CLUSTER–ID ROUTING SCHEME IN WIRELESS SENSOR NETWORKS

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ABSTRACT

One of the major issues in wireless sensor network is developing an energy-efficient routing protocol. Since the sensor nodes have limited available power, energy conservation is a critical issue in wireless sensor network for nodes and network life. There are several existing routing protocols to solve this problem. LEACH (Low-Energy Adaptive Clustering Hierarchy), a clustering-based protocol that utilizes randomized rotation of local cluster base stations (cluster-heads) to evenly distribute the energy load among the sensors in the network. LEACH has a drawback that the cluster is not evenly distributed due to its randomized rotation of local cluster-head.

A new routing protocol has been proposed known as CIDRSN (Cluster ID based Routing in Sensor Networks). CIDRSN takes the cluster-ID as next hop address in routing table and eliminate the cluster formation phase and routing phase in each round. Both cluster formation phase and routing phase are only executed during the initialization of network. CIDRSN constructs clusters based on the number of cluster members. The cluster topology in the network is distributed more equally through our cluster constructing. And cluster heads for the next round will be elected based on the remaining battery level of the nodes. All routes are based on cluster-ID rather than cluster head ID. This reduces the energy consumption and increases network life time.

Keywords : Wireless Sensor Networks, LEACH, CIDRSN

1. Introduction

Wireless Sensor Networks usually contains thousands or hundreds of sensors which are randomly deployed. Sensors are powered by battery, which is an important issue in sensor networks, since routing consumes a lot of energy. An efficient routing scheme in sensor network is also important.

Networking unattended sensor nodes are expected to have significant impact on the efficiency of many military and civil applications [3] such as combat field surveillance, security and disaster management. These systems process data gathered from multiple sensors to monitor events in an area of interest. For example, in a disaster management's setup, a large number of sensors can be dropped by a helicopter. Networking these sensors can assist rescue operations by locating survivors, identifying risky areas and making the rescue crew more aware of the overall situation. Such application of sensor networks not only increases the efficiency of rescue operations but also ensure the safety of the rescue crew. On the military side, applications of sensor networks are numerous. For example, the use of networked set of sensors can be limiting the need for personnel involvement in the usually dangerous reconnaissance missions. Security applications of sensor networks include intrusion detection and criminal hunting.

2. A New Protocol For Cluster-ID Routing in Sensor Network

Our approach is assigning ID to each cluster. i.e. each cluster has unique ID. It uses cluster-ID as a next hop address in routing table. All routes are based on cluster-ID rather than CH-ID. A cluster node keeps this cluster-ID token as long as it remains the CH of this cluster. When the round is over and new CH has been elected on the basis of max energy, this token is transferred to CH. In this way CIDRSN eliminates the need of re-computation of the entire routing table, in each round.

2.1 ***Proposed New Protocol CIDRSN (Cluster-ID Routing Scheme in Sensor Network)*:**

Our proposed scheme analyzed in the following manner.

1. Network life time increased by using node energy as one of the routing metrics.
2. Heavily loaded transit clusters are alleviated by adaptive size of transit clusters.
3. The total energy consumption decreased through cluster-ID based routing.

With all these features CIDRSN has following phases.

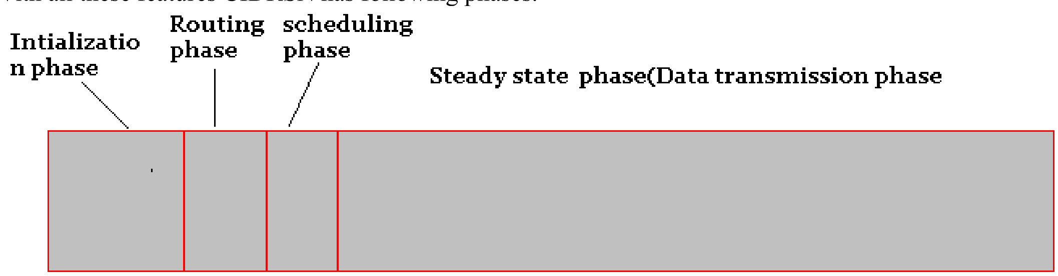

Fig 1.1: Different phases of CIDRSN

1. Initialization phase: In the start, every node broadcasts a Hello packet within its transmission range P1 (This range is determined a priori, it confines the neighbor CH distance approximately less than or equal to 4P1 , 4P1 is the case when neighbor CH's are at the opposite boundaries of the clusters) for cluster formation. This broadcast contains the node ID and remaining energy of the node. When a node receives a predefined number (Np) of Hello packets, it broadcasts a message that "I am a cluster-head (CH) candidate". Now all nodes in its transmission range stop sending the Hello packets and not declare themselves as CH candidate even if their neighborhood degree exceeds Np. After 2T time, these nodes send their association message to CH with higher SNR, that we are the member of this cluster, where T is the repetition period of Hello packet.

