THE ANNALS OF "DUNĂREA DE JOS" UNIVERSITY OF GALATI
FASCICLE III, 2013, VOL. 36, NO. 2, ISSN 2344-4738, ISSN-L 1221-454X
ELECTROTECHNICS, ELECTRONICS, AUTOMATIC CONTROL, INFORMATICS

NEW STRATEGY TO COMBINE CLUSTER HEAD'S DATA FOR INCREASING WSN LIFETIME

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Abstract: This article represents a new method to select several distinct routes among cluster heads want to limit the direct connection of all cluster heads and base station. Cluster heads use those near base station to transfer their own data. Thus, the method selects several distinct, pretty, equal, long routes forms workload balance among cluster heads, decrease energy consumption. Finally, it increases the network lifetime. This method investigates a hierarchy convergence sensor network includes cluster heads, so that each of them are responsible to collect and send data from members.

Keywords: Clustering, Data Collection, Wireless Sensor Network (WSN), Network lifetime, energy.

1. INTRODUCTION

Wireless sensor networks are developed smart networks consists of many sensor nodes capable of collect and transmit data and corporate with each other in order to do different jobs (Akyildiz, et al., 2002a). In this network, sensors collect data from the environment and send all to a place where it needs this information for their decision making and usually it is far from a space that sensors expanded in all of them, therefore in wireless sensor networks; data transmission uses most of the energy and due to the limited power of sensors and high application of these networks (Akyildiz, et al., 2002a, 2002b; Akkaya and Younis, 2005).

We need these methods to decrease energy consumption in communication process and save network energy then in order to decrease energy consumption during data transmission. We could use clustering protocols based are routing by applying mechanisms like cluster heads selection from sensor nodes and data transmission from the sensor node to cluster heads and combination data in cluster heads and also sending data from cluster heads to base station that decrease energy consumption and communication significantly and save network energy (Akyildiz, et al., 2002a; Rajavivarma et al., 2003; Chong and Kumar, 2003).

Many algorithms and protocols delivered in this area. Clustering protocols attempt to somehow decrease network energy consumption and increase network long life, but in most of their mechanism or methods to transfer cluster heads data to base station and cluster heads send data to base station directly.

Amongst, there are cluster protocols that address this point but most of applied methods for data hierarchical transmission among cluster heads depends complex algorithms and more calculation costs. In this article, we attempt to represent a simple method to transmit cluster heads data to each other in hierarchical form to prevent direct connection of all cluster heads with base station to decrease cluster heads consumption energy in homogeneous sensor networks.

The rest of this article is organized as follows. Section 2 describes related work. Section 3 explains

This paper was recommended for publication by Adrian Filipescu

proposed model, and section 4 describes proposed model complete with an example. Finally, section 5 concludes the article.

2. RELATED WORK

In this section, briefly, we review some of clustering protocols to better clarify of delivering method concepts. Many algorithms and protocols represented in clustering field that we classified them into 3 categories due to purpose the article.

First category like LEACH (Heinzelman, et al., 2000), HEED (Younis and Fahmy, 2004), and protocols delivered LEACH-SWDN (Wang, et al., 2011) T-LEACH (Hong, et al., 2009) and DS-LEACH (Bagherzadeh and Samadzamini, 2009); those never considering the distance of cluster heads and base station and only cluster heads are selected according to specific mechanisms and the combined data and transmit directly to the base station.

Second category are protocols like EECS (Ye, et al., 2005) and protocols delivered in (Xunbo, et al., 2010; Min, et al., 2010) that attempts to somehow decrease cluster heads distance to a base station or to optimize this distance.

Third category describes those protocols that related to cluster head distance factor to base station and its effect in trend of decrease cluster head numbers or nodes that directly connect to a base station. One of these protocols is PEGASIS (Lindsey and Raghavendra, 2002). This protocol uses chain production method of nodes and connects each node just with its adjacent nodes in order to transmit data to base station. This chain configured by process of base station or by nodes using Greedy algorithm. In this method, the most remote node of a powerful signal was used to measure all adjacent node distances and then set its signal power based on that distance, so that due to modified signal just one neighbor could hear the signal.

Chain in this protocol includes nodes close to each other and makes a route to base station and after chain configuration; each nodes combined received data of other nodes with itself and proceed until to reach the base station (Lindsey, et al., 2000). After raising of PEGASIS protocol and creation of node chains, the information delivered delay to base station raised and in this field to plan delivered (Lindsey, et al., 2002) to improve how chain shaped that one plan have the potential of sensor nodes CDMA and the other is without it. Both methods by applying a binary complex plan with parallel communication and low expense and delay time to receive and send data and create routing to send data to base station.

