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An Efficient Routing Scheme for Wireless Sensor Networks

Manjunath K.G. #, Dr. Jaisankar N.*, Pradeep M #

Research Scholar, V.I.T. Vellore, India,
** Professor, V.I.T. Vellore, India,*
 # M.Tech. CSE S.I.T. , Tumkur, India.

Abstract— **WSN acquires the data of surrounding environments with sensors attached to each node. It is important to design sensor networks that can communicate energy efficiently as well as to derive sensor readings with high accuracy. The proposed routing scheme that assures high accuracy and significantly reduces data transmission costs in WSN with faults. A number of network topologies randomly for routing sensor readings to the base station. Because every sensor node is connected to each other with a single path, redundant transmissions are not incurred. It can reduce unnecessary transmissions and guarantee final sensor readings with high accuracy. To show the superiority of the proposed scheme, it is compared with an existing multi-path routing scheme and with increased number of sensors in the area been deployed.**

Keywords— **WSNs, Sensor Network, Routing, Multiple tree, Fault.**

I. INTRODUCTION

WSN is constructed by distributing a lot of sensors and consists of sensor nodes that are connected to each other. The sensor node with the small size is characterized by the battery with a low capacity, the limited use of energy, the limited data processing capability. As the sensors which are used in sensor networks are mostly operated in the environments that we cannot access, it is impossible to replace the battery of each sensor node. Therefore, it is important for design requirements to be made so that WSN uses energy efficiently and reduces the communication costs. Because a continuous query in WSN collects data periodically and causes a lot of data to be transmitted, reducing the communication cost is necessary. Processing aggregation queries can reduce the communication cost by transmitting data merged in the network in the course of data routing and by reducing the number of message transmissions consequently. In addition, the sensor network is used in various environments with the errors such as the noise of communication channels and hardware failures in transmitting and receiving data. Since it is also operated based on limited energy resources, errors arising from the energy exhaustion of nodes frequently occur.
The routing schemes in WSN are classified into the tree-based routing scheme and the multi-path routing scheme. The tree based routing scheme is used to collect the query result data to the base station. The tree based routing scheme transmits data using single paths. If it undergoes the faults of the sensor network or the change of the topology, data of the child nodes of a particular node may be lost. As a result, the collected query result in the base station may be incorrect. In order to alleviate the weakness of the tree based routing scheme mentioned above, the multi-path routing scheme that can minimize the effect due to the network faults was proposed. However, because data are transmitted by multipath, redundant transmission of data can occur. Therefore, the accuracy of data becomes low.
The multi-path routing schemes provide the high accuracy in spite of the network faults or the change of topology. However, when transmitting the collected data in a particular node, because its unique bit label as well as the collected data are transmitted together, the multi-path schemes increases the scale of the transmitted data and causes high data transmission costs. To overcome these problems, the proposed routing scheme collects the result data of queries with a number of routing trees without data redundancy. Therefore, it assures the high accuracy of result data and reduces the transmission of unnecessary data can be lessened.
The main objective of this work is to propose a novel routing architecture that assures high-accuracy and significantly reduce data-transmission cost in wireless Sensor network with faults. Wireless Sensor Network collects data periodically deploying a continuous query. Sometimes it causes a lot of data to be transmitted, reducing the communication cost which is very much required. Processing aggregation queries can reduce the communication cost by transmitting data merged in the network in the course of data routing and by reducing the number of message transmits consequently which are the basic criteria of motivation to perform research in this area.

II. RELATED WORKS

An energy efficient various routing schemes has been studied in [1][2][3][4]. In [1] the author has described the efficient multi-candidate greedy routing scheme in wireless sensor networks. In [2] the author described the energy-efficient tree based message ferrying routing schemes for wireless sensor networks. In [4] author explained An Efficient Multiple Tree-Based Routing Scheme in Faulty Wireless Sensor Networks. Energy-Aware Routing [12], which is a set of sub-optimal paths are used. These paths are chosen by means of a probability function, which depends on the energy consumption of each path. The author in [13] prove that from the energy consumption point of view, it is better to communicate using short, multi-hop paths between the sender and the receiver.
Many tree-based routing schemes were proposed for collecting data to the base station [14, 15, 16]. Although they are useful for collecting result data with high accuracy and for processing aggregation queries, they are not comfortable in frequently or which has many faults multi-path routing schemes [17, 18] such as sketch [19] which consider network faults and the change of the network topology were proposed.

In case of multi-path routing schemes, there is no problem with accuracy when deriving the result data of the general query. However, when processing an aggregation queries, there remains the problem that derives inaccurate results which show high deviation resulting from the redundant data transmission. CountTorrent [20] has been suggested as a method of solving the data redundancy problem in processing aggregation queries.

