VOL. 2, ISSUE 2, FEB. 2013 ISSN NO: 2319-7471

Multipart Nets Structure- Collecting Data and reducing interruption

S.Nirmala[1], S. Jancy Sickory Daisy[2]
[1]Asst.Professor, Department Of CSE, P.R.Engineering College, Vallam, Thanjavur
[2]Asst.Professor, Department Of IT, P.R.Engineering College, Vallam, Thanjavur
[1]s_nirma_be@yahoo.co.in, [2]jancydaisy@yahoo.com

Abstract: There are strong needs to develop wireless sensor networks algorithms with optimization priorities biased to aspects besides energy saving. Energy saving is always crucial to the lifetime of a wireless sensor network, since they are battery-powered devices. The objective of the proposed network formation algorithms is, therefore, to achieve the proposed network structure while keeping the energy consumption in the data collection process at low value. It has been focused on conserving energy by clustering. Wireless sensor nodes are used to collect information from their sensing terrain in wireless sensor networks. In order to construct the proposed network structure in a centralized and a decentralized approach, there are two network formation algorithms are implemented. Performances of the proposed network structure are evaluated using computer simulations.

Index Terms: Centralized control, distributed control, clustering networks, optimization methods, multihop network.

I. INTRODUCTION

Wireless sensor networks consist of large amounts of wireless sensor nodes, which are compact, light-weighted, and battery-powered devices that can be used in virtually any environment. Because of these special characteristics, sensor nodes are usually deployed near the targets of interest in order to do close-range sensing. The data collected will undergo in-network processes and then return to the user who is usually located in a remote site. Sensor nodes must conserve their scarce energy and stay active in order to maintain the required sensing coverage of the environment.

A network with clustering is divided into several clusters. Within each cluster, one of the sensor nodes is elected as a cluster head (CH) and with the rest being cluster members (CM). The cluster head will collect data from its cluster members directly or in a multihop manner. By organizing wireless sensor nodes into clusters, energy dissipation is reduced by decreasing the number of nodes involved in long distance transmission. The number of data transmissions and energy consumption can be further reduced by performing data/decision fusion on nodes along the data aggregation path. Clustering provides a significant improvement in energy saving. Let T be the average transmission delay among nodes. In Fig. 1(a), a base station will take 4×T to collect a complete set of data from the network. By transforming the network into a multihop network, as shown in Fig. 1(b), it can be shown that the time needed by the base station to collect a full set of data from the network can be reduced to 3×T.

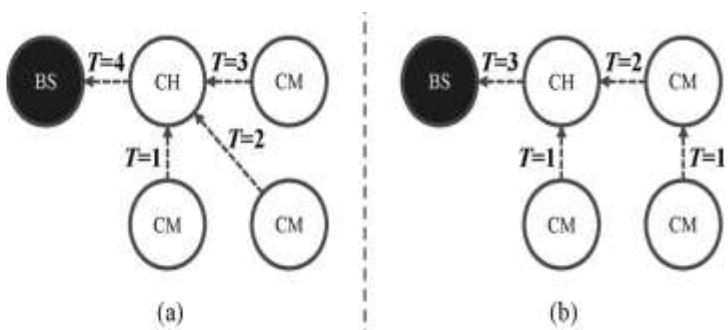

Fig.1. (a) Data collection in a two-hop network and (b) data collection in an improved multihop network. Circles with CM represent the cluster members. Circles with CH represent the cluster heads. Filled circles with BS represent the base stations. A dashed arrow represents the existence of a data link and the direction of the arrow shows the direction of data flow.

In the modified network, apart from requiring a shorter delay in data collection, cluster members will need smaller buffers to handle the incoming data while waiting for the belonging cluster head to become available.

The aim of this paper is to investigate the characteristics of a delay-aware data collection network structure in wireless sensor networks. Two algorithms for forming such a network structure are proposed for different scenarios. The proposed algorithms are operating between the data link layer and the network layer. The algorithms will form networks with minimum delays in the data collection process. At the same time, the algorithms will try to keep the transmission distance among wireless sensor nodes at low values in order to limit the amount of energy consumed in communications.

