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An Enhanced Data Gathering Protocol for Wireless Sensor Network with Sink Mobility

Varshitha K, Madesha M

4th Sem M.Tech, Dept. of CS&E, Sahyadri College of Engineering and Management, Adyar, Mangalore, India

Assistant Professor, Dept. of CS&E, Sahyadri College of Engineering and Management, Adyar, Mangalore, India

ABSTRACT: In Wireless Sensor Network, sensor nodes have limited battery lifetime so energy consumption is one of the main issue in WSN. An energy efficient approach for data gathering can be achieved in WSN by using sink mobility. Currently researches focus on predicting mobile sink moving path in advance to obtain enhanced network. In many applications movement of mobile sink based on pre-calculated path is not applicable. In this paper an efficient data gathering protocol, Sinktrail and Sinktrail-S has been proposed when mobile sink's further location cannot be scheduled in advance. Sinktrail allows sufficient flexibility in the movement of mobile sinks to dynamically adapt to various terrestrial changes and without requirements of GPS devices or predefined landmark, Sinktrail establishes a logical coordinate system for routing and forwarding data packets, making it suitable for diverse application scenarios.

KEYWORDS: WSN- Wireless Sensor Nodes, mobile sink, data gathering, routing, logical coordinates.

I. INTRODUCTION

Wireless Sensor Network is a type of Wireless Network, consist of a collection of tiny devices called sensor nodes. Wireless Sensor Network is used in various applications in area such as environmental monitoring, health care monitoring and precision agriculture. Wireless Sensor Network consist of nodes that are individual and these node need to collaborate to complete their required tasks. Nodes are connected to each other by wireless links used for communication with each other. Sensor field contains sensor nodes. Basically sensor nodes consist of five components and they are controller, memory, sensors, communication devices and power supply. A controller controls the communication protocol, executes the tasks and manages energy. Memory is storage medium in which information is stored. Sensors are the devices that sense changes in event. Communication devices transmit information through a wireless channel. Power supply provides energy. WSN are developed by using sensors, these sensors have limited battery lifetime, their energy is limited so replacing or recharging is difficult. Hence energy saving is an important issue in WSN. If sensor nodes and the sink are static, then more energy is needed for data transmission towards the sink. To avoid this researches introduced a new concept of sink movement. Mobile sink such as a vehicle or robot which is armed with radio devices with a processor involved within it [1]. These radio devices are sent into network which interact directly with nodes, and then send the data to the destination. This reduces the energy consumption. Mobile sinks efficiently provides a solution for data gathering which helps in balancing the energy consumption among sensor nodes throughout the network. When mobile sink moves in the network, path should be determined by the mobile sink. Take an example of precision agriculture application shown in Fig.1, where mobile sink which collects the data follows field boundaries to prevent damage of crops.

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Fig.1 A photograph showing a farmland of irregular shapes . A mobile sink's movement is constraint in such environment [1]

For effective movement of the mobile sink in the network, path should be determined on which the mobile sink can move. Many algorithms are provided by using the predefined path such as AODV, geographical routing etc. But the problem in geographical routing is that, it assumes that the path is predefined in advance.

Currently researches focuses on predicting mobile sink moving path in advance to obtain enhanced network. Movement of mobile sink based on pre-calculated path is not applicable for some events. Therefore energy consumption would be reduced if the sensor would define the path of mobile sink movement. SinkTrail, efficient data gathering protocol is used in sensor network where the sink moves continuously in the network, in relatively low speed and gather the data. At some point control messages are transmitted around network will low speed. This position is called as "footprints". Considering these footprints as virtual landmark, sensor node can identify its track count distance. Sensor node's coordinate in logical coordinate space developed by the mobile sink can be represented by combining the track count distance [1]. Considering the destination coordinate and its own coordinate, sensor node can select the next hop with enhanced network. This protocol allows adaptable movement of mobile sink, finds efficient path without using a predefined path as well as reduces the energy consumption.