III. PROPOSED SYSTEM

A novel routing scheme is proposed that assures high accuracy and significantly reduces data transmission costs in WSN with faults. First, the system will organize a number of network topologies randomly for routing sensor readings to the base station. Because every sensor node is connected each other with a single path, redundant transmissions are not incurred. It can reduce unnecessary transmissions and guarantee final sensor readings with high accuracy. First, in the initial stage of the network, the level of each node and candidate parent that is intended for the set-up of path and data are determined. And then, in the stage of a routing path set-up and data collection, the query and QoS are distributed to each node. The routing trees in k epochs are built up when the network faults occur. Since several result data in the epochs are collected, the proposed scheme supports the high accuracy. The proposed architecture has a unique way of termination. If the QoS meets the criterion that is set up at the time of the query, the base station terminates the query processing by transmitting a beacon message to all of the nodes.

A. Algorithm Description

Network Initialization Stage

In this stage, a node which can be selected as the parent for a particular node is saved in cache memory. The base station prepares a network initialization message <src_id, level>, where src_id is the identifier of the source node and level is the level of the node in the routing tree. It transmits the message to a whole network with the flooding method.

Figure given below shows the network initialization process. If a node receives a network initialization message from a neighbouring node, it stores the neighbouring node which transmits message in cache memory as the candidate parent node and sets up the level value of the message as its own level. And then the node transmits its own ID as the src_id property of the network initialization message to its neighbouring node. On the other hand, the node sets up the level value which adds 1 to its own level value and transmits it to its neighbouring node. This process is repeated until all sensor nodes store each level and the candidate parent node in their cache.

B. ROUTING PATH SET-UP AND DATA COLLECTION STAGE

In this stage, the routing path set-up and data collection in each epoch for the query result are performed. In the data collection stage, data between sensor nodes become aggregated in the parent node. This work begins from the nodes of the lowest level of the routing tree to root node according to level. The sensor node determines its parent node randomly among candidate parent nodes which are stored in its cache and transmit the sensed data to the parent node with the format <sensor_num, aggr_data>.

Here, sensor_num represents the number of nodes that participate in data collection. The nodes of the lowest level set the sensor-num as value 1 and transmit it to the parent node. Aggr_data stands for data collected in a node. The node transmits aggr_data to its parent node. The parent node gets together its own data and the data received from the child nodes and performs packet aggregation. It also adds 1 to sensor_num. Finally, it transmits sensor_num and aggr_data to its parent node. Because information such as unique bit label allocation shown in the existing multi-path routing scheme is not transmitted together in the proposed scheme, unnecessary data transmission can be lessened. Figure given below shows the routing path set-up and data collection process when the energy exhaustion failure in the node 4 of level 2 occurs. In Epoch_1, when node 6 chooses node 4 as a routing path among candidate parents, node 4 does not exist due to energy exhaustion any more. As a result, in Epoch_1, we do not get the accurate result because the data of node 6 are not reflected in the result. In Epoch_2, the proposed scheme reorganizes the routing path which is different from Epoch_1 and generates the accurate result data.

The unit which collects the result data after query transmission is called as Epoch and the number of Epochs is determined according to QoS which is set up along with the query. The routing path set-up and data collection in each Epoch are performed. Since the data are transmitted by electing a node among parent nodes which were not selected previously, a unique routing tree in each Epoch is constructed. Because the proposed scheme enables the routing path trees corresponding to the number of Epochs to be generated, in spite of network failures, it provides the high quality of accuracy.

RESULT OF A QUERY

QoS about final packet collected in base station in each Epoch is calculated using equation (1). If the QoS meets the criterion that is set up at the time of the query, the base station terminates the query processing by transmitting a beacon message to all of the nodes.

$$\text{QoS}(\%) = \frac{\text{The number of Sensor Nodes involved in Data Collection}}{\text{The number of Sensor Nodes}} \times 100 \qquad (1)$$

On the other hand, in case the query result does not satisfy the QoS, next Epoch is performed. Such processes are repeated within the number of epochs determined according to QoS at the time of query. In case the query result does not meet the QoS in all Epochs, the data which has the highest value of sensor_num among collected results as the final result of the query are returned.

IV. RESULTS AND DISCUSSIONS

We have used Java net beans to implement the Multiple Tree-Based Routing Scheme for Wireless Sensor Network. Fig 4.1 shows the forms menu option to create nodes in the workspace. Fig 4.3 shows how various nodes are generated and Fig 4.4 shows how virtual links generated between the nodes the work space. Fig 4.5 shows how the message is flooded from base station via different nodes to destination node. Fig 4.6 shows the line graph drawn between accuracy of query result data and Network failure rate. Fig 4.7 shows the line graph drawn on the amount of data transmission in bytes versus number of sensor nodes.

