ANALYSIS ON PERFORMANCE COMPARISON OF VIRTUAL GRID-BASE DYNAMIC ROUTE ADJUSTMENT IN WIRELESS DETECTOR NETWORKS

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Abstract

A virtual Grid-based dynamic routes adjustment scheme (virtual grid routing) for wireless sink-based wireless sensor networks is a recent introduction. 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 the most favorable routes to the mobile sink's recent location. It will improve the lifetime and reduce the cost consumption. This method highlights many routed schemes. A few such novel routing schemes are Virtual Grid based Dynamic Route Adjustment (VGDRA), Multiple Enhanced Specified-deployed Sub-sinks (MESS), Virtual Circle Combined Straight Routing (VCCSR), Hexagonal cell-based Data Dissemination (HexDD), Hierarchical Cluster-based Data Dissemination (HCDD), Backbone-based Virtual Infrastructure (BVI), Line-Based Data Dissemination (LBDD), Rail Road, Quadtree-based Data Dissemination (QDD), and Two-Tier Data Dissemination (TTDD). But, each scheme has its own advantages and disadvantages.

Keywords:

VGDRA, MESS, VCCSR, HCDD, BVI, LBDD, QDD, TTDD, WDN, Grid Routing, Data Mining

1. INTRODUCTION

A large number of sensor nodes are used in the Wireless sensor network (WSN). In the sensors, lie the heart of any WSN. In the last decade, multi-sensor technologies like micromechanical systems (MEMS), CMOS, sensors and wireless technologies have been rapidly improving [1] [13]. This development has turned the sensors into a technology for collecting real-world contexts. The node can be static or mobile to communicate with one another to accurately collect data. Among the sensing, processing and communication of each node in the network, the monitoring and tracking are the most important applications of the wireless sensor network. Wireless sensor networks apply to other domains, including fighting, volcano surveillance, industry surveillance, traffic surveillance, etc. [2][14].

The main features of wireless sensor networks are power consumption, node failure capacity, node mobility, node heterogeneity, ease of use, etc. The base stations constitute a part or more of the wireless network of sensors with significantly greater resources in computers, energy and communication. They act as a gateway between senor nodes and the end user as the data from the WSN usually transfers to a server [3] [4].

The source and sink, where sink can be static or mobile, are the two important elements in the wireless sensor network. The network size of the static sink does not scale and hence, increases the network congestion. The introduction of a mobile sink can prevent these problems. Energy and bandwidth are restricted at sensor nodes and energy efficiency [5] [6] depends on network lifetime.

Routing is the way to select the best paths within a network. For many types of networks routing is carried out. Routing transfers packets to packet switching networks by means of intermediate nodes. In other words, it moves the logically-addressed network packets from the source to their destination. In different environments, WSN is generally used. For example, in the disaster management system, the rescuer will be able to monitor any survivor in the area that is in question using a PDA device [7] [16].

In dynamic network topologies [8] - [12], as the mobile sink continues to change its position for efficient data delivery, nodes are expected to keep track of the most recent mobile sink position. A track for the mobile sink is created in the virtual structure by a set of nodes that are covered in the sensor field. Collisions and transmissions such as those in other data diffusion protocols are reduced by this method. Diffusion directed is also reduced.

The field of the sensor is divided into k cells of equal size. The cell headers are selected as nodes near the centers of the cells. These headers consist of a virtual network backbone. The aim is to reduce the energy consumption of this virtual structure by minimizing the cost of routes adjustment. Only a small group of cell headers under virtual grid routing schemes participate in the adjustment of routes based on a latest mobile sink location, thereby reducing communication costs [9] [15].

2. OVERVIEW OF ROUTING SCHEMES

Different data dissemination protocols were introduced in WSN on the basis of virtual structure. We shall discuss and compare some of the previous protocols with our approach in this paper.

The uncontrolled sink mobility is considered in this paper and the mobile sink speed and/or direction is not controlled. The sink mobility is freely moved in this type of sink, whereas the velocity and/or direction of the sink is operated and controlled by an external observator or according to network dynamics in a controllable sink mobility scheme.

- *Virtual Grid based Dynamic Route Adjustment* [29]: The VGDRA system is an algorithm of converge-cast tree. It constitutes a virtual structure with virtual circles and straight lines. A set of nodes are selected in virtual circles and straight lines, forming a virtual backbone network, as cluster heads.

