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A Virtual Grid Routing Design and Implementation Using Matlab.

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Abstract – Previously, a virtual Grid-based dynamic routes adjustment scheme (Grid Routing) for mobile sink-based wireless sensor networks using NS-2 was introduced. The virtual grid routing design and implementation using Matlab is a basic concern of this paper. The same energy model is used in this paper as used in [12]. Distance and energy of the network communication used in grid routing approach are calculated in matlab.

Index terms- wireless sensor networks, energy model, mobile sink, routes reconstruction cost, network lifetime.

I. INTRODUCTION

Wireless sensor networks are created by small devices communicating over wireless links without using a fixed networked infrastructure. More detailed routing algorithms are essential for the applicability of such wireless networks, As energy has to be conserved in low powered devices and wireless communication always leads to increased energy consumption.

The method of selecting best paths in a network is called routing. Routing is executed for many types of networks. 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.

WSN has been widely used in various environments. E.g. in Disaster management system, a rescuer can check for any survivor around the affected area using a PDA device. In an intelligent transport system, sensor nodes located at various places like car parking's, area expecting falling of rocks, can give early warnings to drivers (mobile sink) at an earlier time than their physical approach. Also in an area where a battle is fought, a commander can acquire information about trespass of enemies, attacks etc via field sensor on the move.

In this approach, dynamic network topology is used because the mobile sink keep on changing its position thus for efficient data delivery, nodes should 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 method and retransmissions like 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 comprise a virtual backbone network. The objective of this virtual structure is to lessen energy consumption by minimizing the routes re-adjustment cost. With virtual 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.

The rest of this paper is prepared as follows: Section 2 describes the related work, containing the information about the various approaches in the literature. Section 3 presents our virtual grid routing scheme. The performance of the VGDRA scheme, simulation and results are presented in Section 4 and Section V is the conclusion of paper.

II. RELATED WORK

Various virtual structure based data dissemination protocols have been introduced in WSN. In this paper, we will discuss some of the previously introduced protocols and compare them with our proposed approach. This paper considers the uncontrolled sink mobility which means that the speed and/or direction of the mobile sink is not controlled. In this type of sink mobility, sink makes its next move freely in terms of direction and speed, whereas in controlled sink mobility scheme, the speed and /or direction of the sink is operated and controlled by an external observer or according to network dynamics.

Virtual Circle Combined Straight Routing (VCCSR) scheme was introduced by Chen et al. [1] which is a converge-cast tree algorithm. It forms a virtual structure containing virtual circles and straight lines. A set of nodes are chosen as cluster heads along these virtual circles and straight lines, which forms a virtual backbone network. VCCSR scheme reduces the routes reconstruction cost in managing the sink mobility due to its set of communication rules, but, the cluster-head as a centerpiece in routes re-adjustment process, depletes its energy much earlier. Another scheme called Hexagonal cell-based Data Dissemination (HexDD) was proposed in [2] which makes a hexagonal grid structure for real-time data delivery. In this, the dynamic conditions of multiple mobile sinks are considered. This scheme results in high energy consumption mainly at higher sink's speeds but it creates early hot-spot problem.

Oh et al. proposed a scheme based on data dissemination called Backbone-based Virtual Infrastructure (BVI) in [3] that creates use of single-level multi-hop clustering. It points to decrease the total number of clusters. It employs HEED [4] for clustering in which priority is given to residual energy level of nodes for electing the CH nodes. The multi-hop clustering is a good approach to minimize the number of clusters, on the other hand, root node which is the centerpiece in routes adjustments generates early energy depletion which reduces the network lifetime.

Multiple Enhanced Specified-deployed Sub-sinks (MESS) in [5], makes a virtual strip in the centre of sensor field. An identical approach has been proposed in Line-Based Data Dissemination (LBDD) [6] which creates a vertical line by partitioning the sensor field into two same sized blocks. Along with this, another comparable approach was found in [7], which points a virtual rail (RailRoad) in the centre of the sensor field. The main disadvantage of MESS, LBDD, and RailRoad is the early energy depletion of nodes near to the virtual structure.

