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ENERGY EFFICIENT ROUTING TECHNIQUE IN MOBILE SINK BASED WSN USING VGA

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Abstract: - In Wireless Sensor networks, the introduction of sink mobility is considered as an efficient strategy to balance the energy among all the nodes. In spite of its numerous advantages, delivering of the data to the mobile sink is a challenging task for the resource constrained sensor nodes. Sink mobility causes the dynamic network topology. And when the sensor nodes are mobile it becomes more complicated for routing. For the data to be delivered efficiently the mobile sink has to keep track of the nodes locations and even the nodes have to keep track of the latest location of the mobile sink. This results in lot of energy consumption which reduces the network lifetime. Hence the proposed scheme aims to create and maintain the shortest route towards the sink by maintaining balanced energy consumption among the nodes which increases the network lifetime.

Keywords*:* Wireless Sensor Networks, Sink Mobility, re-adjusting route, energy efficiency.

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1. Introduction

Wireless Sensor Network (WSN) is a large collection of sensor nodes that forms an adhoc distributed sensing network [1] which collects detailed information about the surrounding environment. These networks are largely deployed and is been widely used in many dangerous and emergency environments. The sensor nodes are battery powered. The sensor nodes monitor (senses) the environment and periodically reports the information to a base-station or sink so that the information can be further processed and analyzed. There arises an energy-hole problem when the sink is static. To balance the node's energy dispersion, Sink mobility has been introduced [2]. The sink mobility also links the isolated network segments when there arise a need. Several application areas naturally require the sink mobility e.g., in a battlefield environment a real-time information can be obtained about the interruption of enemies, their activities and attacks via field sensors moving around the field. Similarly in a disaster environment sink mobility is required in a sensor field, a rescuer equipped with a PDA can be let free to move around the disaster area in search of any survivors. In an ITS (Intelligent Transport System), the nodes provides prior warnings to the drivers about the physical approach of any danger.

Introduction of sink's mobility [3] helps to prolong the network lifetime by resolving the problem of energy-hole. The mobility would be especially useful in particular applications like in emergency situations [4] where the sink can move around the disaster area and better estimate the emergency situation. However it brings new challenges for the data propagation. As the sink keeps on changing its location the topology of the network becomes dynamic. Hence the sensor nodes need to keep track of the latest location of the mobile sink whenever it changes its position. Frequent propagation of the updates of the sink's mobility must be avoided because of the scarce energy resources since it undermines the goal of energy conservation. To eliminate this problem and to enable the nodes to maintain the fresh routes towards the latest location of the mobile sink with minimum cost of communication, virtual infrastructure [5] over the physical network is taken to be an efficient approach. Only a set of designated nodes in the sensor field are used to keep track of the location of the sink.

This paper aims to optimize the trade-off between the energy consumption and the data delivery performance using the mobile sink based WSN. The proposed scheme minimizes the network overhead by enabling the dynamic sensor nodes to maintain the nearly optimal routes to the latest sink's location. A virtual backbone network is constructed by partitioning the sensor field into a virtual grid of K equal sized cells using virtual grid architecture (VGA) [6], [7]. The main goal behind construction of such a virtual structure is to minimize the cost of re-adjusting routes so that the data is propagated to the mobile sink in an energy efficient manner. It also sets up communication routes in such a way that the end-to-end delay and the cost in terms of energy are minimized.

2. Related work

Sink mobility patterns are classified as controlled and uncontrolled schemes [8] [9]. In controlled mobility, the sink's mobility is controlled by an external observer. In uncontrolled mobility the sink moves independently in terms of speed and direction. This paper considers uncontrolled sink mobility. Routing strategies in WSN is proposed in [7], [10], [11].

Classification of Mobile Sink based Data Collection schemes proposed in [8],[12] comprises of different infrastructures used for the collection of data. It aims to improve the data delivery performance. It consists of efficient strategies for the data dissemination to the Mobile Sink. It includes frequent propagation of updates regarding the location of sink in the network periodically which consumes lot of energy for the propagation of update packets. Hence it reduces the network lifetime.

Based on the literature, at the expense of consumption of energy data delivery performance is increased. Hence our main aim in this paper is to propose a scheme in which the shortest path is selected for the data delivery by balanced energy consumption among all the nodes in an energy efficient manner.

3. Proposed model

A virtual structure is constructed by partitioning the entire sensor field into a virtual grid of K equal sized cells using virtual grid architecture (VGA). The cell-members are set free to move within its cell. The nodes which are at the center of the cells are selected as the cell-headers which have the responsibility of collecting data from all the cell-members and delivering the data to the mobile sink. Each cell-header periodically broadcasts its status information in the cell. The status information consists of ID of the cell-header, location information, and the cell ID to which the cell-header belongs. Similarly the cell members will be periodically broadcasting their status. The cell-headers are responsible for keeping track of the latest mobile sink's location. The cell-members report the data been observed to their cell-headers. A virtual backbone structure is constructed by the association of cell-headers and the gateway nodes.