- *Virtual Circle Combined Straight Routing* [28]: Due to its set of communication rules, however, the cluster lead as a centerpiece in a re-adaptation process, depletes its energy much earlier. VCCSR reduces the cost of road reconstruction to manage sink mobility.
- *Hexagonal cell-based Data Dissemination* [27]: For the real time data delivery, HCDD system makes a hexagonal grid structure. This takes into account the dynamic conditions of several mobile sinks. This scheme mainly leads to higher sink speeds with high energy consumption but it poses a problem at an early point to point. A hierarchical cluster architecture in which the second-tier mobile sink cluster heads are chosen as routing agents who keep the track of a mobile sink at the latest location. Nodes that use HCDD suffer from high energy consumption in high sink mobility. In this system the data supply paths are not optimal because they are high latency.
- *Backbone-based Virtual Infrastructure* [25] [26]: BVI creates a multi-hop clustering single-level approach. The number of clusters is decreasing. It uses HEED for clustering where the residual energy level of the nodes for the choice of CH nodes is given priority. The clustering multi-hop approach is good to minimize the number of clusters, but the root node, the core of route adjustments, leads to early energy consumption, reducing network lifetime.
- *Line-Based Data Dissemination* [23] [24]: By dividing the area of sensor into two same blocks, LBDD scheme creates a vertical line.
- Quad tree-based Data Dissemination [22]: The QDD system reduces the lifetime of the overall network. Another approach called the Two-tier Data Dissemination (TTDD) virtual grid-based approach in which a single virtual grid structure approaches the whole sensor field per source node is created. TTDD prevents topological updates from flooding the sink but reduces network life by the virtual grid source.

3. VIRTUAL GRID-BASE DYNAMIC ROUTE ADJUSTMENT SCHEME

Dynamic route adaptation scheme is based on the virtual grid, including how to create the virtual infrastructure and to maintain fresh routes to the latest mobile sink location. A virtual infrastructure is constructed by dividing the sensor field into a virtual grid of similar cells in which the total cell count depends on the number of sensor nodes. A series of nodes close to the center of the cells are fixed to ensure that the track of the latest mobile sink location is kept, and that the other members are released from participating in the road adjustment process. Nearby cell headers communicate through gateway nodes. The cell header group and the gateway nodes create the virtual structure of the backbone.

First of all, the area where nodes are created is defined. In each cluster, the best communication path is selected by similar numbers of nodes. The number of nodes also depends on the quality of the network's service parameters.

For the development of a virtual network structure the total area is separated into equal parts. The mobile sink is then located. Every node requires initial energy because every node requires some energy. Every area divided has a single head of cluster. The cluster head is the node closest to the center of the cell. Once the heads of the cluster have been selected, the selected cluster heads select the communications route.

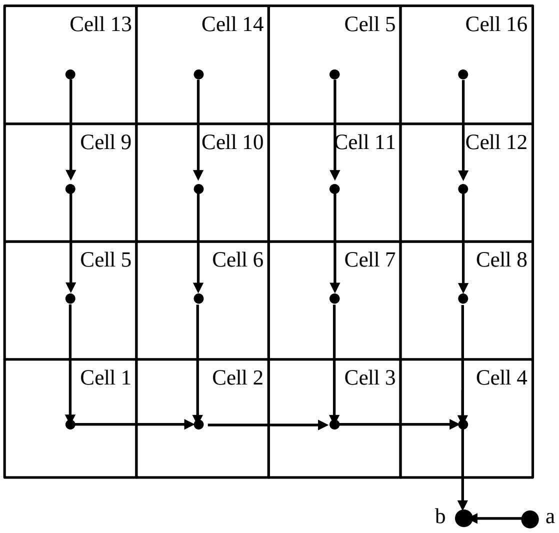

Fig.1. Virtual Grid Routing

This virtual grid routing (Fig.1) approach is used for direct line communication. Now, each node's energy is used to calculate the network energy.

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.

Step 2. 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, the numbers of nodes in each cluster are entered.

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

Step 4. After dividing the 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 needs some amount of energy. In this step, each node is assigned an initial energy.

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

Step 7. Once the cluster heads are selected, the communication route is chosen on the basis of the selected cluster heads. Then, the communication route is decided according to each area, and subsequently, the nearest node is chosen as the next node and the path is decided on the basis of these nearest located nodes.

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.