Quadtree-based Data Dissemination (QDD) scheme was proposed by Mir and Ko in [8], this also results in early energy depletion of nodes as in above schemes. This approach also reduces the overall network lifetime. Another approach called Virtual grid based Two-Tier Data Dissemination (TTDD) in [9] dedicatedly creates a uniform per source node virtual grid structure approaching the entire sensor field. TTDD even though avoids the flooding of the sink's topological updates, but, the per source virtual grid construction reduces the network lifetime.

Geographical Cellular-like Architecture (GCA) in [10] makes a cellular-like hierarchical hexagonal virtual structure to handle sink mobility. Though GCA avoids flooding of location information of sink, but 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 chosen as routing agents which are responsible for maintaining the track on latest location of mobile sink. In high sink mobility, nodes which are using HCDD suffer from high energy consumption. In this scheme, high latency is there because the data delivery paths are not optimal.

Virtual Grid based Dynamic Routes Adjustment (VGDRA) in [12], creates a virtual backbone network and uses straight line communication. In this, a limited number of the cluster headers take part in the routes reconstruction process which reduces the overall communication cost

III. VIRTUAL GRID ROUTING SCHEME

In this section, detailed description of our virtual grid routing scheme, including how to create the virtual infrastructure and how to keep fresh routes towards the latest location of the mobile sink. A virtual infrastructure is designed by partitioning the sensor field into a virtual grid of similar sized cells where the total number of cells is a function of the number of sensor nodes. A set of nodes near to centre of the cells are fixed as cell-headers which are responsible for maintaining track of the latest location of the mobile sink and relieve the rest of member nodes from taking part in routes re-adjustment. Neighboring cell-headers communicate with each other via gateway nodes. The group of cell-headers nodes together with the gateway nodes constructs the virtual backbone structure.

Table I Summary And Comparison Of Virtual Structure Based Data Dissemination Protocols.

SCHEME	AUTHOR NAME	YEAR	DRAWBACK
GCA[10]	X. Chen and M.Xu	2003	High latency and packet loss ratio.
TTDD[9]	H. Luo, F. Ye, J. Cheng, S. Lu, and L. Zhang	2005	Reduces network lifetime
QDD[8]	Zeeshan hameed mir and young-bae ko.	2006	Early energy depletion of nodes and decrease the overall network lifetime.
RailRoad[7]	J.-H. Shin and D. Park	2007	Early energy depletion of nodes
LBDD[6]	E. B. Hamida and G. Chelius.	2008	Early energy depletion of nodes
BVI[3]	S. Oh, E. Lee, S. Park and J. Jung.	2010	Early energy depletion and reduces network lifetime.
HCDD[11]	L. Buttyán and P. Schaffer.	2010	High latency and high energy consumption.
HexDD[2]	A. Erman, A. Dilo, and P. Havinga.	2012	It makes early hot-spot problem and high energy consumption.
VCCSR[1]	T.-S. Chen, H.-W. Tsai, Y.-H. Chang, and T.-C. Chen.	2013	Decrease the route reconstruction cost.
MESS[5]	B. Tang, J. Wang, X. Geng, Y. Zheng, and J.-U. Kim.	2014	Early energy depletion of nodes

The methodology of the technique is described below:

1. Firstly the area is defined in which nodes are created.
2. Similar numbers of nodes are established in each cluster for selecting the best path for communication. also the quality of service parameters of a network depend on the number of nodes.
3. Total area is partitioned into equal parts for creating a virtual network structure.
4. After this, location of mobile sink is taken.
5. Initial energy is appointed to each node as every node require some amount of energy.
6. Each divided area has unique cluster head. The node closest to the centre of the cell is elected as the cluster head.
7. Once the cluster heads are selected, then the communication route will be selected on the basis of these cluster heads selection. Straight line communication is used this virtual grid routing approach.
8. Now, the energy of each node will be used to calculate the energy of the network.

