHs can communicate in a straight line with basestation. The clusters have variable size, such that those nearer to the CH are bigger in size and those farther from CH are smaller in size. It is proved to be energy efficient in intra-cluster communication and excellent improvement in the total network lifetime. Energy Efficient Unequal Clustering mechanism (EEUC), was anticipated for uniform energy consumption within the network. It forms unequal clusters, with a supposition that each cluster can have variable sizes. Based on nodes" residual energy, connectivity and a unique node identifier, the cluster heads election is done in Distributed Efficient Clustering Approach (DECA). It is extremely energy efficient, as it uses fewer messages for CH selection. The main problem with this algorithm is that high possibility of incorrect CH selection which leads to discarding of all the packets sent by the sensor node. In order to select CH based on weight: ablendof nodes" residual energy and its distance to neighboring nodes, Distributed Weight-based Energy-efficient Hierarchical Clustering (DWEHC) has been proposed. It generates well balanced clusters, independent on network topology or dimension. Hybrid Energy-Efficient Distributed Clustering (HEED) is a well distributed clustering algorithm in which CH selection is made by taking into account the residual energy of the nodes as well as intra-cluster communication cost leading to prolonged network lifetime.

Low Energy Adaptive Clustering Hierarchical Protocol (LEACH): It uses the following techniques to accomplish the design goals: randomized, self-configuring, adaptive cluster formation, local control for data transfers, low-energy media access control and application specific data dispensation [5]. LEACH protocol has various rounds and each round has two phases: setup phase and steady state phase. In set up phase, it provides cluster formation in adaptive manner and in the steady state phase data transfer takes place. LEACH uses a TDMA toreduce inter-cluster and intra-cluster collisions. The energy utilization of the information gathered by the sensors node to reach the BS depends on the number of cluster heads and radio range. *LEACH-F*: In this algorithm the number of clusters will be permanent throughout the network lifetime and thecluster heads are rotated within the cluster. Steady state phase of LEACH-F is alike as that of LEACH. LEACH-F may or maynot offer energy saving and this protocol does not provide flexibility to sensor nodes‟ mobility. *LEACH-C*: LEACH cluster formation algorithm has the disadvantages of having no guarantee about the number of cluster head nodes. Since the clusters are adaptive, there is deprived clustering set-up during around. However, by using a central control mechanism to form clusters can produce better clusters by distributing the cluster head nodes throughout the network.

LEACH-B: This algorithm operates in the following phases: cluster formation, cluster head selection and datatransmission. Every sensor node chooses its cluster head by evaluating the energy dissipated in the path way between the last receiver and itself. It provides better energy efficiency in comparison with LEACH. *LEACH-ET*: The cluster will adjust only when one of the following conditions is satisfied: Energy consumed by any one of the CHs reaches energy threshold (ET) in one round, every sensor node should have the knowledge of the energy threshold (ET) value. During the initial phase, if anyone of the cluster head nodes dies, it should have the energy dissipated value and compares the dissipated value with the energy threshold (ET) value. *Energy–LEACH*: This mechanism provides improvement in selection of cluster heads of LEACH protocol. Itmakes residual energy of a node as the main factor which decides whether these sensor nodes turn into the cluster head or not in the next round. E-LEACH helps a large in the cluster head election procedure.

TL-LEACH: This algorithm works in three phases: cluster-head casing, cluster setup and data transmission phase. This protocol is an improvement of LEACH where some of the cluster heads elected during setup phase in LEACH are chosen as the level-2 cluster heads (CHs), which communicates with the base station. *MH-LEACH:* This protocol improves the communication mode from a single hop to multi hop between clusterhead and base station. In LEACH, every cluster head directly communicates with sink ignoring the distance between the sink and the cluster head. The modified form, MH LEACH protocol adopts an optimal path between the base station and cluster head; there by multi hop communication takes place among cluster heads [6].*ACHTH–LEACH:* ACHTH–LEACH was proposed to improve the shortcomings of LEACH. The clusters are setup on the basis of Greedy k-means algorithm. The cluster heads are elected by considering the residual energy of sensor nodes, which may adopt two hop transmission store duce the energy spent on forwarding data to the BS. The performance of ACHTH-LEACH can be further improved if some parameters and threshold values are optimized.

3. Proposed Method

The proposed clustering algorithm is well distributed, where the sensor nodes are deployed randomly to sense thetarget environment. The nodes are divided into clusters with each cluster having a CH. The nodes throw the information during their TDMA time slot to the irrespective 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 theexisting algorithms, the proposed algorithm has two distinguishing features.

First, the proposed algorithm usesvariable transmission power. Nodes nearer to CH use lesser transmission power and nodes far away from CH useextra power for transmission from nodes to CH or vice versa, which can lessen considerable power.