4. PERFORMANCE COMPARISON

For data collection on large wireless sensor networks virtual infrastructure systems are most efficient. For mobile sink-based wireless sensor networks, the systems are highly supported. It reduces the cost of dissemination by using virtual infrastructure schemes. The new proposed method schemes are designed to support multiple wireless sensor networks based in the sinks. It gives different performances based on the virtual backbone structure. The programs are compared based on parameters such as network convergence time, road reconstruction cost, packet delivery ratio, and so on. Virtual construction costs are considerably lower in proposed method compared to other methods at various network sizes. The lifetime of the sensor field network is higher in the proposed method in terms of rounds.

Table.1. Network convergence time of different schemes

Number of Nodes	Proposed Method	VGDRA	VCCSR	HexDD	BVI
100	49.54	51.38	53.85	57.16	61.60
200	51.43	53.92	57.25	61.71	67.69
300	53.99	57.35	61.84	67.87	75.95
400	55.74	59.69	64.99	72.08	81.59
500	57.91	62.60	68.88	77.30	88.59

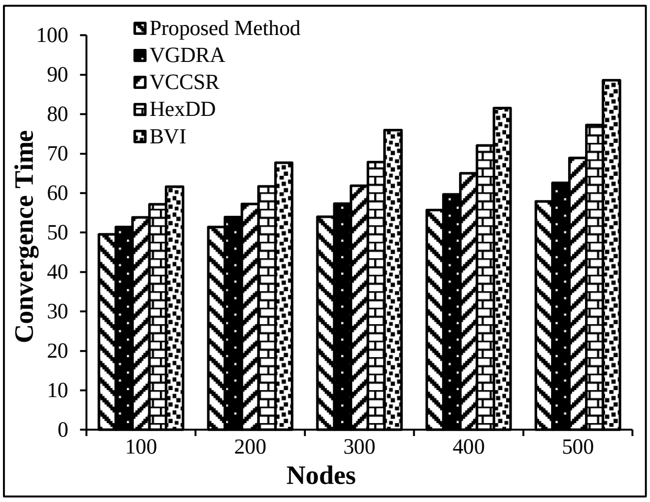

Fig.2. Network convergence time of different schemes

With the proposed method, the route readjustment process involves only a part of the cells' headers, which reduces the total overhead network and easily adjusts the route to the most modern mobile sink location.

Network lifetime is the amount of time that a wireless sensor network would be fully operative. This matric is commonly used in WSN to reflect the time span from the network initial deployment to the first loss of coverage. The data dissemination scheme in a virtual infrastructure minimizes the total number of nodes to ensure the maximum network lifetime.

Table.2. Comparing network lifetime in terms of number of rounds

Number of Nodes	Proposed Method	VGDRA	VCCSR	HexDD	BVI
100	100.06	89.67	81.92	76.13	71.82
200	102.95	91.83	83.53	77.33	72.71
300	106.51	94.49	85.51	78.81	73.82
400	109.26	96.54	87.04	79.96	74.67
500	112.43	98.90	88.81	81.27	75.65

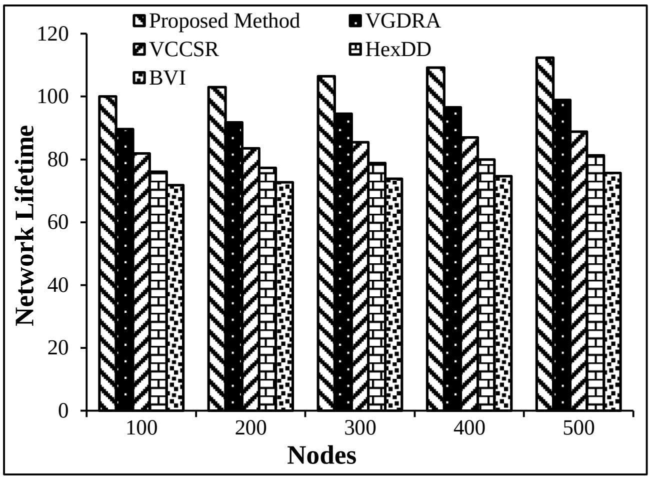

Fig.3. Comparing network lifetime in terms of number of rounds

Table.3. Comparing per round route reconstruction cost for different network sizes

Number of Nodes	Proposed Method	VGDRA	VCCSR	HexDD	BVI
100	1.00	2.75	4.05	5.02	5.75
200	1.03	2.77	4.07	5.03	5.76
300	1.07	2.79	4.09	5.05	5.77
400	1.09	2.82	4.10	5.06	5.78
500	1.12	2.84	4.12	5.07	5.79