Figure 1 shows the Comparison of virtual structure construction cost for different network sizes with other schemes using NS-2 software in [12].

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Fig 1. [12]Comparing the virtual structure construction cost for different network sizes.

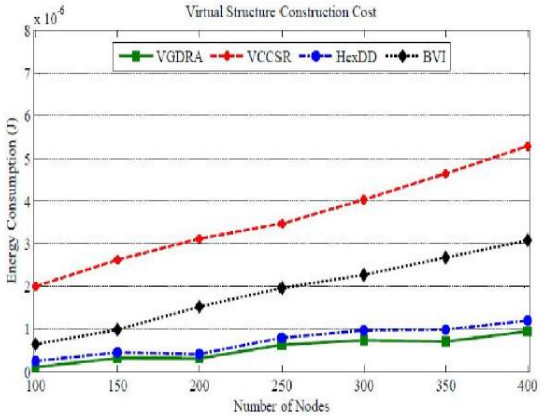

Figure 2 shows the Comparison of network lifetime in terms of number of rounds around the sensor field with other schemes using NS-2 software in [12].

Fig 2. [12]Comparing the network lifetime in terms of number of rounds around the sensor field.

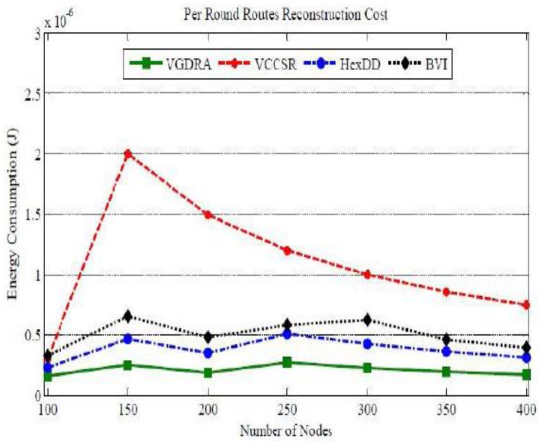

Figure 3 shows the Comparison of per round routes reconstruction cost for different network sizes with other schemes using NS-2 software in [12].

Fig 3. [12]Comparing the per round routes reconstruction cost for different network sizes.

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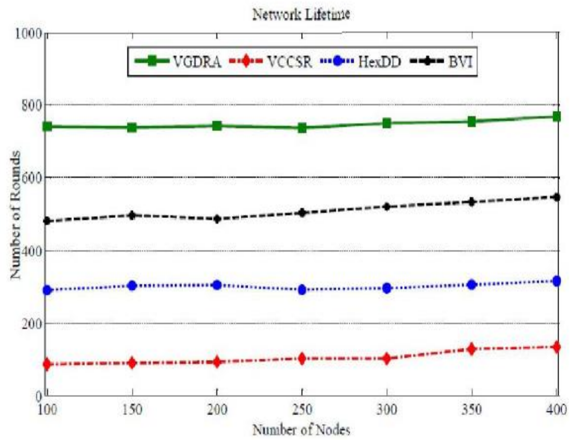
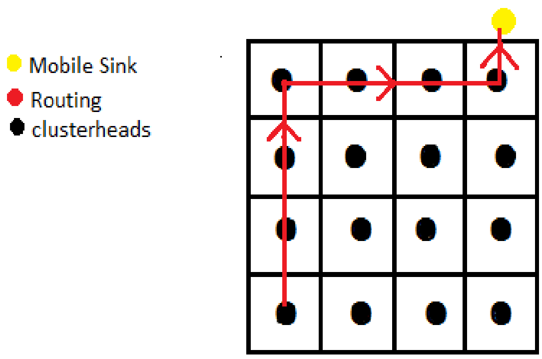


Figure 4 shows the straight line communication used in virtual grid routing approach.
Fig 4.[12]Straight line communication in virtual grid routing approach.