The following are some of the network characteristics that are assumed:

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- The nodes are randomly deployed and set free to move within its cell to cover the entire area within the cell.
- The mobile sink moves around the periphery of the network.
- The mobile sink communicates with the border-line cell-headers for periodic data collection.
- The mobile sink is free from the constraints of the resources.

A. The virtual grid structure

Based on the number of nodes in the cell a virtual grid is constructed by dividing the entre sensor field into number of cells of equal size in a n*n matrix. This kind of portioning is been done to distribute the work-load uniformly on the cell-headers which results in prolonged network lifetime.

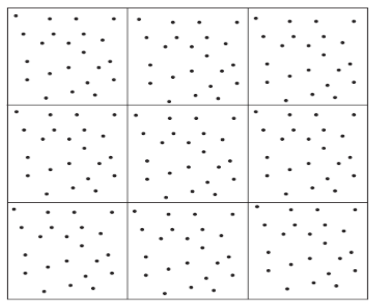

Figure 1: Virtual grid structure of network after partitioning.

B. Route setup

The nodes are set free to move within its own cell and sense the area within the cell. A set of nodes are selected as the cell-headers. Initially the cell-header is selected as to be the node which is closest to the center of the cell. Only the nodes whose distance to the mid-point of the cell is less than a threshold take part in the cell-header election for reducing the cost of communication. Each cell notifies its status to the nodes within the cell. Each cell-header periodically broadcasts its status information in the cell. The status information consists of ID of the cell-header, location information, and the cell-ID to which the cell-header belongs. Similarly the cell members will be periodically broadcasting their status information consisting of ID of the cell member, its location and the ID of the cell to which the node belongs. This broadcasting helps in the inter-cell data transaction.

The cell members monitor the environment, collect the data and forwards the data to its cell-header. In order to avoid the collisions the TDMA concept [1] is been used. Each cell-member in the cell would have been given a particular timeslot within which it has to report the data to its cell-header.

Initially, the mobile sink registers its location information with the closest cell-header to construct the route. The cell-header sets its next hop to the sink. The cell-header forwards the sink’s location to its neighboring cell headers. The other cell-headers calculate its distance to the mobile sink using the Euclidian distance formula given in equation (1). The cell-header which has the data to be forwarded checks with other cell-headers who is having the minimum distance to reach the mobile sink and forwards the data to the particular cell-header by setting its next hop to that cell-header. This continues until the data is delivered to the mobile sink.

$$\sqrt{(\,((x2 - x1)2 + (y2 - y1)2)} \qquad (1)$$

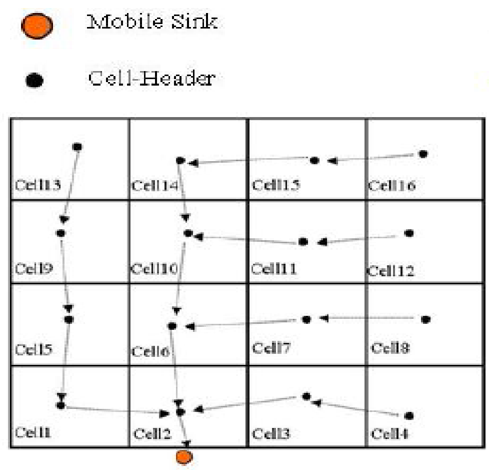

Figure 2: Routes setup

C. Re-adjusting routes

To minimize the network control overhead when the sink keeps on changing its location, route re-adjustment is done using the re-adjusting routes algorithm. This algorithm helps in reconstructing the route towards the latest location of the mobile sink. The reason behind this partial route re-adjustment is to minimize the overhead caused due to the reconstruction of route to the latest location of sink.

Algorithm for Re-adjusting routes:

Step 1: When Mobile Sink (MS) moves to next position it broadcasts its location.
Step 2: The cell-header (CH) on receiving the location update sends to CHs.
Step 3: if cell-header is in the range of MS, transmit the data to the MS.
Step 4: else find the shortest path to reach MS using Euclidean distance formula.
Step 5: Two CHs which are near to MS acts as gateway for CHs.
Step 6: One CH among the gateway CHs will be selected to transmit the data considering it's remaining energy.

