Sensor Route Management Scheme for Wireless Sensor Network

Md. Obaidur Rahman, Choong Seon Hong
Dept. of Computer Engineering, Kyung Hee University
e-mail : rupam@networking.khu.ac.kr and cshong@khu.ac.kr

Abstract

A wireless sensor network is the combination of a large number of deployed sensors over an area. Communication between the sensors is the most important factor for a successful sensor network. It is mandatory that long distance and multi-hop communication will occur between sensors. Generally sensors relay the sensed data of a particular territory to the command center via a base station. For the non uniformed deployment of sensors many sensors may deploy in hostile areas surrounded by full of obstacles or in other condition it may be out of the direct communication range of the base station. It seems a critical problem for routing data to and from those sensors to the base station. This paper proposes a route management scheme using a dynamic load balancing approach based on residual energy of each agent sensors.

1. Introduction

Wireless sensor networks are a hastily striking resource to scrutinize the environmental conditions where people wish to implement their thoughts, expertise application etc. Wireless sensor networks are the strategy for many new kinds of applications, and logistics. Wireless sensor networks management along with their communication link and applications are still to be designed for various purposes. Management and Structuring of a sensor network after deployment can be an incessant practice. Actually sensor management establishes an association of sensor nodes with other sensor nodes via communication link. Routing strategy, topology control, energy efficiency etc. are to be implemented and evaluated by the management scheme of sensor networks. Communication between sensors can be as diverse as establishing one-to-one relationships by attaching sensor nodes to specific items to be monitored [1], covering an area with locomotive sensor nodes [2] or throwing nodes from an aircraft into an area of interest [3]. As wireless sensor network is collection of sensors and each sensor has limited amount of energy and capacity. So management issues like routing, communication are very important. Now a day for the improvement of the network lots of sensor management related research is going on.

Most common works on sensor network management issues is the cost effectiveness, energy consumption, structuring of nodes etc. To maintain lower communication cost and energy multi hop routes are to be implemented to collect the sensing information. Multi hop paths minimize the total transmission power by shortening the distance of a radio signal needs to travel from a transmitter to a receiver.

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Generally sensors relay the sensed data of a particular territory to the command center via a base station. For the non uniformed deployment of sensors many sensors may deploy in hostile areas with full of obstacles or it may be out of the direct communication range of the base station. The problem can be assumed by considering the **figure 1**. In that figure two scenarios presented that after deployment of sensors there may be some sensors which will be out of the scope of a base station.

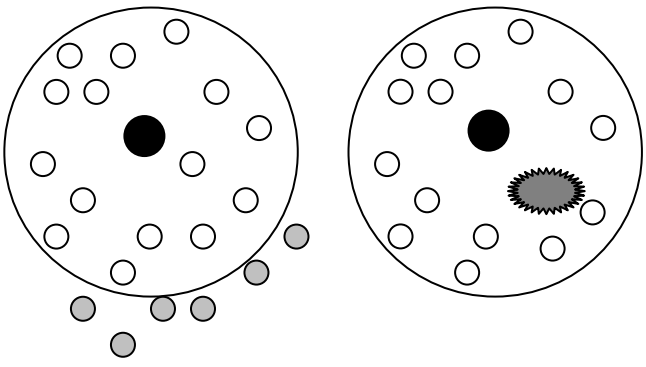

Figure 1: Sensor Deployment Scenario. a) Sensors out of transmission range of base station b) Sensors lose direct communication from base station due to obstacle

To cope with this problem a solution of agent sensor based group route management technique has been proposed in thi s paper. Here we presented the route management scheme co nsidering the load balancing approach. The approach form gr oups of sensors based on residual energy of agent sensors. M oreover for the group management each group can contain a maximum number of member nodes. This maximum number can be considered depending on the overall topology of the n etwork.

2. Related Work

It is mandatory to mention that lots of research is going on for the management architecture of wireless sensor network. Actually present research train gives a huge importance to this sensor network management. Communication required in sensor network from multiple sources to sink node. As sensor nodes are limited in energy and power so the major focus of present research is on better utilization of the sensor energy. Zhigang Li et. al chalked out the key issues of wireless sensor network management in [5]. So far this is one of the papers that solely narrated management layer architecture for sensor network. The unique requirements of monitoring sensor networks are well analyzed in [6]. This approach assigns neighbor sensors to monitor each other. But the main problem of this approach is that the neighbor sensor may not able to communicate with the base station due to the above mentioned shortage of communication range.

Another approach proposed in [7], where instead of monitoring the individual sensors it scans the network for available energy information and balance the network accordingly. The main drawback of this approach is that the sensor nodes always have to be in power in active mode. As a result energy degradation will happen very frequently. The sensor network management scheme that we have taken to compare has very little difference from our proposed scheme. In the proposed sensor management scheme of [4] the load balancing technique for the agent sensors depend upon the distance, which does not seem to be a good solution for load balancing for the agents. It will create bottleneck condition for multiple agents that can be used as hop for other sensors which are out of transmission range. Moreover the energy utilization scheme they have shown is quite incompatible than our proposed scheme.

3. Proposed Route Management Scheme

To utilize the limited energy or power of the sensor nodes here we propose a network architecture for the monitoring and routing management of the sensor networks. To define the architecture we have to follow a route group formation algorithm. In the proposed system model we define two types of sensors: agent sensor and isolate sensor. Those sensors which have a direct communication with the base station are called 'agent' sensors. And sensors which are out of the communication range from the base station or which can not receive the radio signal from the base station due to obstacles are called 'isolate' sensors. The agent sensors act as hops for the route of the isolate sensors. Unlike [4] our proposed network architecture forms groups for the isolate sensors where each group contain at most one agent sensor. Moreover based on the residual energy an agent sensor can be a hop for a certain maximum number of isolate sensors to route their data to the base station and vice versa. In this case the initialization phase is almost like the approach used in [4]. The only difference we made here for the route group formation approach. The proposed group formation algorithm is an inexpensive and more energy saving in compare to the existing group formation algorithm.

