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A Virtual Grid based Dynamic Route Adjustment Scheme in Wireless Sensor Network

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Abstract — A virtual Grid-based dynamic routes adjustment scheme (virtual grid routing) for wireless sink-based wireless sensor networks was introduced in recent times. Each mobile node in the network is capable of sensing, processing and communicating. In the present scenario, sensor networks are used in a variety of applications such as military, commercial, industrial etc., which require constant monitoring and detection of specific event. The approach of efficient data delivery using communication of distance priority is used, avoiding the technique of previous schemes. Our method aims to reduce the routes reconstruction cost of sensor nodes while maintaining nearly most favorable routes to mobile sink's recent location. It will improve lifetime and reduces cost consumption.

Index terms - wireless sensor networks, distance priority, energy model, mobile sink, routes reconstruction, distance enhancing grid routing.

I. INTRODUCTION

Wireless sensor network (WSN) comprises of nodes with calculation, sensing and communication capabilities. These nodes are capable of communicating with each other or directly to an external mobile sink. WSN has been generally used in different environments. E.g. in system of Disaster management, a rescuer will be able to check for any survivor in the region of the affected area using a PDA device. In an intelligent transport system (ITS), sensor nodes positioned at various places e.g. in car parks, area admitting to falling rocks, can give early warnings to drivers (Mobile sink) at a time prior to their physical approach. In an area where a battle is fought, a commander can get the information regarding trespass of enemies, attacks etc. through field sensor on the move. The method of selecting best paths in a network is called routing. Routing is executed for many types of networks, which includes the telephone network (e.g. circuit switching), electronic data networks (e.g. Internet), and transportation networks. Routing in electronic data networks with packet switching technology is basic concern of this paper. Routing conducts packet forwarding in packet switching networks i.e. the transfer of logically addressed network packets from their source in the direction of their final destination, through intermediate nodes. Intermediate nodes are generally the network hardware devices e.g. routers, gateways, bridges , firewalls, switches. The routing process typically directs forwarding on the base of routing tables that maintain a record of the routes to different network destinations. Thus, creating routing tables, which are occupied in the router's memory, is vital for efficient routing. The majority of routing algorithms make use of only one network path at a time. Multipath routing techniques allows the use of multiple alternative paths.

There are various routing schemes such as, unicast routing scheme which delivers a message to a single specific node, broadcast routing scheme delivers a message to every node in the network, multicast routing scheme delivers a message to a set of nodes that have shown interest in receiving the message, anycast routing scheme delivers a message to anyone out of a set of nodes, usually the one nearest to the source, geocast routing scheme delivers a message to a geographic area. Unicast routing scheme is the main form of message delivery on the Internet. This article concentrates on unicast routing algorithms.

In this approach, dynamic network topology is used because the mobile sink keep on changing its position thus for efficient data delivery, nodes must keep the track of latest position of mobile sink. In virtual structure, just a set of nodes covered in the sensor field participate in creating a track of mobile sink's location. Collisions are reduced by this scheme and retransmissions similar in other data dissemination protocols e.g. Directed Diffusion are also reduced.

The sensor field is divided into k equal sized cells. Nodes that are close to centers of the cells are selected as cell headers. These cell headers make ups virtual backbone network. The ambition of this virtual structure is to lessen energy consumption by minimizing the routes re-adjustment cost. With DE-Grid Routing scheme, just a small group of cell headers participates in routes readjustment according to the latest location of mobile sink, which reduces the communication cost.

Geographical Cellular-like Architecture (GCA) in [10] creates a cellular-like hierarchical hexagonal virtual structure for handling sink mobility. GCA however prevents flooding of location information of sink, however there is increase in latency and packet loss ratio because of non-ideal data delivery paths. Hierarchical Cluster- based Data Dissemination (HCDD) in [11] approaches a hierarchical cluster architecture in which the second level cluster-heads of the mobile sink are selected as routing agents which are responsible for maintaining the track on most recent location of mobile sink. In high sink mobility, nodes that are using HCDD experiences high energy consumption.

