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ENERGY EFFICIENT GRID BASED DATA DISSEMINATION TO MOBILE SINKS IN WIRELESS SENSOR NETWORK

NAVPREET KAUR[1], MITHILESH KUMAR DUBEY[2] and RAVI KANT SAHU[1]

[1]School of Computer Science and Engineering
Lovely Professional University
Jalandhar - Delhi G.T. Road, Phagwara
Punjab 144411, India
E-mail: Navkaur21191@lpu.co.in
Ravi.16920@lpu.co.in

[2]School of Computer Applications
Lovely Professional University
Jalandhar - Delhi G.T. Road, Phagwara
Punjab 144411, India
E-mail: Mithilesh.21436@lpu.co.in

Abstract

Sensor nodes are distributed randomly without predetermining their positions over a particular area or field and these sensor nodes are automatically installed. The technology behind the wireless sensor network allows it to develop a single network instead of various large networks [1]. In this paper, the communication architecture of wireless sensor network is analyzed that explains how the sensor nodes, dissemination nodes, sensor field and sink are related to each other. When an event occurs, the sensor nodes deployed in that sensor field work to sense environmental or physical conditions such as temperature, sound, pressure etc. The data gathered after monitoring the sensor field by the sensor nodes is processed and the information is broadcasted to the sink which is actually the base station through dissemination nodes. An algorithm SNDD is proposed for the utilization of energy to increase the lifetime of the network by reliably storing and disseminating the data in wireless sensor network and the concept of mobility of the sink is also discussed [4].

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Introduction

Over the last few years, Wireless Sensor Network has sustained enormous technological advancements. A lot of work is being done on consumption of energy, low memory of sensor nodes etc and there are many issues to be concerned for enhancing the life period of a wireless sensor network [2].

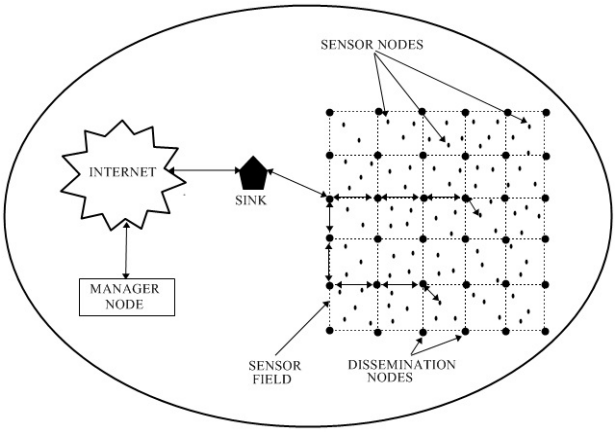

Figure 1.1. Wireless Sensor Network Communication Architecture.

In Figure 1.1, it is shown that how source sends the announcement message to nearest dissemination node, how one dissemination node forwards the data to another dissemination node and finally the announcement message reaches to the sink [3]. The sink then sends the queries to the source and after receiving the response of those queries, it sends the complete information to the manager node through the internet. Manager node makes plans to take appropriate actions correspondent to the particular events that are sensed by the sensor nodes [5]. The components that communication architecture of wireless sensor network includes:

- Sensor nodes.
- Dissemination nodes.
- Sink.
- Manager node.

Literature Review

The reviewed literature describes the data dissemination in different cases i.e. in case when the sinks are stationary and in case when the sinks are mobile. The shortest paths which are considered to disseminate the data so as to utilize the energy is also described. Various research papers have been reviewed to analyze the grid construction, efficient data dissemination, energy efficiency and mobility of the sink after sending the query to the source, shortest paths between source and sink.

Rohit Kumar Vishwkarma et al. [17], have proposed the data dissemination protocol which conserves the energy in the wireless sensor network as conservation of energy is very important in the WSNs. To conserve the energy, they have explained the concept of renewable energy sources such as solar energy. These energy sources may extend the lifetime of the Wireless Sensor network.

