ISSN:0975-9646

Ranjeet Kagade et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (1) , 2014, 16-19

Lifetime Improvement of Wireless Sensor Network Based on Sleeping Algorithm

Ranjeet Kagade , Prof.R.A.Satao

Dept.of Computer Engineering, SKNCOE,Pune University,Pune,India

Abstract: Wireless sensor network is one of the most powerful domain for research based on many characteristics that is power consumption, node failures, communication failures, large scale deployment , network problem, coverage problem .In this literature concentration goes towards network coverage problem as well as energy saving, Sleeping algorithm is used for randomly deployed WSN in order to increase the network lifetime. It offers good performance in terms of saving energy to increase the network lifetime in randomly deployed sensor network. In proposed system we are going to position the nodes in the network in such a way that, sleeping of node, if all its neighbors are awake should not result into blind point in network. We have also assumed that if node is at the centre of all neighbors, there is maximum probability that its sensing area is covered by its neighbors. Also, we are using remaining energy based sleeping algorithm to increase the lifetime of wireless sensor network.

INTRODUCTION TO WSN

Wireless sensor networks (WSNs) [1] consist of a large number of wireless sensor nodes that have sensing, data processing and communication functionalities. WSNs are typically used to monitor a field of interest to detect movement, temperature changes, precipitation etc. The nodes are typically equipped with power-constrained batteries, which are often difficult, expensive and even impossible to be replaced once the nodes are deployed. Therefore energy awareness becomes the key research challenge for sensor network protocols.

The energy consumed by a node depends on its state. Each node may be in one of four states: transmit, receive, idle (when the node keeps listening to the medium even when no messages are being transmitted) and finally sleep state (where the radio module is switched off: no communication is possible).

A wireless sensor network consisting of a large number of small sensors with low-power transceivers can be an effective tool for gathering data in a variety of environments. The data collected by each sensor is communicated through the network to a single processing center that uses all reported data to determine characteristics of the environment or detect an event. The communication or message passing process must be designed to conserve the limited energy resources of the sensors. Clustering sensors into groups, so that sensors communicate information only to cluster heads and then the cluster heads communicate the aggregated information to the processing center, may save energy.

Network Lifetime and Coverage Problem

Before introducing the proposed algorithm, the network lifetime and some related works are presented Wireless sensor networks are useful in military, scientific and environmental applications. Network lifetime and coverage are two important issues noticed by the researchers. In WSN [1] coverage can be defined as a measure of how well and for how long sensors are able to monitor the physical space. Nodes communicate [12] via RF signal using built-in antenna. Basically WSN's are used for monitoring the field of interest to detect temperature changes, movements etc.

[1]S. Zairi et al: The coverage problem may be divided into three categories depending on what exactly that you are attempting to monitor. 'Area coverage' [4]: the overall goal is to have each location of the interest area within the sensing range of at least one node. 'Target coverage' [6]: observes a fixed number of targets. 'Barrier coverage' [7]: refers to the detection of movement across a barrier of sensors.

In [12] the coverage idea is used as QoS metric for WSN. This idea is introduced to answer the fundamental question ,"How well the sensor can monitor the target area?".

Connectivity can be considered as the ability of the sensor nodes to reach the data sink. If the path is not present between the sensor nodes to data sink then collected data cannot be processed.

Communication range of the node can be defined as the area in which another node can be located in order to receive data. Sensing range of the node can be defined as the area which can be monitored or observed by a node. The two ranges may be equal but are often different.

Issues in Wireless Sensor Networks

1. Coverage Types

Before deploying a wireless sensor network, the determination of area of interest that needs to be monitored is very important. The area of interest may be an entire area, set of targets or may be a breach among a barrier [9]. If every single point within the field of interest is within the sensing range of at least one sensor node then coverage area is known as full or blanket coverage. Ideally we expect the minimum number of sensors must be deployed in order to achieve blanket coverage [9].

[1] S. Zairi, B. Zouari, E. Niel, E. Dumitrescu "Nodes self-scheduling approach for maximizing wireless sensor network lifetime based on remaining energy" Published in IET Wireless Sensor Systems.

2. Deployment

A sensor network deployment [9] can usually be categorized as a dense deployment and a sparse deployment. In dense deployment higher number of sensor nodes are deployed in a given field of interest while in a sparse deployment will have fewer nodes. A situation in which it is very important to detect every event dense deployment model is used. [9] When the target area needs to covered with minimum number of nodes then sparse deployment model can be used.