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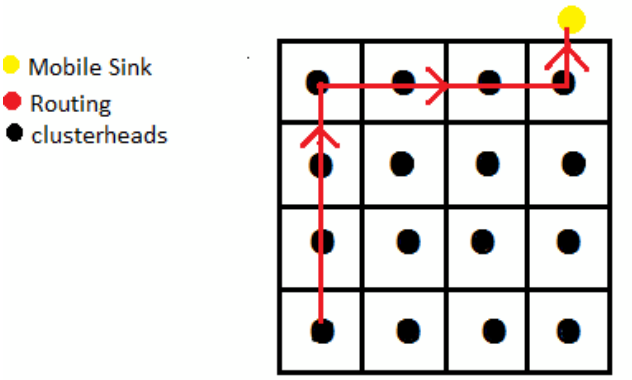

Figure 1. Straight line communication in virtual grid routing approach.

II. THE PROPOSED SCHEME

In this section, detailed methodology of proposed scheme is discussed, including how to build an area and how to keep fresh routes towards the most recent location of the mobile sink. The area is designed by dividing the sensor field into equal sized cells. A group of nodes near to middle of the cells are chosen as cell-headers which are responsible for keeping track of the most recent location of the mobile sink and relieve the remaining of member nodes from participating in the routes re-adjustment. Nodes apart from the cell-headers associate themselves with the nearest cell-headers and give information of the observed data to Figure 1 shows the straight line communication which is used in VGRDA. Figure 2 shows the communication based on distance priority which is used in our distance enhancing grid routing approach.

Step 1: The first step is defining the area of the network in which the nodes are to be created. So, before anything we would first enter the area of the network.

Step2: The next need for the approach is the nodes. Numbers of nodes are required for selecting the best path for communication and the quality of service parameters of the network also depend on the number of nodes. So in the second step numbers of nodes in each cluster are entered.

Step 3: Now, the total area is to be divided into parts.

Step 4: After dividing area into number of parts, the mobile sink is to be targeted. In this step the location of mobile sink is taken.

Step 5: There are number of nodes in the network, and each node need some amount of energy and this is what is done in this step. Each node is assigned an initial energy.

Step 6: Each divided area have a unique cluster head. The cluster heads are elected on the basis of minimum area from the centre of the whole area.

Step 7: As the cluster heads are selected, and then the communication route will be chosen on the basis of these cluster heads selected. After the selection of cluster heads, the communication route is decided according to each area, then nearest node is chosen as the next node and the path is decided on the basis of these nearest located nodes.

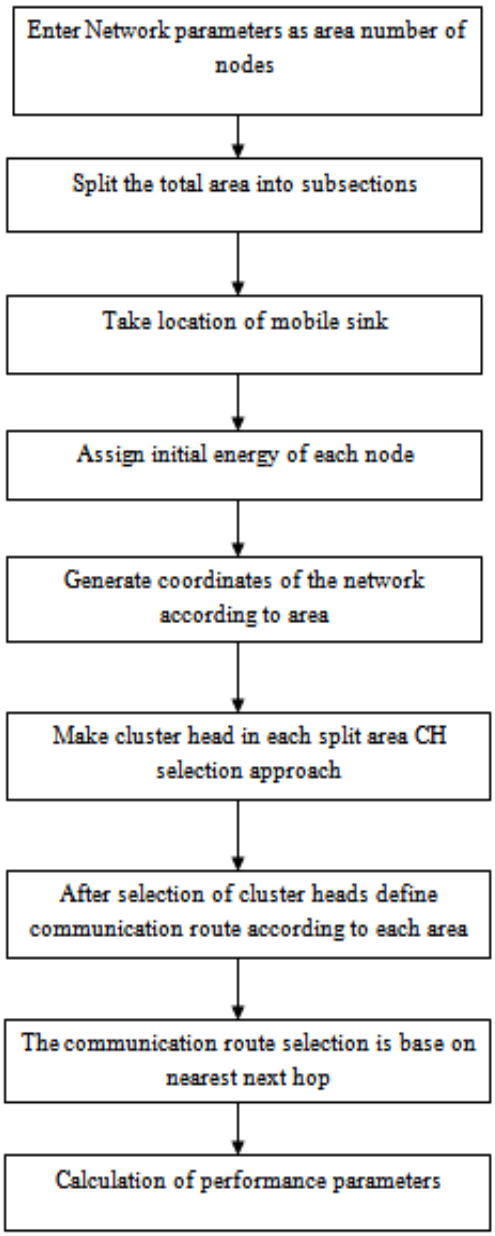

Figure 2. Flow Chart of methodology

Step 8: The communication route selection is on the basis of next nearest hop.