II. RELATED WORK

Due to the energy constraint of individual sensor nodes, energy conservation becomes one of the major issues in sensor networks. In wireless sensor networks, a large portion of the energy in a node is consumed in wireless communications. The amount of energy consumed in a transmission is proportional to the corresponding communication distance. Therefore, long distance communications between nodes and the base station are usually not encouraged. One way to reduce energy consumption in sensor networks is to adopt a clustering algorithm. A clustering algorithm tries to organize sensor nodes into clusters. Within each cluster, one node is elected as the cluster head. The cluster head is responsible for: 1) collecting data from its cluster members; 2) fusing the data by means of data/decision fusion techniques; and 3) reporting the fused data to the remote base station. In each cluster, the cluster head is the only node involved in long distance communications. Energy consumption of the whole network is therefore reduced. Intensive research has been conducted on reducing energy consumption by forming clusters with appropriate network structures.
The objective of this paper is to form data links among wireless sensor nodes and thus to shorten the delays in the data collection processes.

III. THE PROPOSED NETWORK STRUCTURE

The proposed network structure is a tree structure. To deliver the maximum data collection efficiency, the number of nodes in the proposed network structure has to be restricted to $N=2^p$, where p=1, 2…. Each cluster member will be given a rank, which is an integer between 1 and p. A node with rank will form data links with nodes, while these nodes are with different ranks starting from 1, 2…. up to k-1. All these k-1 nodes will become the child nodes of the node with rank k. The node with rank k will form a data link with a node with a higher rank. By following this logic, the distribution of the rank will follow an inverse exponential.

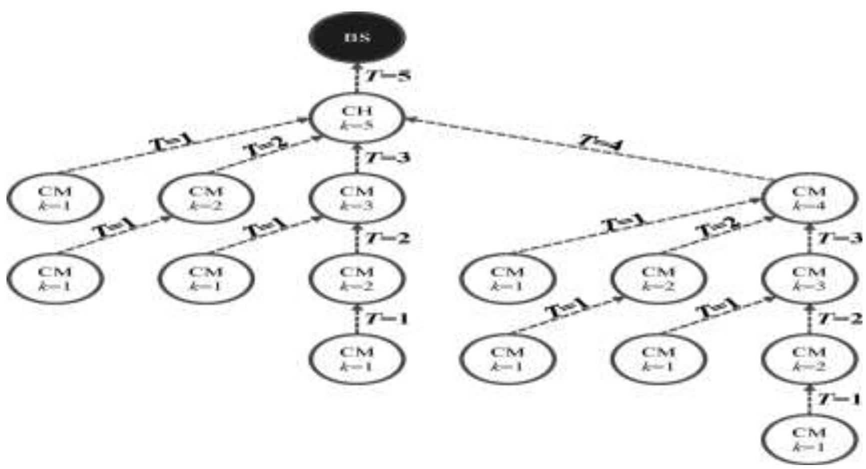

Fig.2: Proposed network structure with network size N=16 Circles with CM represent the cluster members. Circle with CH represents the cluster head. Filled circle with BS represents the base station. Rank of each node is represented by the variable K. A dashed arrow represents the existence of a data

Through adopting the proposed network structure, a node of rank (where) requires time slots to collect data from all its child nodes.

Proof: Consider a network with $N=2^p$, where p=1, 2…. For a node of rank k=2, the time slots required for it to collect data from all its child nodes is equal to the number of child nodes it has, which is 1. Thus, the case for k=2 is true. Now, let us assume that any node k=n of connection requires n-1 time slots to collect all data from its child nodes. For node i of rank k=n+1, it has n directly connected child nodes. Each of these directly connected child nodes has different ranks ranging from 1 to n. Thus, they need 0 to time slots to collect data from all their sub-child nodes plus one extra time slot to report their aggregated data to node. Therefore, the maximum time slots required for node to collect data from all its child nodes. By induction, the Lemma is proved.

VOL. 2, ISSUE 2, FEB. 2013 ISSN NO: 2319-7471

IV. NETWORK FORMATION ALGORITHM

It has been proven in the last section that the delay in the data collection process of a wireless sensor network can be greatly reduced by adopting the proposed network structure. Since energy consumption is always a major issue in the study of wireless sensor networks, A wireless sensor node can be considered as a device built up of three major units, namely the microcontroller unit (MCU), the transceiver unit (TCR), and the sensor board (SB). Each of these units will consume a certain amount of energy while operating.