3.1 Initialization Phase

Like [4], in the initialization phase each base station send a beacon message to the deployed sensor nodes. Actually it wants to asses the quality of its communication link to other sensors. As a result the sensor which has direct communication to the base station collects the information of those sensors that can not reach the base station directly.

After the initial radio signal transmission each sensor can have the following information:

- **Agent Sensor (A):** If it has a direct communication link to the base station.
- **Isolate Sensor (I):** If the sensor has a link to an agent sensor but not direct to the base station.
- **Neighbor List (N):** It is the set of sensors which are within the transmission range of a sensor.
- **Hop List (H):** It is the set of sensors which are agent sensors but within the transmission range of a sensor.

3.2 Route Management Algorithm

In this section we proposed our route management algorithm in **Figure 2**. Isolate sensors are organized in a group where each group contain one agent sensor. All agent sensor have a direct link to the base station so for them hop communication via agent is not needed. Each isolate sensors are included in a group and their route has been set up by the *route(*I, A*)* function.

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Algorithm (A, I)

1.  for each isolate sensor Ij
     calculate the cardinality of Hop list(H)
    end for

2.  Sort isolate sensors I in a non
    decreasing order of Hop List (H)

3.  for all agent sensor Aj
      set agent_id(Aj)= 0
    end for

4.  for each isolate sensor Ij

     if (Cardinality(H)==1)
      set agent_id(Ij)= Only reachable Agent(Aj)
      add Ij to group_list(Aj)
      set route (I,Aj)

     else if (Cardinality(H)>1)
       for each Agent Aj in the Hop list (H)
         calculate res_energy(Aj)
       end for

       if (Agent(Aj)has highest res_energy(Aj)
            && group_list(Aj)< MAX)
         set agent_id(Ij)= Agent(Aj)
         add Ij to group_list(Aj)
         set route (I,Aj)
       else if(Agent(Aj)has highest
          res_energy(Aj)&& group_list(Aj)= MAX)
          remove Aj from Neigbour List(Ij)
          repeat step 4 for Ij

    end for
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Figure 2: Route Management Algorithm

Figure 3 represents a scenario for our proposed sensor network route management model. Here four groups each have an agent sensor along with maximum three isolate sensors. We considered that each group will contain MAX four sensors including an agent sensor.

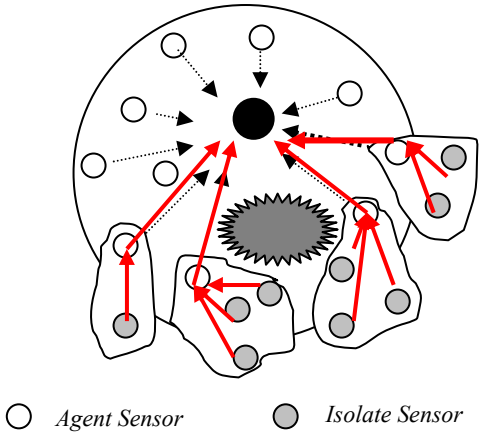

Figure 3: Routing Management Algorithm

4. Experimental Validation

An experimental environment has been set up by deploying 200 sensors randomly in an area of 1000 x 1000 m^2 area. For the base station we choose a random position within the area of interest. Initially we consider each node with full of energy with energy level 1 and when a node is out of energy then its energy level considered as 0. For the presence of the obstacle some deployed sensors communication link has been broken out. We compared our proposed sensor group based route management model with the existing group management model proposed in [4] and also without the group formation.

Figure 4 represented a performance metric for total energy utilization (%) for various numbers of nodes which reflects that our proposed scheme has an improvement for existing scheme. In terms of energy utilization of sensor network it is so important for sensor network route management.

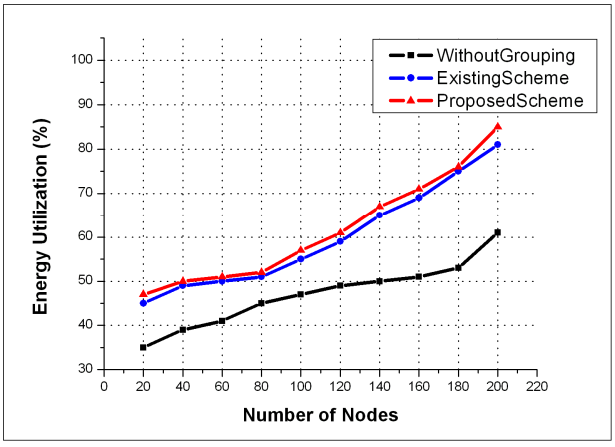

Figure 4: Effect of routing for energy utilization

5. Conclusion

Wireless sensor networks are now a day becomes a key technology for the environmental network systems. This paper addresses a different idea regarding the sensor route management in terms of group formation technique. Here an inexpensive and energy efficient group formation algorithm has been proposed so that the data routing and performance of network can be maintained and managed for a successful network. The experimental result indicates that the performance of the proposed scheme has a well load distribution approach than the existing scheme. The simulated result of this paper proved that the proposed scheme could be implemented in a larger extent of wireless sensor network.

In case of advance level of research in wireless sensor network communication management our approach can play an important role. Though the sensor network management is a critical issue for wireless sensor network still we hope our promote progression of this paper will contribute enormously.

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