In most of the WSN's sensor node deployment is assumed to be static, node stays in the same place once they are deployed. [9]Newer sensor nodes (mobile nodes) have the ability to relocate after they are deployed. The algorithm in [9] has each sensor node determining the location it needs to move, in order to provide maximum coverage.

RELATED WORK

The coverage problem was also addressed in [13] where nodes are placed in an r-strip construct. In an r-strip construct nodes are located r distance away from the neighboring node. Where, r is the radious of sensing area. The problem with this method is deployment of nodes in this formation is impractical.

The key weakness of an algorithm presented in [10] is that each node must be within the sensing range of another node. Nodes in the network need to move in order to determine the optimal location. If any node can not be seen by any other node then it will not be able to determine its relative location.

In most of the sensor network nodes are deployed in the field of interest by either placing them in predetermined locations or having the nodes randomly deployed in the area. Networks with mobile sensors [10] usually start out with a random deployment and utilize the mobility property in order to relocate to the optimal location. Random deployments of sensor nodes regard the ability to maintain coverage while minimizing the amount of energy used.

Sensor nodes are battery dependent for getting energy and in most deployments battery replacement is not feasible. Due to this reason it is very important to conserve the energy and increase the network lifetime. [2]"When sensors are arranged in a hierarchical network then cluster heads can be used to aggregate data and reduce the amount of information sent up to the sink. This will relieve some of the burden on the nodes that are along the transmission path and increase their lifetimes."

Chen et al. [7] extend a barrier coverage protocol to increase energy efficiency. Node will put itself in a sleep state once it will detect adequate k-coverage in the area. Node will enter wakeup mode after a random amount of time and perform next check. When node is not needed then it will decide when it should wakeup again.Single coverage ensures that each target or point in the field of interest must be monitored by at least one active node. In multiple coverage, field of interest or point in the area needs to be monitored by at least k different active or working nodes, this is called as flat k-area-coverage problem [10] for area coverage. If the area is covered by k-distinct set sets of sensor in order to provide full coverage of sensing area, then area is k-covered. Problem is called as k-area coverage problem. The coverage problem can be further divided into 1-connectivity and k-connectivity coverage problem.

In algorithm presented in [11], node plays multiple roles, namely head, sponsor, and regular node. Each node determines the set of its sponsors covering its sensing area and sends a request message (REQ) to each presumed sponsor.

OGDC [15] Zhang et al. 2005, a localized protocol provides coverage control while maintaining connectivity. Protocol computes positions for all active nodes to achieve full coverage. Then OGDC selects nodes closest to these positions as active node and change the all other nodes into sleep state to conserve energy. This approach is built with the assumption that the network density is high.

"The main approach in Ottawa protocol Xing et al., 2002 is to derive off-duty eligibility rules for redundant nodes and then schedule the work status of these eligible nodes. The Ottawa protocol can result in redundancy after turning off only a subset of eligible nodes. However, Ottawa protocol support only 1-coverage and can not meet the requirements of some applications such as target localization or tracking which requires at least 3-coverage."

In [16] problem related to energy consumption is described, the sensor node resources are limited due to the high density. Number of nodes may generate and transmit duplicate data causing unnecessary energy consumption which reduces the network lifetime. Hence the basic issue in WSN is the redundancy. If the area of a node is covered by k-active nodes then that nodes is called as k-covered and is a redundant node. By turning of such redundant nodes energy can be conserved to great extent. Hence a redundant node is also called as off-duty eligible node [5]. Solution to find redundant node is to find out all sub regions divided by the sensing circles of all neighboring nodes and checking whether each sub region is k-covered or not.

If such eligible nodes are found by CER then, a sleep scheduling protocol CMP is used to balance energy consumption and network life time is increased.

A centralized algorithm is run on one or more nodes in a centralized location usually near the data sink. Author's cardei et al. put the idea of central data collector node called as base station. The base station will determine which sensor to deactivate in order to conserve energy and preserve k-coverage. Also the authors in [4] used a central data collector node to gather information from the other sensor nodes to decide which sensors to put into sleep mode.

ERGS algorithm aims to provide full coverage of field of interest with minimum number of active nodes. This decision

[2] Raymond Mulligan , Habib M. Ammari "Coverage in wireless sensor network: A survey" Network Protocols and Algorithms ISSN 1943-3581 , 2010, Vol. 2, No. 2

must done with minimum knowledge and message exchange [1].