The energy consumed by a wireless sensor node can be expressed as

$$E_{i\text{-}SN} = E_{i\text{-}MCU}+E_{i\text{-}TCR}+E_{i\text{-}SB}$$

where $E_{i\text{-}MCU}$ represents the energy consumed by the MCU, $E_{i\text{-}TCR}$ represents the energy consumed by the TCR, and $E_{i\text{-}SB}$ represents the energy consumed by the SB.

$$E_{TOT}(N) = C1+C2+C3\sum d_i^2$$

Here, (7) shows that the total energy consumption of the network can be minimized by reducing .Thus, the objective of the proposed network formation algorithms is to construct the proposed network structure, while keeping at low value. In this section, two network formation algorithms, namely the top-down and the bottom-up approaches, are proposed to achieve the objective mentioned above.

A. Top-Down Approach

The top-down approach is a kind of centralized control algorithm. In this approach, the base station is assumed to have the coordinates of all sensor nodes in the network. The whole approach is going to be executed at the base station. At the end of the optimization process, the base station will instruct the sensor nodes to establish the essential data links and form the appropriate network structure. The proposed network structure can be constructed according to the following algorithm.

The algorithm starts with considering the whole network as a fully connected network. The term connected refers to the existence of a data link between two wireless sensor nodes which is used to transmit data packets in the data collection processes. Select b nodes from H_S set to form H_{S+1} set, such that $\sum_{ij\in Hs+1}$ is maximized. Here, d_{ij} denotes the geographical distance between i node and j node. The rest of the nodes H_S from will form H_{S+1}set. The algorithm will then remove all connections (data links) among H_{S+1}nodes within H. Repeat step 2 until b< 2. Set r =2.

Nodes with degree N-r form set. Nodes with degree N-r greater than form set U such that set L and set U are of the same number of nodes. After reducing the number of connections, set r← r × 2 Repeat step 4 until r = N.

B. Bottom-Up Approach

The operation of the bottom-up approach is to join clusters of the same size together. It can be implemented in either centralized or decentralized fashion. Specifically, a decentralized bottom-up approach can be described as follows.

1) Each node is labeled with a unique identity and marked as level. The unique identity will only serve as an identification which has no relation with sensor nodes' locations and connections. For a cluster of nodes, its value is equal to $\log_{2i}$. Within each cluster, one node will be elected as the subcluster head SCH. In the bottom-up approach, a SCH can only make connection (i.e., setup a data link) with another SCH of the same level. Since there is only 1 node in each cluster, all nodes begin as SCH (0). The dimensions of the terrain (t_x, t_y) are provided to the sensor nodes before deployment.

2) Each SCH performs random back off and then broadcasts a density probing packet (DPP) to its neighboring SCHs which are within a distance of m.

3) Each SCH will do a random back off and then broadcast an invitation packet (IVP) to its neighbors within m. The IVP contains the level and the identity of the issuing SCH. A SCH will estimate the distances to its neighboring SCHs using the received signal strength of the IVPs received.

4) Once they are connected, the two SCHs and their belonging level- clusters will form a composite level cluster. One of the two involved SCHs will become the chief SCH of the composite cluster. The chief SCH will listen to the communication channel and reply any CR from lower levels with a rejecting packet (RP). When no more CR from lower levels can be heard, the chief SCH will start to make connection with other SCHs of the same level.

5) If a RP is received, a SCH will send a CR to its next nearest neighbor in its database. If such neighbor does not exist, the SCH will increase its. The SCH will then broadcast a CR using the new. Upon receiving the CR, a SCH of the same level will grant the request if it is still waiting for a CR.

6) If no connection can be made within a period of time, either all neighbors of the same level are unavailable or all CRs have been rejected, the SCH will increase its and broadcast the CR again. This process repeats and the SCH will make connection with the base station directly. The above processes continue until no more connection can be formed.