In non-CDMA plan, is possible to make parallel communication among nodes far away from each other's, and a three layered hierarchical chain plan does it appropriately. Initially, all nodes divided into G groups of sequential nodes and at first a chain of N/G shaped among nodes. G groups of N/G nodes obtained. One node of each group activated at second level, and then G nodes exist in second level.

This G node divided to two sequential nodes in the second level, in turn, three hierarchical levels were created. G was calculated based on node numbers and network size. Figure 1 shows this for 100 nodes, in this figure, c_{18} node is leader and in each span of transmission to the base station, different leaders exist to distribute workload. All nodes will send their data in the direction of index 8 within their group since 18 modulo 10 is 8.

The delay at the first level is nine units. Then the second level will contain nodes c_8; c_{18}; c_{28} . . . c_{98}. These 10 nodes will be divided into two groups. If we have more levels in the hierarchy, then distances between nodes become further apart, causing higher energy costs.

By experimentation, for the networks under consideration, having three levels gives us the best balance of energy and delay. Since the leader position is 18, all nodes that are in the first group will send down the chain 10 positions from its own position on the chain.

So, node c_{48} will send to node c_{38}, and node c_{38} will send to node c_{28} and so on. Since node c_8's position is less than node c_{18}'s, node c_8 will transmit to a position that is N=G greater than its own. In group two, nodes know in which direction to send the data using the leader position N=2. So, here, the nodes in group two would send in the direction of node c_{68} in the same manner as in group one. This gives us a delay of four units for the second level. In the third level, node c_{68} transmits to node c_{18}; who is our leader, and then, finally, node c_{18} transmits the combined packet to the BS.

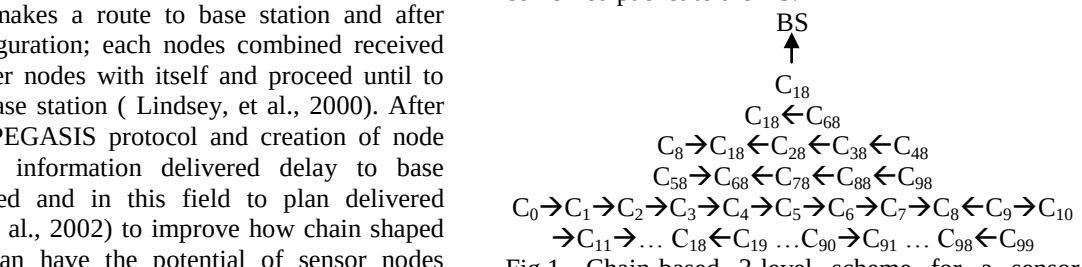

Fig.1. Chain-based 3-level scheme for a sensor network with non-CDMA nodes (Lindsey, et al., 2002)

In HCC (Banerjee and Khuller, 2001), clustering structure created multi layered, in this protocol the lowest rate ID node gets priority to start clustering process and if several groups tend to make cluster

they must perform two job level, 1. Tree discovery, 2. Cluster formation that in turn, tree discovery based on a distributed frame BFS (Breadth-First-Search) performed in first node and after tree discovery on the discovered sub-tree, due to some circumstances cluster was created.

In (Abdellah, et al., 2010) it was used a higher energy node rather than normal nodes that if these nodes were not selected as cluster head in the cluster head selection process, they were used as a node gateway in order to routing and orientation of data from cluster heads to base station. In (Biradar, et al., 2011), a protocol namely-multi hop-LEACH was delivered that in fact was developed LEACH protocol.

This protocol allows cluster head behave as multi-hop when the distance of cluster head and base station was great and using interfaces cluster heads transmit their data to base station. In this protocol, it was attempted to select a route with the minimum hop-count among cluster heads and base station by flooding method.

In (Xiangning and Yulin, 2007), a protocol was presented at the same of the above method except that to communicate among cluster heads, at first, some routes were designed in between and then appropriate route selected among them and each cluster head forward its data to the nearest cluster head to the base station so that data reach the base station.

In (Zhixiang and Bensheng, 2007), three-layered routing protocol proposed. In this protocol, in order to create multi-hop communication between cluster heads, initially, first level cluster heads selected based on probability and then from first level cluster heads, second level head clusters were selected based on energy.