Principles of the ERGS algorithm:

As in [1] nodes contribute to the coverage of area of interest through its sensing area. Hence,Each node guarantees the full coverage of it sensing area by subset of working nodes before entering in sleep state. Each node can self-schedule its activity using local decisions. If all nodes take the simultaneous decision to enter in sleep state then blind point may appear.

Most of the scheduling algorithm uses additional exchange of messages (deactivation or negotiation messages) to avoid such blind points.

Now, it is clear that no two nodes should take decision of entering sleep state to avoid blind point. To achieve this objective a notion of priority is introduced [1] between nodes. The value of priority is based on local information i.e. remaining energy of node, so that it can be computed by nodes locally. Exhausted nodes [1] should have higher priority to enter into sleep state.

So decisions can be easily made by each node in the network using its own remaining energy and remaining energies of neighbor. Still, a problem may occur if two nodes will have same remaining energy which can be avoided by comparing the node unique ID.

PROPOSED SYSTEM

In proposed work, initially all nodes are randomly deployed and then the mobility property of nodes is used to change the positions of nodes. All nodes in the wireless network are arranged by calculating Euclidean distance between the nodes. All nodes will be placed at a distance equal to radius of sensing area of a node. Arrangement of nodes results in such a way that sleeping of central node will never create blind point in the network. We made assumption that if node is at the centre and all its neighboring nodes are awake then, there is maximum probability that its sensing area is covered by its neighbors.

Start up

1. Let x = x coordinate of node
2. Let y = y coordinate of node
3. Let CX= x coordinate of centre of neighbours
4. Let CY= y coordinate of centre of neighbours
5. CX=x
6. CY=y
7. Start timer STARTUP_TIME
8. Broadcasts HELLO PACKET, which (x, y).
9. Upon receiving HELLO PACKET
    a. CX= (CX+x)/2
    b. CY=(CY+y)/2
    c. Reply HELLO REPLY(x, y)
    d. Add or update entry into routing table
10. Upon receiving HELLO REPLY
    a. CX= (CX+x)/2
    b. CY=(CY+y)/2
    c. Add or update entry into routing table
11. Upon finish of STARTUP_TIME
    a. x =CX
    b. y=CY
    c. Move node to center of neighbour position (CX,CY).

Sleeping Algorithm

1. NS = number of neighbours in sleep
2. If NS=0 then
    a. Node announces intension for sleeping with (id, remaining energy) to it's neighbour.
3. Upon receiving sleeping intension
    a. If my remaining energy < received remaining energy
        i. Sends negative acknowledgment(disagree)
    b. Else
        i. Sends positive acknowledgment
4. Upon receiving positive acknowledgment
    a. Wait for other neighbours to reply
5. Upon receiving negative acknowledgment
    a. Cancel sleeping intention for some period
    b. Restart algorithm after some fixed time period
6. Upon receiving all positive
    a. Send NOW Sleeping(id, time) to all neighbours
    b. Sleep node.
7. Upon receiving NOW Sleeping(id, time)
    a. NS=NS+1

Mathematical Notations

Network N consist of n nodes as

$$N = \{n1, n2 \dots . nn-1, nn\}$$

Let x_i as x coordinate of i^{th} node, Let y_i as y coordinate of i^{th} node,

Area of network is denoted by NA, Sensing area of n_i is

$$\text{SAi} = \{p \in NA | d(ni, p) < Rs\}$$

Where Rs is sensing range.

Function d is Euclidean distance given by

$$d(p1, p2) = \sqrt[2]{(x1-x2)^2 - (y1-y2)^2}$$

Set of neighbours of i^{th} node denoted by NS_i given by

$$\text{NSi} = \{nj \in N | d(ni, nj) < Rc\}$$

Where Rc is communication range.

Let Cx_i as x coordinate of centre of neighbours of nodes i^{th} node, Let Cy_i as y coordinate of node i^{th} node, given by

$$\text{Cxi} = \frac{1}{|\text{NSi}|} \sum_{j=0}^{|NSi|} xj$$

Similarly

$$\text{Cyi} = \frac{1}{|\text{NSi}|} \sum_{j=0}^{|NSi|} yj$$

At the end of start up phase, node n_i is relocated at centre of neighbour (Cx_i, Cy_i)

CONCLUSION

In the above proposed work we have assumed all nodes with mobility property, which enable WSN's to be very robust in order to fully monitor the field of interest. Also this mobility of nodes will allow us to deal with the node failure. In case of failure of any node all node can be moved to the required positions, to maintain the robust topology WSN. Also the sleeping algorithm is used by the sensor nodes to enter into sleep state in order to preserve energy and full area coverage.