Step 9: Now, the energy of each node is used to calculate the energy of the network.

These are the main steps taken for our proposed scheme which will reduce the routes reconstruction cost of sensor nodes. Energy model is used for reducing energy consumption of nodes. It will also improve lifetime and reduces cost consumption. Figure 3 is flow chart which follows the steps of our technique. In the end, performance parameters are calculated and compared with the Grid Routing scheme.

III. SIMULATION AND RESULTS

In this section, we present the simulation results using Mat lab 7.10.0.499(R2010a) version. The area of 200*200 dimensions is taken with 15 nodes in each cluster. Area is divided into 16 equal sized clusters and 1500 rounds are taken. A mobile sink moves around the sensor field counter clockwise. Initially all the sensor nodes have uniform energy reserve of 1 mJ. We considered the energy model being used in [13]. In addition, we considered energy consumption of nodes in transmission (Tx) and receiving (Rx) modes which are computed using following Equation 1 and 2 respectively.

$$Tx = (Eelect \times K) + (Eamp \times K \times d^{*}d) \quad (1)$$

$$Rx = Eelect \times K \quad (2)$$

In Equation 1 and 2, K is message length, Eelect is energy dissipation of nodes and Eamp is energy dissipation by the transmitter amplifier to control the channel noise. In our technique, we took Eelect =50 nJ, and Eamp =10 nJ/bit/m2 and K =8 bits. Our proposed technique.

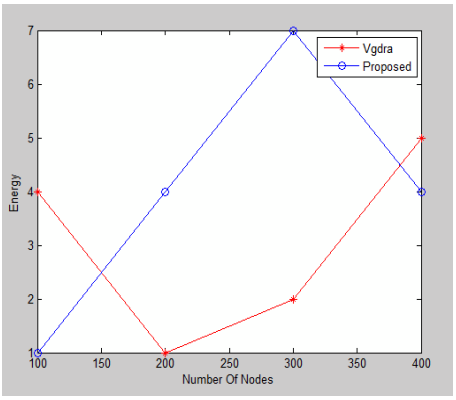

Figure 4 shows the comparison of energy of our proposed scheme i.e. distance enhancing grid routing with virtual grid routing scheme for different no. of nodes and it can be seen that at the end, energy consumption of number of nodes is less than the virtual grid routing scheme. As in this approach, the energy model is used for reducing energy consumption of nodes.

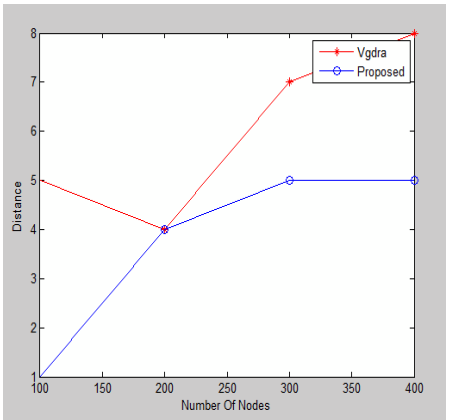

Figure 5 shows the comparison of distance of our proposed scheme with virtual grid routing scheme for different no. of nodes and it is clear from the figure that distance of our proposed scheme is very less than the virtual grid routing scheme because communication of distance priority is used in our proposed approach.

IV. CONCLUSION

In this paper, the implementation of distance enhancing grid routing scheme is introduced in which, the selection of cluster head is based on shortest distance between next clusters choose to communication or nearest cluster. The energy model is considered to reduce energy dissipation which will improve the energy consumption and data delivery performance. Lifetime of the network will also be improved. Our technique divides the area into equal number of cells. A mobile sink while moving around the sensor field keeps on changing its location and connects with the nearest border-line cell-header for data collection. By using a set of communication rules, only a limited number of the cell headers participate in the routes reconstruction process which reduces the overall communication cost. In future work, we aim to improve the performance of our proposed scheme by using the swarm based algorithms. Various optimization algorithms can also be used for improving the performance of distance enhancing grid routing scheme.

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