V. SIMULATIONS

In this section, the proposed network structure will be compared with a MC2H network, a SC network, a MST network, and a CTP network. Networks having nodes with varying from 4 to 64, with a step size of 4, will be distributed randomly and evenly on a sensing field of 50. The center of the sensing field is located. In the simulations, synchronization among wireless sensor nodes is maintained by the physical layer and the data link layer. For the simulations on network lifetime, each node is given 50 J of energy. A network will perform the data collection process periodically. The lifetime of a network is defined as the number of data collection processes (in terms of rounds) that a network can accomplish before any of its nodes runs out of energy. Each data packet is p_{data} bits long. Other packets are all regarded as control packets. Each control packet is p_{ctrl} bits long.
For the proposed network structure to work as a Type I structure, either the top-down or the bottom-up approach can be applied provided that sufficient dummy nodes are added. To work as a Type II structure, the proposed network structure can be constructed by the bottom-up approach without adding any dummy node.
Simulation results are shown in Figs. 3-7.

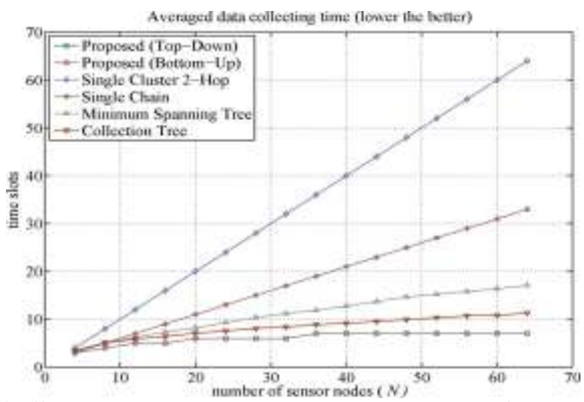

Fig. 3. Averaged data collection time of different single tree structures. Note that results obtained from the proposed algorithm using the top-down approach are overlapping with those obtained from the bottom-up approach.

VI. ANALYSIS

The DCT of networks with the proposed Network structure is the lowest among Type I structures. In simulations among the six Type I structures, DCT of networks with the proposed network structure is the lowest, followed by networks with CTP. Since the aim of the MST is to minimize the total weight of edges, it does not perform well in reducing bottleneck and therefore it ranks fourth.

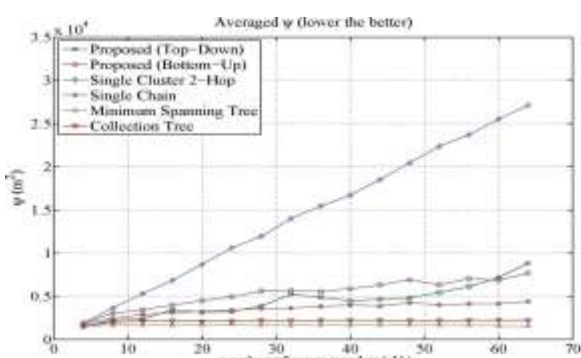

Fig 4.Averaged lifetime of different single tree structures.

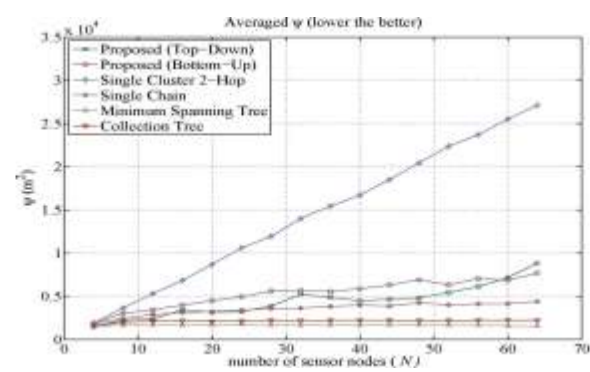

Fig.5. Averaged of different single tree structures.