Second, CHsends one message for every cluster nodes but many existing algorithms transmits numerous messages forcluster-setup. The schematic clustering method is shown in Figure 4.

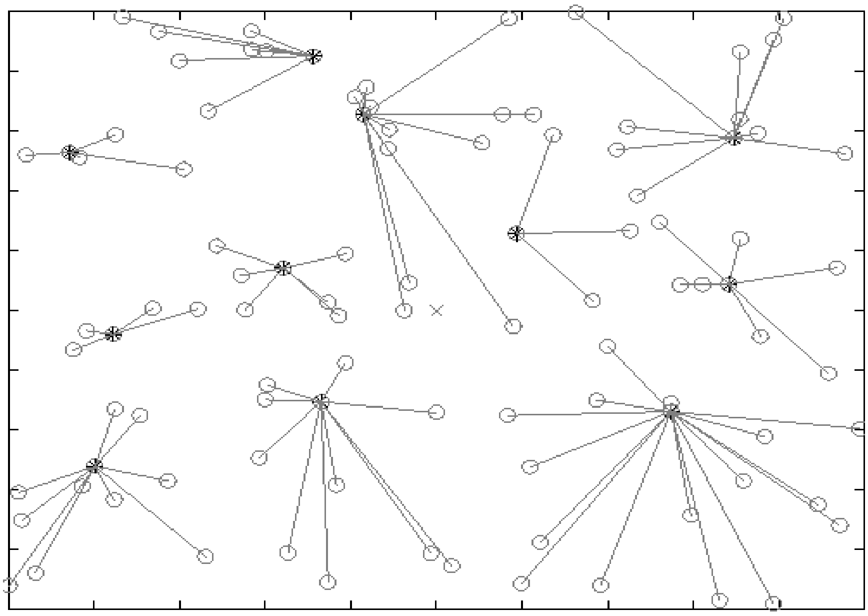

Figure 4. Schematic clustering

Table 1. Results of the simulation outcome

Number of Rounds		10	20	30	40	50	60	70
% Lifetime	HEED	90	63	45	21	8	2	3
	LEACH	89	55	40	20	3	1	2
	PROPOSED	93	88	83	65	50	35	19

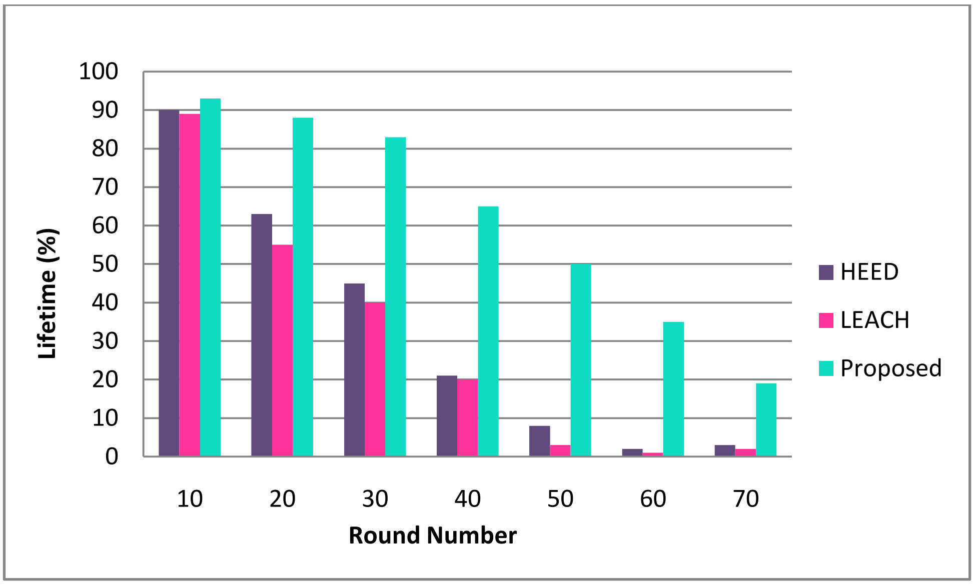

Figure 5. Lifetime Comparison

Figure 5 shows the lifetime comparison of LEACH, HEED and Proposed methods. The average lifetime of HEED is 33.14%, the average lifetime of LEACH is 30% and the average lifetime of proposed method is 61.85% that is largely enhanced when compared with existing methods.

4. Conclusion

To overcome the drawbacks of these existing algorithms a distributed clustering model hasbeen proposed for clustering the wireless sensor nodes. Based on the criterion, the algorithm hasbeen formulated to form efficient clusters in a wireless sensor network. The proposed distributed clustering algorithm can show much improvement in communication energy. The performance of the proposed algorithm can show a drastic improvement in the total energy of the wireless sensor system. The overall lifetime is greatly enhanced in the proposed method when compared with LEACH and HEED clustering methods.

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