II. RELATED WORK

Energy efficiency and increasing the life of sensor nodes are the main issue in WSN. Geographical forwarding [2] protocols maintain local information. Protocols imagine that, exact location of the sink is predicted by the nodes. Such illusions are valuable only when sink is static and provides low performance for mobile sink. Considering movement of the nodes data gathering technique are classified as Unpredictable mobility pattern in which the mobile sink's moves randomly. Shah [3] introduced "data mules" in which mobile sink contains a feature of random movement in network. Data gathering is done by nodes and then data is filtered and then drops data at a point. This approach reduces consumption of energy. Jea[4], in this approach data collected using mobile node by following a straight path. Bratalin[5] introduced "NIMS", where data gathering by the mobile collectors was done within fixed cables so that maintenance is very easy and movement of sink cannot be defined in advance. Such approaches are not modifiable for changing environment. Another approach is Predictable mobility pattern in which the mobile sink's movement to locate data is not fixed and mobile sink takes pre-defined path. Data is gathered from every sensor node using single hop transmission. Ma and Yang [6] introduced an algorithm in which data uploading of node is done in single hop. Zhao [7] proposed data gathering technique which minimizes the transmission length by collecting data from multiple sinks using single hop which reduces the data updating time. Basagni [8] an model was proposed (MILP) in which sink path increases the lifetime of network and also sink moves towards the path where the nodes have higher energy. SDMA [9] technique, mobile sinks moves in controlled manner, which reduces energy consumption to be balanced and also data transfer will be done in a shorter time. ERUP protocol [10] overcomes the disaster that would occur when nodes where sending packets to mobile collector, this protocol would reconstruct another path so that packet transferring would occur. Tiny Aggregation [11] in this approach every epoch is divided to a relative time slots which define the routing tree in a reversed form. Every node is identified with respect to the situation in tree and data will be sent in timely manner. During this approach the node is synchronized which leads to energy consumption. LEACH [12] randomly distributes energy among nodes. Nodes form clusters and one node acts as a cluster head. If selection of cluster head is

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based on priority then, cluster heads time to live will be reduced and the nodes in these clusters will be finished. To overcome this, LEACH chooses nodes with high power as cluster head. Compression of data takes place when it needs to be transferred from cluster head to base station, so LEACH uses local data fusion. Directed Diffusion Approach [13, 14] in this approach to identify the information, receivers and resources use some attributes. This approach was developed to find a multi way route to transmit information between source and sink. Each task is given a value and every value is set of attribute value pair. EEMC [15] (An energy efficient multi level clustering) in this approach for cluster formulation sending and receiving of the data is done by sink node. A cluster consist of nodes in them and among them cluster head is selected. At every step cluster head is elected depending on residual energy and also distance very efficiently. VLEACH [16] is a new version of LEACH which reduces energy consumption. During this approach Vice cluster head is selected by using this cluster nodes will always reach sink. This solves problem of electing new cluster head each time the cluster head dies. Two-Tier Data Dissemination (TTDD) [17] is been developed by existing idea of virtual backbone also known as virtual grid. In this approach mobile sink sends information to the nearest grid points along the flooding and data will be sent back to the sink using reverse path. As a result, control overhead which are formed during sink movement are limited to the grid cell where sink is located. SEAD (Scalable energy efficient asynchronous dissemination) [18] protocol assigns some nodes as access nodes and this protocol depends on these access nodes to control traffic. Mobile sink selects one among neighbor nodes as path nodes. This protocol generates an energy efficient dissemination tree from source to other path nodes. Using this tree Data is transmitted and then path nodes send them to sink.

III. PROPOSED ALGORITHM

Consider a network which contains sensor nodes in it. These sensor nodes are connected with each other with links that are needed for communication. These sensor nodes are active when data gathering process begins. For data gathering mobile sink such as robots which are external devices are sent into the network, mobile sink is used to gather the data can be recharged whenever needed. The data gathering starts when mobile sink enters the network and terminates whenever enough data is collected or there is no more data left. Sinktrail[1] is used for data gathering process. Mobile sink moves in very low speed. It stops at some place for some time. That point is known as track point and transmit messages to the network, these messages are known as track messages. These messages contain <track no, track count>. Fig.2 represents the architecture of system.