In (Liu and Li, 2009), PECRP (power-efficient clustering routing protocol) presented. In this protocol verified multi-hop effect of communication among cluster heads. In addition, to create multi-hop communication among cluster heads it was used this method that each cluster head select its adjacent cluster head based on its distance to the base station and adjacent cluster heads send data to base station directly, but in this method it may data cluster head receives several adjacent cluster heads and routs are not distinct and the route had different distances.

3. PROPOSED NETWORK MODEL AND ASSUMPTIONS

We used a hierarchical architecture model consists of several nodes, these nodes classified into some groups and each cluster has a cluster head that is responsible for collecting and combining data from member nodes. Cluster heads forward their data to base station. The network used a stable and constant base station and nodes distributed in the network evenly. Figure 2 shows supposed network model.

Assumptions:

1. Our network is a homogeneous wireless sensor network consists of many sensor nodes with limited potential and also this network use a stable base station with unlimited energy.

2. Sensor nodes are static.

3. Each cluster head knows its position.

4. We study data collection application periodically. In this function, sensor nodes send their data periodically and cluster heads combine and collect data.

5. Due to receive a package from the base station for cluster heads that contain selected route forward data to other cluster heads or base station.

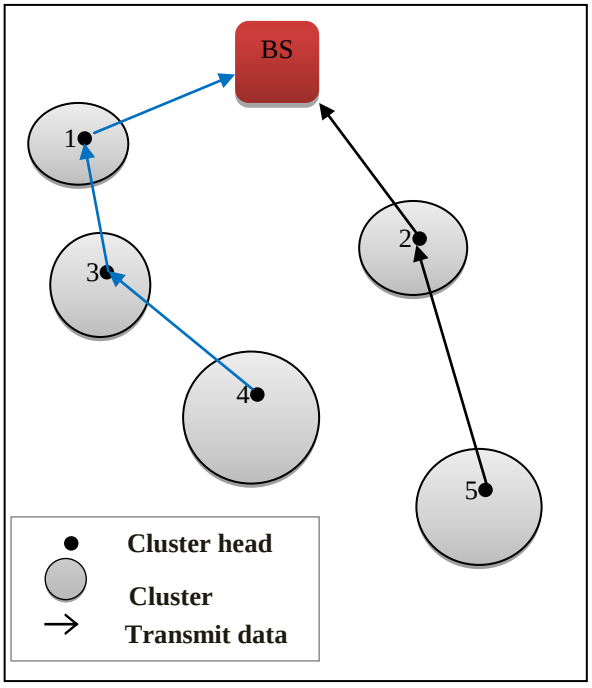

Fig.2. Network model

4. ORIENTATION STRATEGY OF DATA AMONG CLUSTER HEADS

At first a converged network was selected among wireless sensor networks that sensor nodes are stable in it; and base station located outside of scattered sensor spaces in static position. The base station does the calculation and the search function to find several distinct routes among cluster heads in order to decrease energy consumption and prevent direct communication with the base station.

In addition, these selected multi routs lengths are approximately equal that results in work load balance among cluster heads and never impose high calculated expenses.

4.1. Routing model and data collection from cluster heads

Routing orientation performed by the base station and forwarded to cluster heads by a message. In this method, according to the Euclidean distance table that was made by the base station at the starting point of each period, base station select routes as it will describe in following section and forward it to remote cluster heads therefore specified their route orientation toward itself. Base station broadcasts a message to the request cluster head location.

Each cluster head that receives its message, in turn, sent it to the base station. When all cluster head positions received by base station due to formula (1); Euclidean distance among each cluster head and itself and each cluster head distance and other cluster heads calculated and placed on the table.

In this formula (1), $d(i,j)$ is the distance of two CH_i and CH_j cluster head with (x_i,y_i) and (x_i,y_i) specification. In the following sections, it was found how to use tables and express the route separately.

$$(1) \quad d(i,j) = \sqrt{(x_j - x_i)^2 + (y_j - y_i)^2}$$

4.2. Strategy of finding the cluster heads route by the base station with an explanation of an example

Figure 2 showed one of intended sensor networks. Its cluster head specification showed in table1.

Table1. Model network cluster head specification

	X	**Y**
BS	5	10.5
CH1	2.5	9
CH2	7.1	8.3
CH3	4	6.2
CH4	6.2	5.1
CH5	9	3.2

This work performed in two stages:

First stage: in this stage due to the above table and formula (1) in the start of each period, base station create table 2 that contains distance of each cluster head to base station and to other cluster heads.

Second stage: due to this point that table 2 sequenced based on distance to base station and table 1 ordered based on it. Two selections performed:

1. Two nodes that have the longest distance to base station selected for example in our model are ch4 and ch5 specified as the start of the orientation stage (routing among cluster heads).