Ravi Kant Sahu et al. [14], "Energy Efficient Grid-Based Data Dissemination in Wireless Sensor Networks" have proposed a virtual infrastructure based data dissemination strategy which reduces the power consumption in grid construction process and exploits the virtual grid for forwarding of query and data. Source appearing in the sensor field actually initiates the grid construction process when no valid grid is present. The grid construction process is initiated by the source with its location coordinates, source id and radius of the expected zone. All other sources appearing during valid grid period share existing grid.

Sung Hwi Kim et al. [6], "Data Dissemination Protocol with Hole Masking Algorithm in Grid-based Wireless Sensor Networks" have explained the issues of hole problem which is faced by the data dissemination protocol in wireless sensor network. Holes are the obstacles for energy efficiency. Various problems occur due to holes and these problems are faced by the routing schemes which are based on geographic greedy forwarding. They described that whenever sensor nodes are failed due to energy consumption or any physical destruction then holes are generated.

Hyungjoo Lee et al. [8], "Data Dissemination Scheme for Wireless Sensor Networks with Mobile Sink Groups" have proposed protocol for dissemination

of data to multiple sinks which are mobile in wireless sensor network. The concept of mobile group entities has been explained in which the multiple mobile sinks move together and stay close to each other while randomly moving within a specified restricted region. They have focused on transmitting the data to all nodes which are within a stationary region.

Soochang Park et al. [12], "Scalable and Robust Data Dissemination for Large Scale Wireless Sensor Network" proposed a novel data dissemination scheme which is completely satisfied with the decoupling properties. The data dissemination scheme proposed before ARBITER scheme did not satisfy full decoupling.

T. P. Sharma et al. [17], "GBDD: Grid Based Data Dissemination in Wireless Sensor Networks" proposed various data dissemination methods to reduce the power consumption in wireless sensor networks. In this approach, the sensor nodes which are deployed do not change their locations and they remain static. They have discussed a dual radio based grid construction strategy which makes use of dual radio mode of sensor node so as to generate a grid over the wireless sensor network. Grid construction is commenced by the sink which appears in the sensor field when any valid grid is not present there. The sink which appears during the authentic grid period shares the grid which is already present in the sensor field so there is no need of new grid construction.

Haiyun Luo et al. [9], "TTDD: Two-Tier Data Dissemination in Large-Scale Wireless Sensor Networks" have explained the approach of Two-Tier Data Dissemination in this paper which provides the efficient and scalable data delivery to the multiple mobile sinks. They explained about the grid structure. TTDD approach utilizes its grid structure. Grid Structure is constructed by each data source and these grid structures enables the mobile sinks to continuously receive the data.

Methodology

The flow chart in figure 1.2 explains how sequentially each and every phase takes place for the reliable propagation of data between the source and the mobile sinks in wireless sensor network.

The data can only be sent and received efficiently in case of mobile sinks

if there is some central storage node which has high storage capacity. In wireless sensor network, this central node should be located in such a manner that it is equidistant from every edge of the network so that it should be easily approachable.

When the query is sent from the sink to the source then before sending the response of that query the source should first check the location of sink in its local grid nodes. Because it might happen that the sink after sending the query moves to some other grid near to the source. So if the sink is moved to the nearby grid of source then the data is not forwarded to storage node otherwise the data i.e. response of the query is forwarded to the storage node.