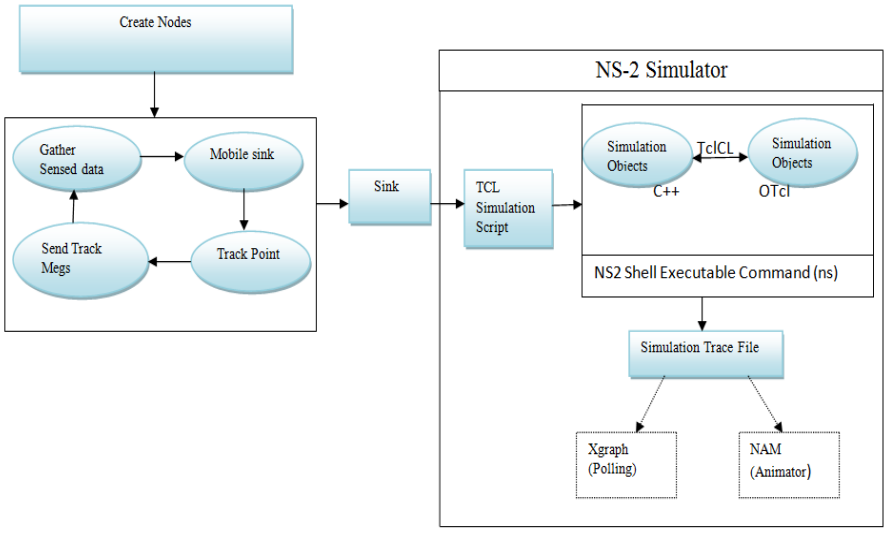

Fig.2 System Architecture

When mobile sink moves from one track point to other in data gathering process, track reference has to be updated. The implementation process has three phases.

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A. *Logical Coordinate Space Construction:*

Every sensor node consists of its own track references. In this phase sensor nodes update their respective track references. Initially, all sensor nodes track references are initialized to [-1, -1…….,-1]. Special variable α is used to track latest message track number. After mobile sink enters the field the track message, <track no, track count> is set to <1,0>. The track messages are transmitted to all sensor nodes by mobile sink. Using this track message, track reference of sensor nodes are updated [1]. These tack reference are used as logical coordinates of all sensor nodes and sink node in network. Sink trail facilitates flexible construction of logical coordinate space.

B. *Destination Identification:*

Sinktrail allows a mobile sink to stop at convenient locations according to current field situation [1].The places at which mobile sink stops are known as track point, are footprints left by the mobile sink. Footprints provide information for tracing the current location of mobile sink.

C. *Greedy Data Forwarding:*

As soon as mobile sink moves and stops at a point known as track point, track reference are exchanged with neighbor node. Data is sent directly to mobile sink if mobile sink is within the range or find neighbor node close to destination. Then all the data is forwarded to that neighbor node which performs data gathering [1].

IV. SIMULATION RESULTS

The simulation studies consist of a network with 30 nodes and sink is been selected as shown in Fig.3. The proposed data gathering protocol is implemented using NS-2. The simulation results shows sink sending its track messages to entire network, energy consumption and throughput.

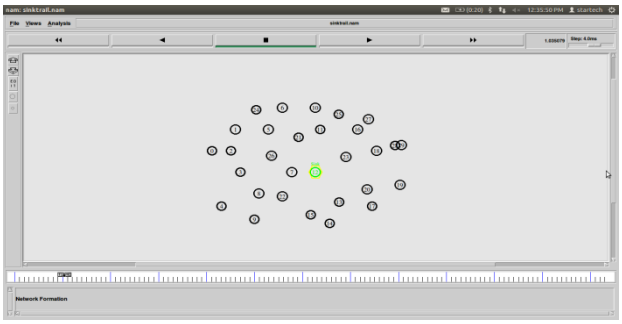

Fig.3 Node creation and sink selection

Nodes receive the track messages from the sink node as shown in Fig.4. Then all nodes collect their neighbour information. Nodes update their track location information by means of track references.