2. Two nodes that have shortest and nearest distance to base station selected as the final clause of orientation (routing among cluster heads).

- Note 1- If the cluster head number were so that in selecting two nodes as the start of orientation stage and two nodes as end of search it was created a common point, there is found no problem.

- Note 2- Nodes as start search clause and message package forwarded to them, if selected in midway, they will be omitted.

- Note 3- Cluster head that was selected once in a route, in second route will remove.

- Note 4- as said above, end of search requirement is to reach one of two cluster heads near to base station and if one of them was selected beforehand in second route we must reach to second cluster heads that was selected as shortest routes.

- Note 5- Number of start and end search routes to make route length closer due to cluster head number might add to the previous ones. (For example: for 5 cluster head, two routes with two nodes selected to start and end search points and if 7 cluster head considered, 3 routes with 3 nodes selected as the start and end points of search and in turn it goes one).

- Note 6- Always start search in the Euclidean table from the remote node with the longest distance from the base station.

Table2. Euclidean distance among cluster heads and cluster head with base station

	BS	**CH1**	**CH2**	**CH3**	**CH4**	**CH5**
BS	0	2.915	3.041	4.414	5.531	8.324
CH1	2.915	0	4.652	3.176	5.375	8.711
CH2	3.041	4.652	0	3.744	3.324	5.442
CH3	4.414	3.176	3.744	0	2.459	5.830

CH4	5.531	5.375	3.324	2.459	0	3.383
CH5	8.324	8.711	5.442	5.830	3.383	0

By doing above mentioned Ifs and notes, these two routes selected by the base station and sent to nodes that have the longest distance. (That is ch4 and ch5)

First route; package contains a route that base station sent to ch5.

CH5→ CH2→ Base station

Route length: 5.442+3.041=8.483

Second route; package contains a route that base station sent to ch4.

CH4→CH3→CH1→ Base station

Route length: 2.459+3.176+2.915=8.55

4.3. Simulation and results evaluation

In this section, we apply the method presented in the previous section on protocol LEACH-SWDN (Wang, et al., 2011) that a hierarchical clustering protocol has been developed based on LEACH protocol. To do this, we used the simulator OMNET++.

Simulation results show that, by using this method, the lifetime of the LEACH-SWDN protocol compared to the previous protocol, the 80s value increases. The diagram in Figure 3, shows the number of alive nodes over time, according to the results of 10 simulation time, and Table 3, shows the conditions of the simulation protocol LEACH-SWDN.

Table3. Simulation parameters

Parameter	**Value**
Number of nodes (excluding the base station)	100
Area	(100,100)
Initial energy	1J
Location of base station	(50,175)
The percentage of cluster heads	5%
Simulation end condition	Number of nodes ≤ 5
Round time	20s

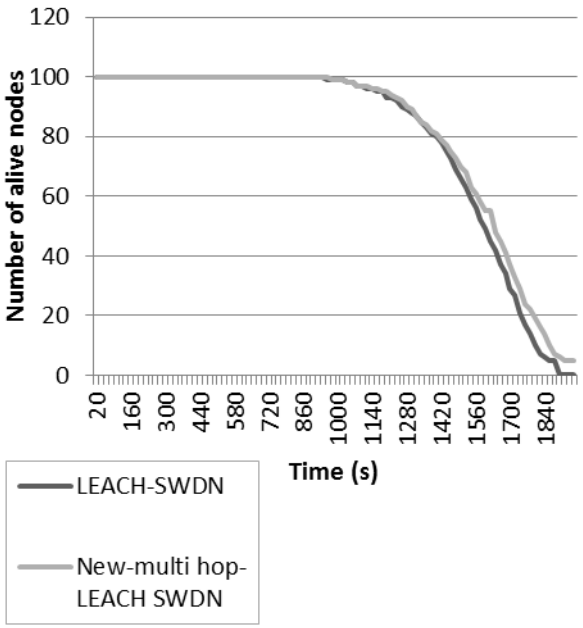

Fig.3. The number of alive nodes over time

5. CONCLUSION

In recent years wireless sensor network because of lack of communicative infrastructure construct got base attention. Because effective routing in energy results in load balance and increase network lifetime. In this research, a simple method using Euclidean distance tables to find and orientate data among cluster heads and create multi-hop communication between cluster heads cause decrease of cluster head energy consumption because of decrease communication distance of them rather than direct communication with the base station. In this method, lengths of several selected routes are approximately equal. Its decrease of performance made computation expense for base station continued and require no complex implementation.

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