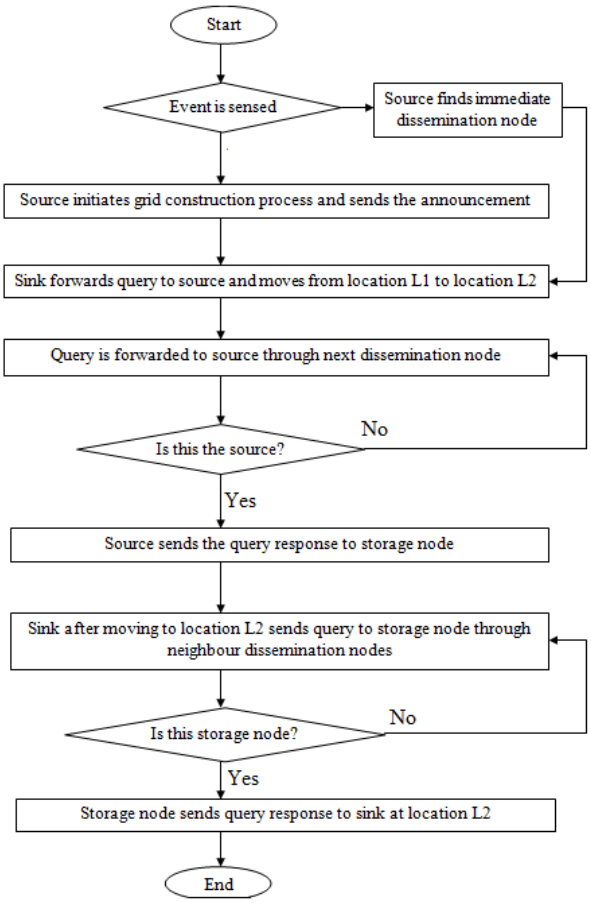

Figure 1.2. Flow chart for energy efficient grid based data dissemination to mobile sinks.

Now if sink moves so many times before receiving the response then at the last it will receive the response message from the storage node. So in this way the energy is utilized which is mainly consumed to send query and response again and again between source and the sink. In Figure 1.3, L1 is the original location of sink when it sends the query message to source and L2 is the new location of the sink where it has been moved.

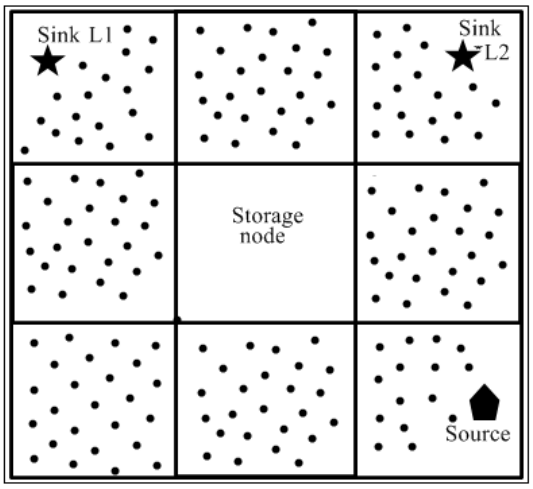

Figure 1.3. Mobile sinks with storage node.

In Energy Efficient Grid Based Data Dissemination to mobile sinks in wireless sensor network approach, SNDD (Storage Node Data dissemination) algorithm has been proposed to disseminate the data by consuming less energy. The complete process of event announcement, query message, query response storage at storage node, query response retrieval by sink from the storage node are described through different algorithms.

Results and Discussion

The results that are collected confirm that SNDD delivers data from multiple sources to multiple mobile sinks. In the sensor field 200 sensor nodes are deployed randomly over an area of 1000∗1000 m2. The sensor nodes that are deployed in the sensor field can have sleeping or sending message or receiving message mode. The transmitting power consumption of a sensor node is 0.66W. The receiving power consumption of a sensor node is 0.395W and the idle power consumption of a sensor node is 0.035W. A query

packet consists of 36 bytes and a data packet consists of 64 bytes. The maximum speed of mobile sink is 10m/s. and every time the simulation runs for 200 seconds. In Table 1.1, the parameters which are used in simulation are mentioned.

Table 1.1. Parameters used in simulation.

SIMULATION PARAMETER	VALUE
Simulation area	$1000m^2$
Number of nodes	200
Transmission range of nodes	100m
Size of query packet	36 bytes
Size of data packet	64 bytes
Transmission power consumption	0.66W
Receiving power consumption	0.395W
Idle power consumption	0.035W

Effect of Number of Sinks and Sources on Total Consumption of Energy

Figure 1.4 describes that how consumption of energy varies with the number of sinks in EGDD and Figure 1.5 describes the overall consumption of energy while SNDD is used.