IV. SIMULATION AND RESULTS

In this section, we present the simulation results using Matlab 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. The energy model being used in [13] is considered in this paper. In addition, energy consumption of nodes in transmission (Tx) and receiving (Rx) modes are considered 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 this technique, *Eelect* =50 nJ, and *Eamp* =10 nJ/bit/m2 and K =8 bits has been taken. Figure 5 shows the first dead means the first node whose energy is finished in round number 950.

Fig 5. First dead node in round -950

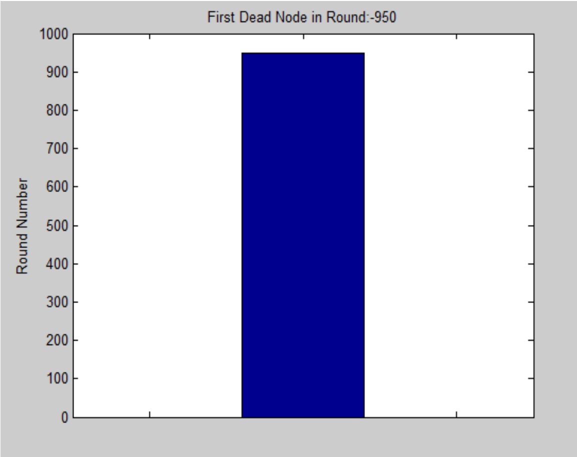


Figure 6 shows the distance of network communication in virtual grid routing which is 754.9174.

Fig 6. Distance of network communication

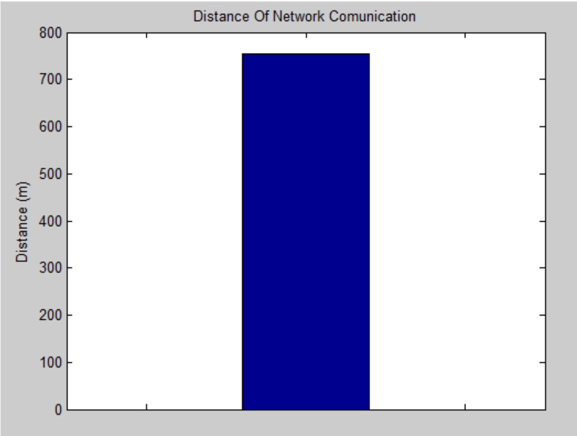
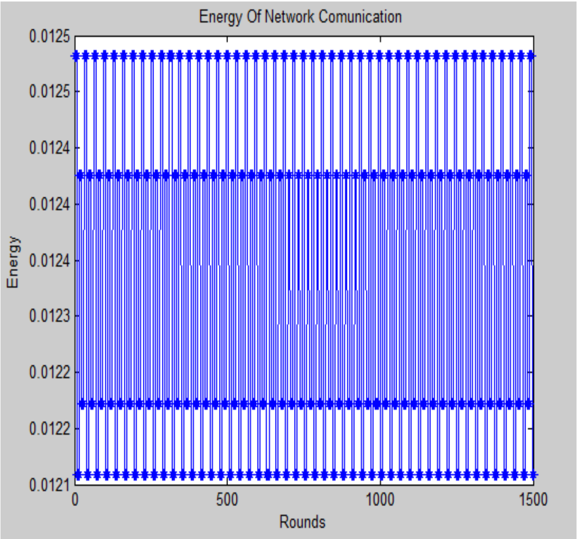


Figure 7 shows the energy of network communication which is calculated using energy model. The energy consumption is reduced as compare to previous schemes discussed above.

Fig 7. Energy of network communication.



V. CONCLUSION AND FUTURE SCOPE

In this paper, a Virtual Grid Routing scheme is implemented in Matlab, which was previously implemented using Ns-2 software. The energy model is considered to reduce energy dissipation which will improve the energy consumption and data delivery performance. This 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. Network lifetime is improved and routes reconstruction cost is reduced by this scheme. In future work, we aim to improve the performance of our proposed scheme by using communication based on distance priority which will improve the lifetime of network and reduce the routes reconstruction cost even more than this scheme. Energy consumption will also be reduced by using distance priority communication.

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