This algorithm confirms the location of CH approximately at the center of cluster; since nodes at the boundary of cluster have less probability to reach the neighbor degree equals Np. After the cluster formation, each CH declares the cluster ID independently. Since each node in network has unique node ID, so it is not difficult to derive a unique cluster ID.

Cluster ID = NodeID.xx

Where xx is an arbitrary two digit number.

Cluster size adaptation

The transit CHs (clusters with CH ID=x12, x13 and x14 in fig.1.3) not only handle their own cluster data but they also relay the data of other clusters towards the BS [6]. They carry larger network load. In order to distribute the load uniformly, cluster size adaptation method is used as shown in fig.1.2 (e.g. Cluster ID=x12.02 and x13.03). In this, the CHs having more than 6 neighbor CHs, reduces their cluster size by eliminating some cluster boundary nodes. These nodes then re-join the neighboring clusters. The cluster near the BS exclusively reduces it size because it carries highest network traffic.

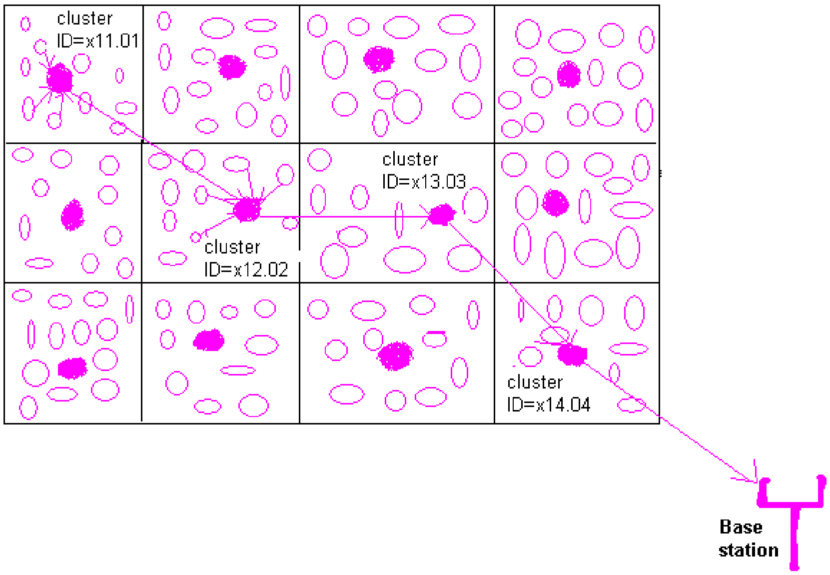

Fig 1.2: Cluster-ID based routing

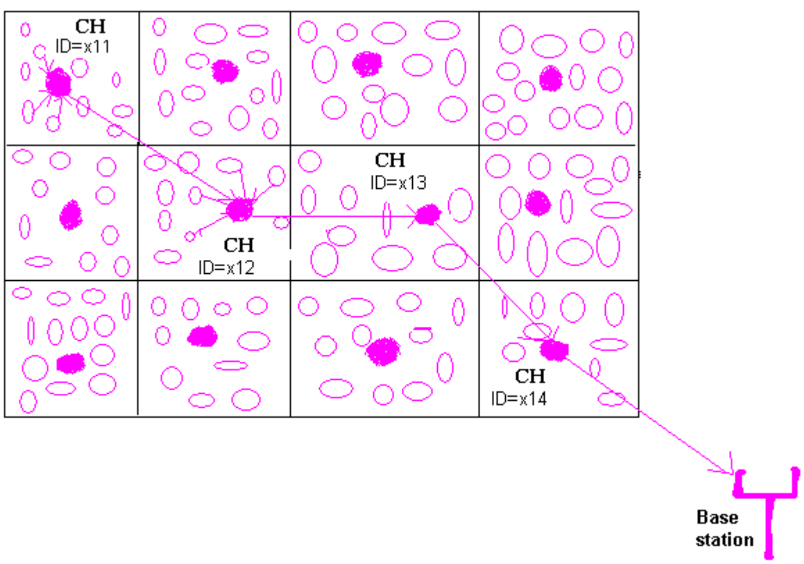

Fig 1. 3: Cluster-head ID based routing

2. Routing Phase: In traditional data networks, routes are computed once the node is powered up and re-computed if and only if any change occurs in the network. However in cluster based WSN, routes are re-computed periodically in each round. Since in each round the CHs are changed, therefore it is necessary to re-compute the entire routes every round. All existing cluster based routing algorithms use CH ID as the next hop ID as shown in fig.1.3 and table 1.2. For example in fig.1.3. Sensor nodes send the sensed data to their CH x11, data aggregation takes place there and then this CH follows the table I for forwarding the data towards BS, i.e. it send data to its neighbor CH x12, x12 send to x13, x13 send to x14 and finally CH x14 forwards data to BS. In next round, CH are changed, their IDs are also changed, now it is necessary to re-compute the routing table in order to obtain the new neighbor CH IDs. Fig.1.2 shows a cluster ID based WSN in which each cluster has a unique ID. It uses cluster ID as a next hop address in routing table. All routes are based on cluster ID rather then the CH ID. A cluster node keeps this cluster ID token as long as it remains the CH of this cluster. When the round is over and new CH has been selected on the basis of maximum remaining energy, this token is transferred to new CH. In this way, CIDRSN eliminates the need of re-computation of the entire routing table in each round as shown in fig.1.2 and table 1.1, which saves a significant amount of processing energy

Cluster-ID based routing		
All Rounds		
source node	destination node	next hop
x11.01	B S	x12.02