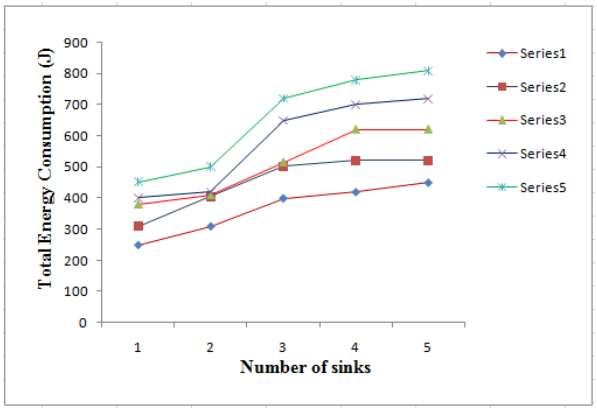

Figure 1.4. Total energy consumption correspondent to different number of sink in EGDD.

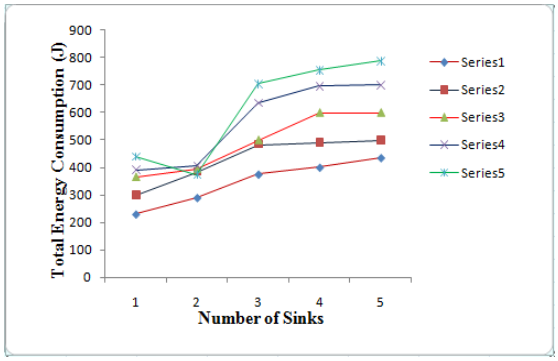

Figure 1.5. Total energy consumption correspondent to different number of sink in SNDD.

Effect of Sink Mobility

Figure 1.6 describes the success rate as the speed of the moving sink varies. For SNDD, success rate remains around 0.88 and for EGDD, it remains around 0.86.

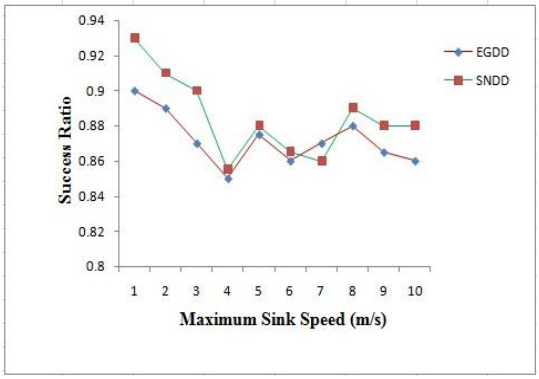

Figure 1.6. Success ratio vs maximum speed of sink.

Conclusion and Future Scope

Energy efficient grid based data dissemination to mobile sink algorithm SNDD is a grid-based data dissemination scheme which uses the virtual grid infrastructure to forward query and data. [19][20] It is an energy-efficient scheme which addresses the issues of reliable and efficient data transmission to mobile sink and the dissemination node failure in wireless sensor network. To handle the movement of sink and to reliably send data to sink, virtual grid infrastructure is useful. [10] This energy efficient grid based data dissemination to mobile sink scheme exploits the information about the location of sensor nodes to construct grid structure over the entire sensor field. In this proposed scheme, the sensor nodes which are randomly deployed are considered during the process of grid construction. Based on the residual energy, dissemination nodes are selected. The proposed data dissemination scheme ensures query and data forwarding through the shortest path between source and sink. This scheme is energy efficient as it reduces the consumption of energy in query and data forwarding when sink moves frequently by introducing the concept of storage node. [11][18]

In future, this proposed data dissemination scheme can be extended for heterogeneous wireless sensor networks. [13] A data dissemination scheme for non-uniformly distributed WSNs can also be proposed and the proposed protocol can be analyzed experimentally using deployment of wireless sensor network [15, 16].

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