REFERENCES:

1. S. Zairi, B. Zouari, E. Niel, E. Dumitrescu "Nodes self-scheduling approach for maximizing wireless sensor network lifetime based on remaining energy" Published in IET Wireless Sensor Systems.
2. M. Cardei and D. Du, "Improving Wireless Sensor Network Lifetime through Power Aware Organization", Wireless Networks , Volume 11 Issue 3, May 2005.
3. M. Cardei, M. Thai, L. Yingshu, W. Weili, "Energy-efficient target coverage in wireless sensor networks", INFOCOM 2005. 24th Annual Joint Conference of the IEEE Computer and communications Societies. Proceedings IEEE, Volume: 3, On page(s): 1976- 1984 , March 2005.
4. Ammari, H.M., Giudici, J.: 'On the connected k-coverage problem in heterogeneous sensor nets: the curse of randomness and heterogeneity'. ICDCS '09: Proc. 2009 29th IEEE Int. Conf. on Distributed Computing Systems, 2009, pp. 265–272
5. A. Balamurugan and T. Purushothaman "Coverage Eligibility Rule based Coverage Maintenance Protocol for Energy Conservation in Wireless Sensor Networks" Journal of Computer Science 7 (10): 1545-1553, 2011. ISSN 1549-3636.
6. Zhang, H., Wang, H., Feng, H.: 'A distributed optimum algorithm for target coverage in wireless sensor the Workshop on Modeling and Optimization in Mobile, Ad Hoc and networks'. Asia-Pacific Conf. on Information Processing, 2009, pp. 144–147.
7. Chen, A.: 'Designing localized algorithms for barrier coverage'. Proc. ACM mobiCom'07, 2007
8. H. Ammari and J. Giudici, "On the Connected k-Coverage Problem in Heterogeneous Sensor Nets: The Curse of Randomness and Heterogeneity", 29th IEEE International Conference on Distributed Computing Systems, 2009.
9. A. Howard, M. J. Matari´c, and G. S. Sukhatme, "An incremental self deployment algorithm for mobile sensor networks," Autonomous Robots, vol. 13, no. 2, pp. 113–126, sep. 2002.
10. Raymond Mulligan , Habib M. Ammari "Coverage in wireless sensor network: A survey" Network Protocols and Algorithms ISSN 1943-3581 , 2010, Vol. 2, No. 2
11. Chih-fan, H., Mingyan, L.: 'Network coverage using low duty-cycled sensors: random & coordinated sleep algorithms'. IPSN'04: Proc. Third Int. Symp. on Information Processing in Sensor Networks, 2004, pp. 433–442.
12. Meguerdichian, S., Koushanfar, F., Potkonjak, M., Srivastava, M.B.: 'Coverage problems in wireless ad-hoc sensor networks'. INFOCOM 2001: 20th Annual Joint Conf. IEEE Computer and Communications Societies, 2001, vol. 3, pp. 1380–1387
13. K. Kar, S. Banerjee, "Node placement for connected coverage in sensor networks", in: Proceedings of Wireless Networks (WiOpt'03), Sophia Antipolis, France, 2003.
14. Xing, G., X. Wang and Y. Zhang, C. Lu and R. Pless, et al., 2005. Integrated coverage and connectivity configuration for energy conservation in sensor networks. ACM Trans. Sensor Netw., 1: 36-72.
15. Zhang, H. and J.C. Hou, 2005. Maintaining sensing coverage and connectivity in large sensor networks. Ad-Hoc Sensor Wirel, Netw., 1: 89-124.
16. A. Balamurugan and T. Purushothaman "Coverage Eligibility Rule based Coverage Maintenance Protocol for Energy Conservation in Wireless Sensor Networks" Journal of computer Science 7 (10): 1545-1553, 2011
17. Tian, D., Georganas, N.D.: 'A coverage-preserving node scheduling scheme for large wireless sensor networks'. WSNA'02: Proc. First ACM Int. Workshop on Wireless Sensor Networks and Applications, 2002, pp. 32–41
18. Gurun, S., Krintz, C.: 'A run-ti feedback-based energy estimation model for embedded devices'. Proc. Fourth Int. Conf. on Hardware/Software Codesign and System Synthesis, 2006, pp. 28–33.