x12.02	B S	x13.03
x13.03	B S	x14.04

Table 1.1

Cluster head ID based routing		
Round-1		
Source node	Destination node	Next hop
x11	BS	x12
x12	BS	x13
x13	BS	x14
Round-2		
x21	BS	x22
x22	BS	x23
x23	BS	x24

Table 1.2

3. Scheduling phase: After the cluster formation, CH election and routing table creation, each CH knows all the members nodes of its cluster. It then creates a TDMA schedule for intra-cluster communications. It allocates one time-slot to each cluster member. Cluster member remains in sleep mode except in its allocated time slot, in which it transmits or receives data.

4. Steady state phase (Data transmission phase): Once the schedule is known, each node will transmit the data during the time slot allocated to it. When the CH receives data from some nodes in its cluster, it will run some data fusion algorithm to aggregate the data, as described by AFST [1] applicable only on cluster-heads.

Cluster-size adaptation technique: Reduces the cluster size by eliminating some cluster boundary nodes. These nodes then re-join the neighboring clusters. The cluster near the BS exclusively reduces it size because it carries highest network traffic.

Cluster formation & assign ID: One of the key futures of this protocol is uniform cluster formation taking the position of nodes into consideration. The no. of nodes in a cluster is limited and each cluster has unique ID.

CH election: CH has been elected on the basis of maximum remaining energy.

Communication inside the cluster: All cluster members will communicate directly to CH and pass the data to the CH. The cost of data transmission is depending on the distance of transmission. If a node transfers data to its CH it will reduce the battery level of both node & CH. So battery of CH drains quickly than the cluster members.

Communication b/w CH & BS: Sensors nodes send the sensed data to their CH, data aggregation take place there this CH forwarding data to BS. i.e. it send data to its neighbor CH2, and this sends to CH3………CHn. i.e. multi-hop transmission. Finally CHn forward data to BS, and there will take 2 parameters into consideration hop-count & energy cost of the path

2.2 ***Mathematical model for CIDRSN:***

For a comprehensive of our proposed scheme we have developed a mathematical model based on the per bit energy consumption in more realistic channel model [2].

$$Ehop = (1+\alpha)N_o/p_b(4\pi d)^2/(G_tG_r\lambda\ M_lN_f + P_{tx\text{-}ele}/Rb + P_{rx\text{-}ele}/Rb$$

$$Ehop\ \alpha\ d2$$

$$P_{tx\text{-}ele} = P_{DAC} + P_{filter} + P_{mixer} + P_{LO}$$

$$P_{rx\text{-}ele} = P_{ADC} + P_{filter} + P_{mixer} + P_{IF} + P_{LNA} + P_{LO}$$

$P_{tx\text{-}ele}$→ Power dissipated in transmitter electric circuit

$P_{rx\text{-}ele}$→ Power dissipated in receiver

R_b→ Transmission bit rate

G_tG_r→ Antenna gains of transmitter and receiver.