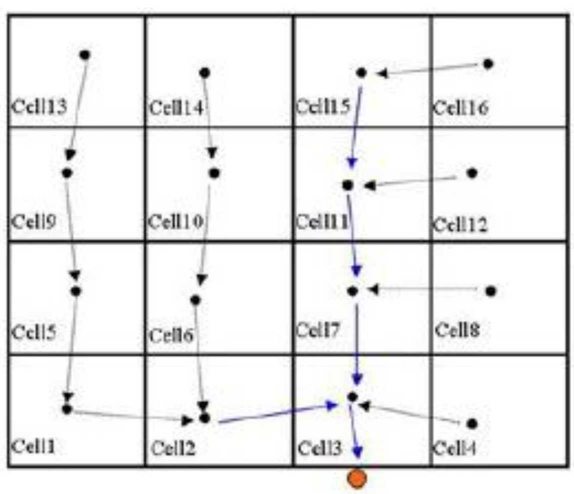

Figure 3: After Re-adjusting routes

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D. Re-electing cell-header

Rotation of Cell-Header in every cell is an important part. The cell-Header is subjected to high energy loss while the data transaction. Hence in order to enhance the network lifetime, the role of cell-Header is rotated. In order to maintain the balanced energy consumption among all the nodes, this is required. The threshold values are maintained for the energy, density and mobility. Whenever the energy, density and the mobility crosses these values a new cell-header election is been done.

4. Simulation and results

We use NS2 for the simulation of our results [13] [14]. We have considered the energy consumption of nodes and the throughput of nodes in the sensor network field. We have compared the proposed scheme with different existing schemes in [13].

A. Energy consumption

As shown in fig 4, the nodes energy consumption is much reduced even when maintaining the shortest path to reach the MS.

Proposed Scheme

Existing Scheme

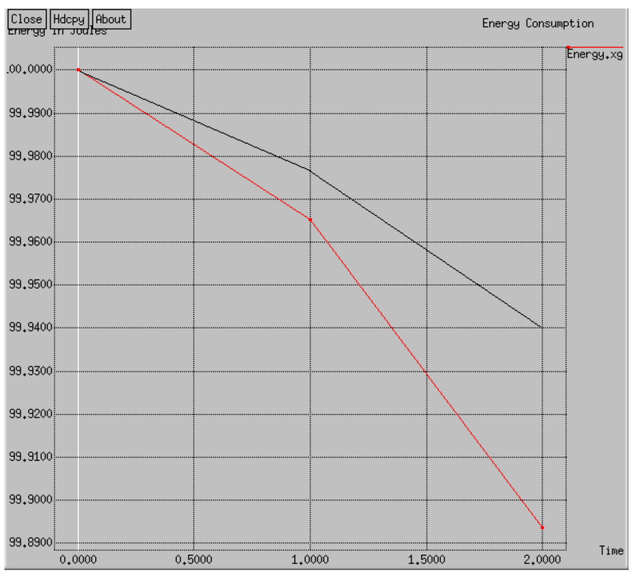

Figure 4: Energy consumption

B. Throughput

As shown in fig 5, the throughput is increased when compared to the existing systems while maintaining the low cost theme of WSN.

Proposed Scheme

Existing Scheme

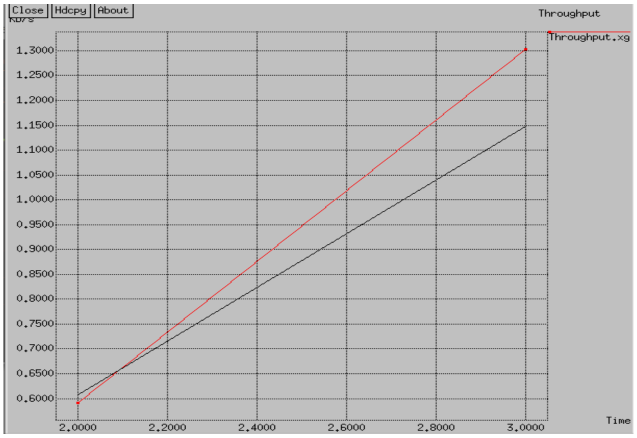

Figure 5: Throughput

5. Conclusion and future work

In this paper, we have proposed how the virtual Grid Architecture (VGA) routing technique can be applied for the dynamic wireless sensor networks. It also presents how the proposed scheme maintains the shortest optimal routes to the latest location of the mobile sink. In order to uniformly distribute the energy among all the nodes how the role of cell header is been rotated considering its energy, density and the mobility criteria. The simulation results shows that energy consumption is reduced which improves the network lifetime.

In future work, we would like to analyze the movement of dynamic nodes in the entire sensor field rather than restricting their movement within the cells.

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A Brief Author Biography

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