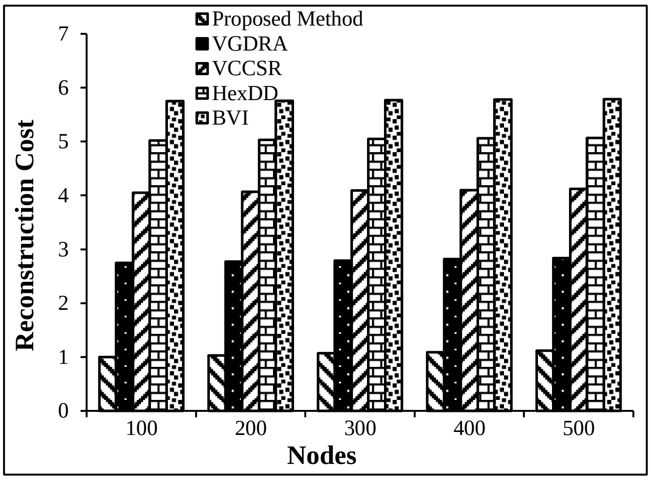

Fig.4. Comparing per round route reconstruction cost

The cost of reconstruction per round route is the amount of node energy required to adjust the road to the newest mobile device location. With the proposed method, the best routes to the latest site of the mobile sink are always provided. The use of the proposed system reduces the cost of reconstruction per route compared to other systems.

The cost of building a virtual structure is an estimate of energy consumption in cell headers and the virtual backbone network. The proposed method takes into consideration the fixed number of cluster head nodes regardless of their network size, for example, 81 cluster head nodes are considered for the network dynamics and, as a consequence, an elevated population of sensor head nodes is involved. Such a clustering network in which all nodes exchange information on the residual level of energy also entails significant communications costs.

In comparison with the proposed method, local processing of HexDD nodes leads to lesser overhead communication. In contrast, the total number of cells and the cell headers depend on the total number of nodes. For instance, the cell heading counts vary from 4 to 16 when *N* varies from 100 to 400 nodes according to our VGDRA scheme. Furthermore, only the nodes in a short distance from the center of the cell participate in the cellular choice, which reduces communication costs.

The reconstruction cost is the cost of re-adjusting the data supply paths for the nodes when the sink moves around the sensor area and completes a round of the sensor area.

In the proposed method, the average energy consumption at nodes in the reconstruction of the routes to the latest mobile plug location is considerably lower than in the other methods. This is mainly due to the least spread of location updates on sinks, by following the set of proposed communication regulations, while keeping almost optimum routes to the latest mobile sink location. The reconstruction process uses our VGDRA scheme to decrease the total reconstruction costs of the roads as the mobile sink completes one round of the sensors field.

The lifetime of the network is defined as the time since nodes are deployed and the energy consumption causes the first node to die. Our experiments have measured the network lifetime in terms of the number of rounds around the sensor field in the mobile sink, until the first node in the grid dies as a result of energy degradation.

The proposed method overrides other network life schemes on different network sizes. In VCCSR, the cluster head at the center of the sensor area suffers more working load in each phase of rebuilding and thus shortens energy considerably earlier than others. Similar behaviors in HexDD decrease the overall network life of the center and border nodes. In contrast to the VCCSR and HexDD, the proposed method is tracking the residual energy of the cellular header nodes and progressively chooses new header nodes to extend the network's lifespan. In addition, the proposed method is the least of network overhead control in comparison with BVI.

The convergence time of the network indirectly reflects the efficiency of data transmission as the more quickly the node gets to know the latest mobile device location, the more efficient routes it can use to diffuse sensed data. It is an estimate of the time elapsed while the nodes forming the virtual infrastructure record an important position change on the mobile sink. The faster the nodes converge to the latest location in terms of convergence time, the better they perform in data dissemination.

The sink moves at a speed of 10 m/s, and the proposed system is swift enough to handle it as compared to VCCSR, HexdD and BVI. The proposed system cleverly chooses a small portion of cell headings for the re-adjustment of the routes with the latest location information on the mobile sink. This partial change greatly reduces the overhead network and leads the nodes to quickly converge into the latest mobile sink location.

5. CONCLUSION

Rooted to the proven opinion that virtual infrastructure is a more efficient approach than the physical network, this study delineates an analysis of various systems deployed for disseminating data on virtual infrastructures, including two latest systems. As disclosed by the preceding parts, the study proceeds further to substantiate the improved performance standards of the proposed new virtual infrastructure-based data dissipation schemes in comparison to the Virtual Grid Based Dynamic Route Adjustment Scheme on the mobile sink-based WLAN and Geographic Convergence on the wireless sensor network.

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