M_l→ Link margin

N_f→ Receiver noise figure

E_{hop}→ Total energy consume per bit per hop

2.3 ***Description of algorithm:***

Step-1: Distribute N nodes on XY-Plane randomly by using rand () function
Step-2: Elect Cluster-Head initially
Step-3: Find the distance of each node to CH
Step-4: Form the cluster of each CH depending up on the distance
Step-5: Assign initial energy to each node of cluster
Step-6: Data transmission takes place cluster member of each cluster to respective CH
Step-7: Find path from CH to BS
Step-8: Elect CH maximum residual energy
Step-9: Repeat STEP-6 to STEP-8 until all nodes are die

2.4 ***Evaluation of CIDRSN:***

The main features of CIDRSN are

1. Cluster-size adaptation technique.
2. Each cluster has unique ID.
3. CH has maximum remaining energy.
4. Reduce the energy consumption.
5. Prolong network life time.

Advantages:

1. The main advantage of CIDRSN it has lower energy consumption compare to both LEACH and MECH.
2. CIDRSN has better network life characteristics than the LEACH and MECH.

Drawback:

The main drawback of CIDRSN is it has lower performance at middle distance because of more circuit energy in more members if small cluster due to cluster-size adaptation, but outperforms LEACH and MECH at small distances and large distances.

3. Simulation and Results

3.1 ***Simulation Parameters***

The various parameters considered for simulation were[7]:
Network size: The size of the network is considered as 100X100 m2.
Area: The radius of the network is a measure of its area. Nodes are randomly deployed in a given area..
Hop count: The maximum hop count between cluster head and any node belonging to the cluster.
Cluster Number: Maximum number of nodes inside a cluster.

3.2 ***Performance metrics:***

Our aim is to minimize the energy consumption in clustering a network, and prolong network life time [5].

Energy: Energy is most considerable parameter in cluster formation. We calculated the initial energy of the whole network and the energy of the network after processing the schedule, which reflects the energy consumed during communication.

Network life time: Network life time depends on the number of dying nodes. Here we assigned time slot to each node before communication, and we calculated the number of rounds after all nodes are die.

3.3 *Results of Above Algorithm:*

First we will discuss about cluster distribution of CIDRSN. Initial we will deploy 100 nodes randomly, and then we will elect cluster-head initially finally form the cluster.