From the graph 4.6 the total number of survival nodes is obtained by using the formulae as

Total no of survival sensor nodes=total sensor node*(1-network failure rate).

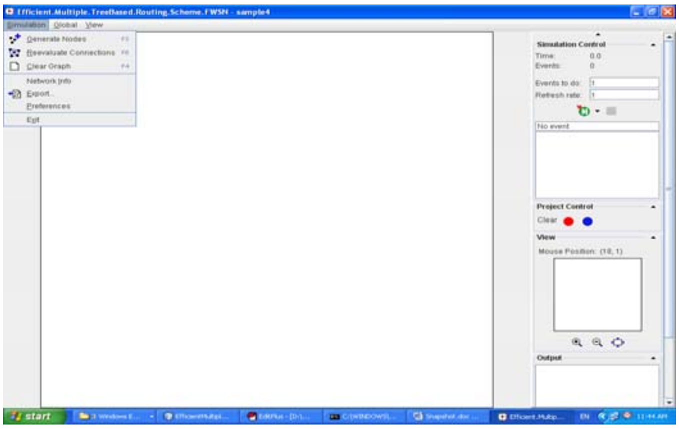

Fig 4.1 shows the menu options to create nodes in the work space

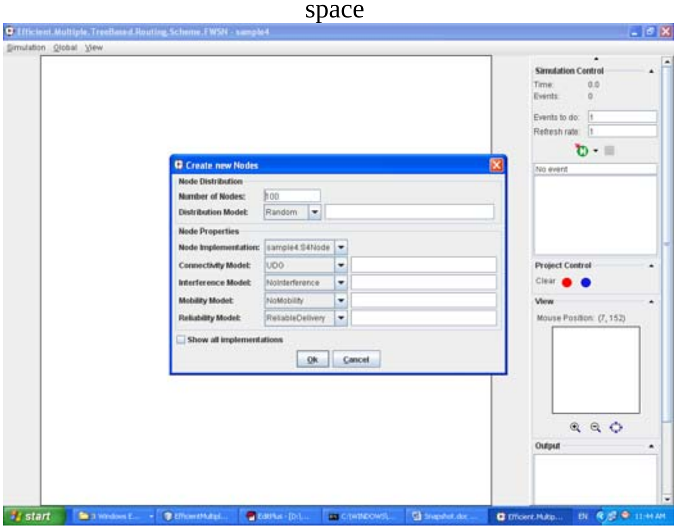

Fig 4.2 shows the different Settings to generate the nodes in the workspace

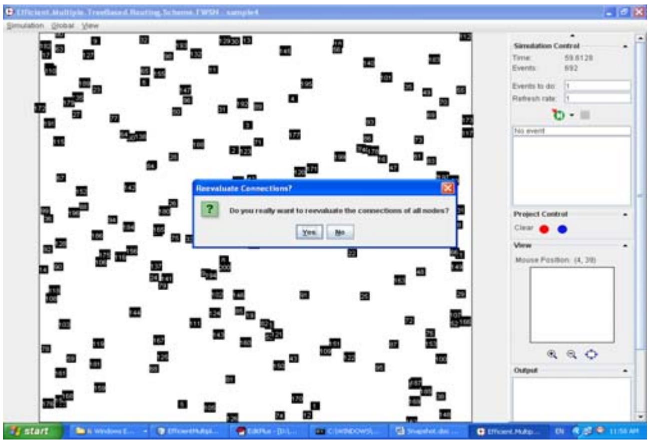

Fig 4.3 shows how Nodes generated according to the settings 2D- grid & Random

Fig 4.4 shows the virtual links generated between the nodes in the work space

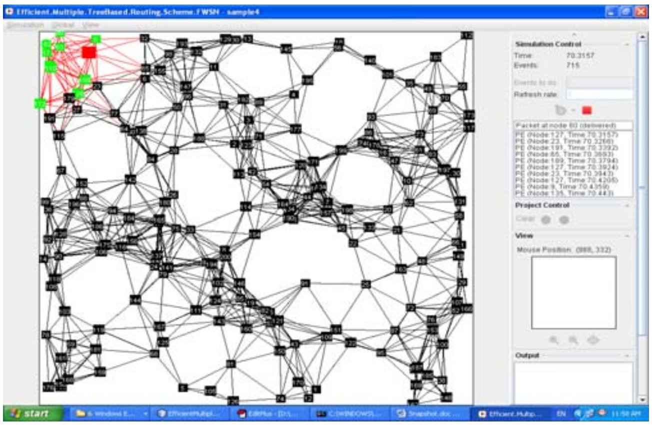

Fig 4.4 shows the virtual links generated between the nodes in the work space

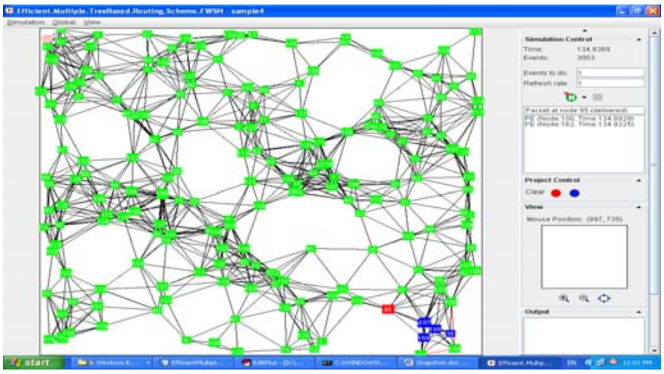

Fig 4.5 shows Message Flooding Stage

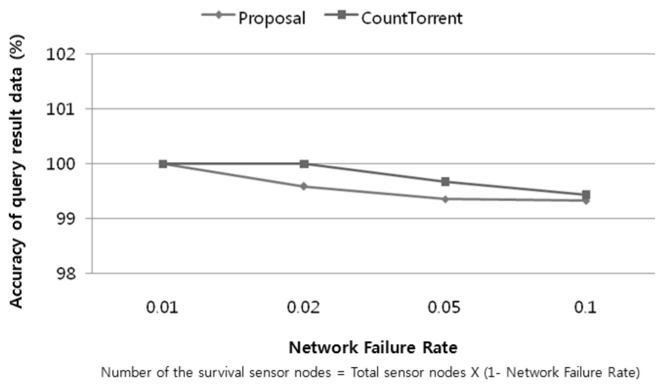

Fig 4.6

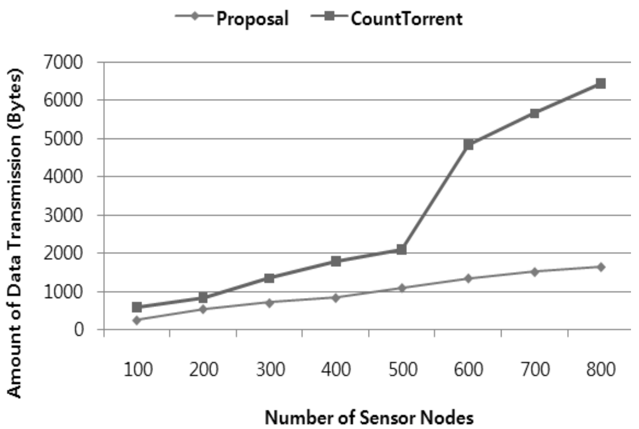

Fig 4.7 Amount of data transmission according to the number of sensor nodes

V. CONCLUSIONS

In this paper, we implemented a new multiple tree-based routing schemes that alleviate the problems of the existing routing schemes using java. To do this, we analysed the problems of the existing tree based routing schemes and multi-path routing schemes. The Scheme reduces unnecessary transmission and guarantee final sensor readings with high accuracy. As information such as unique bit level llocation as known in existing multipath routing scheme is not transmitted together in the proposed architecture, so unnecessary data transmission can be lessen. As the project architecture enables the routine path trees corresponding to the number of epochs to be generated, in spite of network failures, it provides the high quality of accuracy.

The existing work can be enhanced by designing an oblivious Routing in Fat-Tree Based System Area Networks with Uncertain Traffic Demands. The future work will consist of studying oblivious routing in fat-tree-based system area networks with deterministic routing under the assumption that the traffic demand is uncertain. The performance of a routing algorithm under uncertain traffic demands is characterized by the oblivious performance ratio that bounds the relative performance of the routing algorithm with respect to the optimal algorithm for any given traffic demand. It can be considered for both single-path routing, where only one path is used to carry the traffic between each source-destination pair, and multipath routing, where multiple paths are allowed. For single-path routing, it is expected to derive lower bounds of the oblivious performance ratio for different fat-trees and develop routing schemes that achieve the optimal oblivious performance ratios for commonly used topologies. The evaluation result is expected to indicate that the proposed oblivious routing schemes not only provide the optimal worst-case performance guarantees but also outperform existing schemes in average cases. For multipath routing, it can be shown that it is possible to obtain an optimal scheme for all traffic demands (an oblivious performance ratio of 1). These results quantitatively demonstrate the performance difference between single-path routing and multipath routing in fat-trees.

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