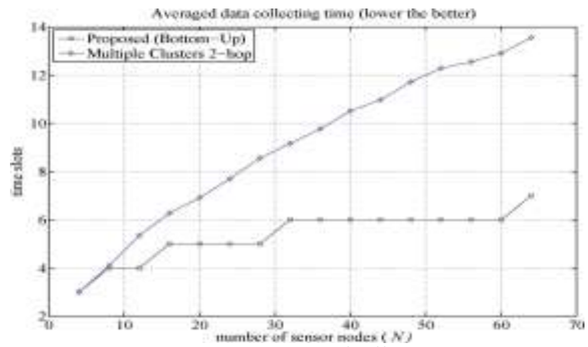

Fig. 6. Averaged data collection time of different multiple-cluster structures

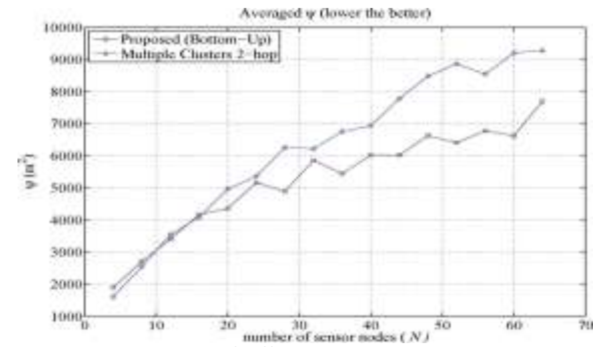

Fig. 7. Averaged □ of different multiple-cluster structures.

In a SC network, it takes a very long time for data to propagate from both ends of the chain to the cluster head at the middle.

The MC2H network is the one with the highest DCT among Type I structures. In terms of minimizing, the MST network no doubt ranks first. The ETX used in network with CTP can greatly reduce the communication distances among sensor nodes and make it ranks second. This is because all the optimization techniques employed in the top-down approach are carried out individually. Although all the optimization techniques will provide optimum solutions, there is lack of a global optimization method. This makes the top-down approach more effective for small-scale networks, but at the same time, it is more prone to be trapped in local optimum points as the network density increases. Therefore, the top-down and the bottom-up approaches are recommended for low density and high density networks, respectively.

VII. CONCLUSION

In this paper, a delay-aware data collection network structure and its formation algorithms are proposed. To cater for different applications, network formation can be implemented in either centralized or decentralized manner. The performance of the proposed network structure is compared with a multiple-cluster two-hop network structure, a single-chain network structure, a minimum spanning tree network structure, and a collection tree network structure. The proposed network structure is shown to be the most efficient in terms of data collection time among all the network structures mentioned above. The proposed network structure can greatly reduce the data collection time while keeping the total communication distance and the network lifetime at acceptable values.

REFERENCES

[1]. J. N. Al-karaki and A. E. Kamal, “Routing techniques in wirelesssensor networks: A survey,” IEEE Wireless Commun. Mag., vol. 11, no. 6, pp. 6–28, Dec. 2004.
[2]. W. B. Heinzelman, A. P. Chandrakasan, and H. Balakrishnan, “An application-specific protocol architecture for wireless microsensor networks,” IEEE Trans. Wireless Commun., vol. 1, no. 4, pp. 660–670, Oct. 2002.
[3]. S. Lindsey and C. S. Raghavendra, “PEGASIS: Power-efficient gathering in sensor information systems,” in Proc. IEEE Conf. Aerosp., Big Sky, MT, USA, Mar. 2002, vol. 3, pp. 1125–1130.
[4]. H. Ö. Tan and Í. Körpeogˆlu, “Power efficient data gathering and aggregation in wireless sensor networks,” ACM SIGMOD Record, vol. 32, no. 4, pp. 66–71, Dec. 2003.
[5]. R. Fonseca, O. Gnawali, K. Jamieson, S. Kim, P. Levis, and A. Woo, “The collection tree protocol,” TinyOS Enhancement Proposals (TEP),vol. 123, Dec. 2007.
[6]. D. S. J. D. Couto, “High-Throughput routing for multi-hop wireless networks,” Ph.D. dissertation, Dept. Elect. Eng. Comput. Sci., Massachusetts Inst. Technol., Cambridge, MA, 2004.
[7]. O. Tekdas, J. H. Lim, A. Terzis, and V. Isler, “Using mobile robots to harvest data from sensor fields,” IEEE Wireless Commun. Mag., vol ,16, no. 1, pp. 22–28, Feb. 2009.
[8]. A. Manjeshwar and D. P. Agrawal, “TEEN: A routing protocol forenhanced efficiency in wireless sensor networks,” in Proc. 15th Int Symp. Parallel Distrib. Process., (IPDPS 2001), San Francisco, CA,Apr. 2001, pp. 2009–2015.