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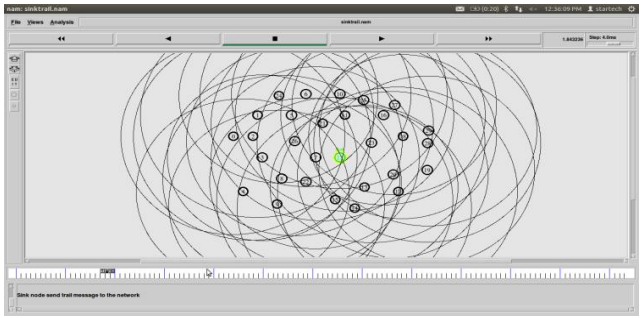

Fig.4 Sink sends trail messages to entire network

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A. *Energy Consumption*

The Fig.5 shows energy consumption of Sinktrail and Sinktrail-S. It shows that the energy consumed by the Sinktrail protocol which is minimized when compared to the energy consumed using Sinktrail-S protocol . Thus the energy of node and network gets improved.

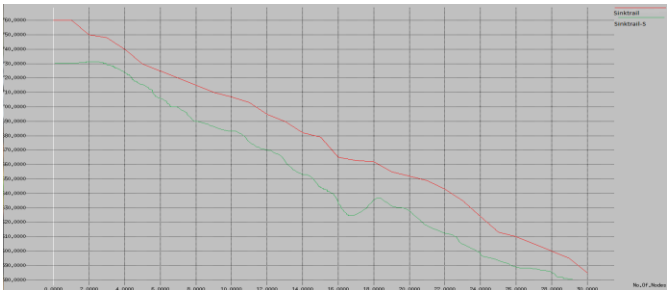

Fig.5 Energy consumption

B. *Throughput*

Throughput is the number of useful bits per unit of time forwarded by the network from a certain source address to a certain destination ,prohibit protocol overhead, and excluding retransmitted data packets. The Fig.6 shows throughput of Sinktrail and Sinktrail-S

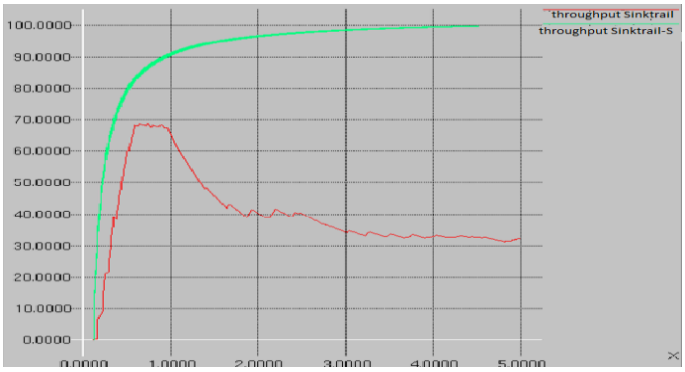

Fig.6 Throughput

C. *Simulation table*

The following Table I describes simulation model.

TABLE I Simulation of NS2

SIMULATOR	Network Simulator 2
SIMULATION OF NODES	Random 30 Sensor nodes
INTERFACE TYPE	Phy/WirelessPhy
CHANNEL	Wireless Channel
MAC TYPE	Mac/802_11
QUEUE TYPE	Queue/DropTail/PriQueue
QUEUE LENGTH	201 Packets

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ANTENNA TYPE	Omni Antenna
PROPAGATION TYPE	TwoRay Ground
SIZE OF PACKET	Five hundred and twelve
PROTOCOL	AODV
TRAFFIC	TCP

V. CONCLUSION

In this paper Sinktrail protocol is proposed which provides an energy efficient data gathering. The main aim of protocol depends on how to transmit data through a shorter path and to gather data efficiently in network. Sinktrail uses logical coordinates to identify the distance and establishes data reporting path by greedily selecting the shortest path to the destination. Sinktrail [1]. adapts different moving patterns. Algorithms are proposed for identifying sink movement and also for track reference update. Sinktrail also considers geographical routing without using GPS or landmarks installed.

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BIOGRAPHY

Varshitha K is currently pursuing her master's degree (M.Tech) in Computer Science and Engineering at Sahyadri College of Engineering and Management, Mangalore, India. She completed her B.E degree (2009-2013) in Information Science and Engineering at P A College of Engineering, Mangalore, India. Her areas of interest are Networking, Database Management.

Madesha M received his B.E degree in Information Science and Engineering from Sri Siddhartha Institute of Technology Tumkur and received his M.Tech degree in Computer Science and Engineering from JNNCE Shimoga. He has 4 years of teaching experience and has guided B.Tech and M.tech projects.