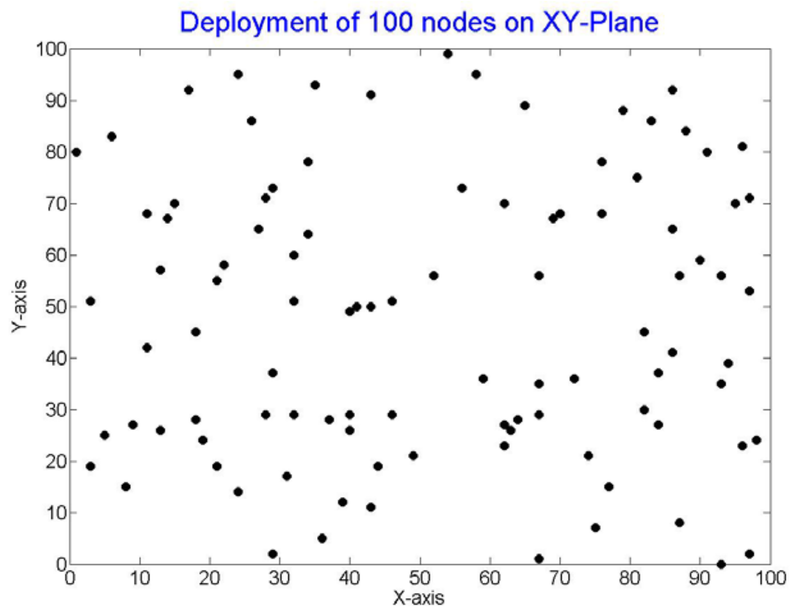

Fig 2.1 node distribution of CIDRSN

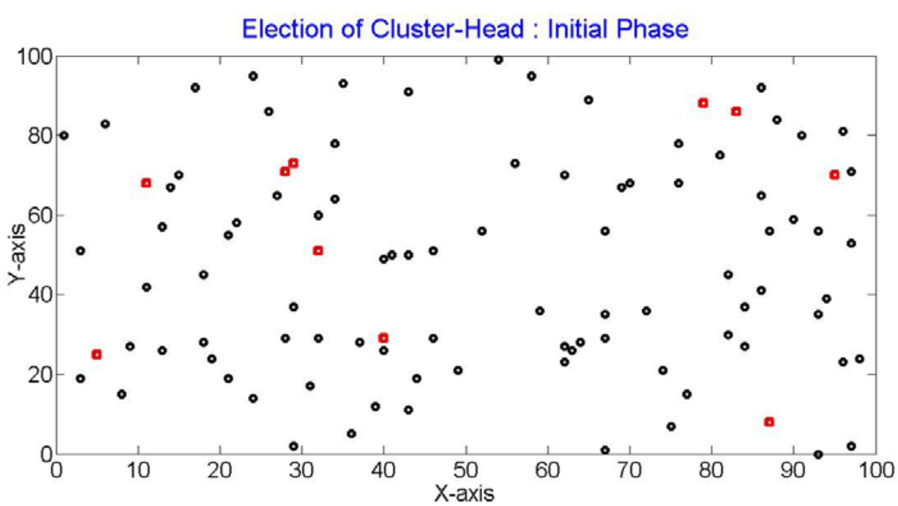

Fig 2.2 Election of initial Cluster-head of CIDRSN

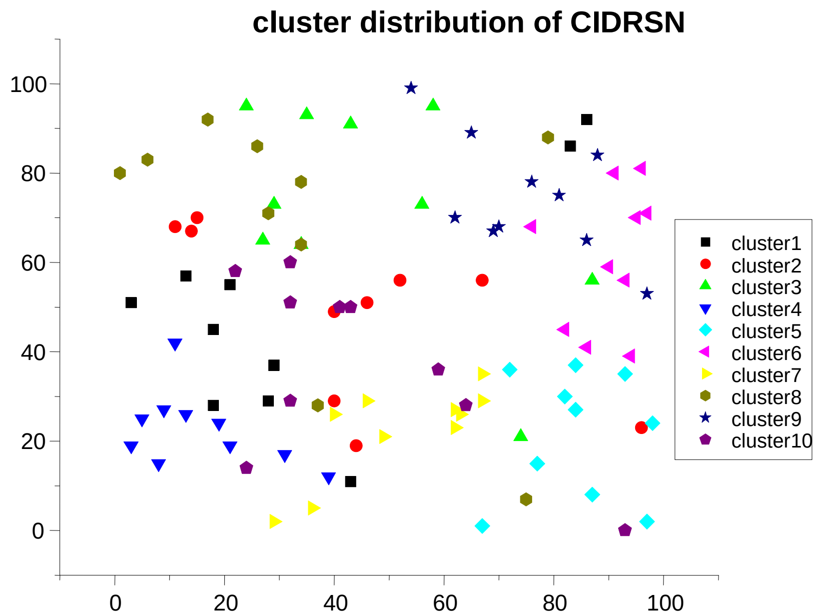

Fig 2.3 Cluster formation of CIDRSN

From the above fig 2.3 it clearly shows that uniform cluster distribution i.e. each cluster has equal number of nodes and which is restricted to each cluster has only 10 nodes by using cluster-size adaptation technique.

4. Conclusion

Here we proposed a new energy-efficient Cluster-ID routing protocol. It uses the number of cluster members to construct clusters in a certain area. The cluster head for the next round will be elected on the basis of max remaining energy levels of the nodes, and it uses Cluster-Id as next-hop address instead of Cluster-head Id which saves significant amount of processing energy and net life time of the network increases and this is shown in the above results.

Bibliography

[1] L. Lin, N. B. Shroff, and R. Srikant, ``Energy-Aware Routing in Sensor Networks: A Large System Approach," to appear in Ad Hoc Networks Journal (Elsevier), special issue on Recent Advances in Wireless Sensor Networks, September 2007.

[2] S. Li and J.W. Evans, "Electrochemical-thermal Model of Lithium Polymerbatteries," J. Electrochem. Soc, vol. 147, pp. 2086-2095, June 2000.

[3] L. Subramanian and R. H. Katz, "An Architecture for Building Self Configurable Systems," in the Proceedings of IEEE/ACM Workshop on Mobile Ad Hoc Networking and Computing, zoston, MA, August 2000.

[4] M. Zorzi and R. R. Rao, "Multihop performance of energy efficient forwarding for ad hoc and sensor networks in the presence of fading," IEEE/ICC'04, 20-24 June- 2004, Paris, France.

[5] Yuon Guo and Janise Mcnair; Cost Efficient Cluster Formation for Wireless Sensor Networks, In Proceedings of CITSA 2004, Orlando, FL, July 2004.

[6] Malka Halgamuge, Siddeswara Mayura Guru, and Andrew Jennings ;Energy Efficient Cluster Formation in Wireless Sensor Networks, In Proceedings of IEEE International Conference on Telecommunications, IEEE ICT 2003, IEEE Press.

[7] M. Petrova, J. Riihijärvi, P. Mähönen, S. Labella, "Performance Study of IEEE 802.15.4 Using Measurements and Simulations", Proceedings of IEEE WCNC, April 2006, Las Vegas, USA.