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Balanced Energy Efficient Spanning Tree Approaches for Wireless Sensor Network with Sleep Scheduling Algorithm

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***Abstract* - We Propose Balanced, Localized, Robust, Dynamic state changing and energy efficient spanning tree approaches for Wireless sensor networks which we call Balanced energy Efficient Spanning Tree with Sleep scheduling(BEESP-SS). They are based on the topologies. It is constructed using RNG. Localized Minimum Spanning tree is constructed based on these topologies(LMST).The actual routing tree is constructed based on the transmitter and receiver residual energy. We also consider different parent selection strategies while constructing routing tree and select the best among them. Our solution also involves the load balancing by measuring the energy level of the nodes in the spanning tree, because energy is drain out when large number of messages travelling through the particular node by limiting the messages travelled through the sensor nodes we can improve the lifetime of the spanning tree, it is done by partitioning the messages based on the energy level of the node in the spanning tree and redirect the messages to the some other nodes in the spanning tree. The proposed solution also adapted the Sleep Scheduling Algorithm, it wake up the sensor nodes in the network when it is needed. This paper also handles the route maintenance it includes node insertion and node deletion.**

***Keywords* - Wireless Sensor network, Partitioning, sleep scheduling algorithm, Localized Minimum spanning tree (LMST),Relative Neighborhood Graph (RNG)**

I. Introduction

Wireless Sensor Network is a collection of nodes organized into cooperative network. Each node consists of processing capability (one or more microcontroller, CPU's or DSP chips), may contain multiple types of memory(program, data and flash memories),have a RF Transceivers, have a power source(batteries and solar cells) and accommodate various sensors and actuators. The nodes communicate wirelessly and self organize in an adhoc fashion. Most important problem in wireless sensor network is limited battery power. Wireless sensor network constitutes two states, they are active mode and another one is passive mode. during the data transmission nodes are in active mode otherwise nodes are in passive mode it is achieved through the use of wakeup antenna. The design wireless sensor network depends on the application requirements. Sensor nodes will periodically sense their nearby environment and send the information to a sink which is not energy limited. The collected information can be further processed at the sink for end user queries.

In order to reduce the communication overhead we propose Balanced Energy Efficient Spanning Tree, it improves the sensor nodes lifetime. An important problem studied is to find balanced energy efficient routing tree by partitioning the messages based on the energy level of the node and also improves life time of the sensor nodes in the network by using sleep scheduling algorithm finally route maintenance.

Several requirements for this paper are, First the visibility graph is constructed using relative neighborhood graph(RNG)[5].

Second Localized Energy Efficient spanning tree is constructed based on RNG using Prim's algorithm. Edge weight assignment based on the transmitter and receiver residual energy, edge weight is changed dynamically based on the energy level correspondingly spanning tree is also updated.

Third Load is balanced with in the resulting spanning tree based on the energy level of the node the message will be partitioned and redirect the packets in some other nodes in spanning tree it distributes communication overhead with in the spanning tree. ie nodes having greater energy level can able to receive the message with maximum size.

Fourth is to Maximize the lifetime of the sensor nodes in the network by using sleep scheduling algorithm. Fifth it handles the route maintenance it includes node insertion and node deletion. Remainder of this paper is organize is as follows Section II discuss about the Literature review, in section III we define the problem statement ,In section IV we discuss about proposed algorithm In section V we discuss about the implementation results finally we conclude our paper with future work.

II. Literature Review

Recent growing interest in wireless sensor network inspired previous effort for energy efficient protocols. Localized power efficient protocol called L_PEDAP is proposed in [1]. L_PEDAP computes self organized, localized, robust and energy efficient tree approaches. But it is only suitable for homogeneous networks.

Power Efficient Data Aggregation Protocol called PEDAP is proposed in [3]. PEDAP extends the life time of the last node. It does not care about the energy level. The edge cost is computed as the sum of the transmitter and receiver energy. Next version is Power Efficient Data Aggregation Protocol with Power Aware called PEDAP_PA, it considers the energy of the sensor nodes based on this spanning tree is constructed. In PEDAP_PA edge cost is computed by dividing the PEDAP cost by transmitter residual energy. Both protocols are centralized in nature, this is the major disadvantage in that.

In [5], the authors proposed Minimum Spanning Tree based Topology control algorithm called LMST for wireless multi-hop networks, in this algorithm, each node builds its local minimum spanning tree independently and only keeps the on-tree nodes that are one hop away as its neighbors in the final topology.

In [7], the authors proposed Distributed and Dynamic Data Gathering Protocol for sensor networks. It is based on Local minimum spanning tree structure,each node selects as parent the LMST neighbor so that the total energy cost of route to the sink is minimal.it is appropriate for all the nodes are not in the direct communication. It may cause chain effect, the change in shortest path in sensors which are far away from the area where insertion or deletion occurred.

In [11], the authors proposed Minimum Energy Mobile Wireless networks. It solves the minimum energy problem with a single master site simultaneously solves the general peer to peer communication problem. The procedure finds the minimum energy links and dynamically update them. This is suitable only for stationary networks.In[15], the authors proposed Maximum Lifetime Routing in wireless sensor network. It uses online Maximum lifetime heuristics method, it maximize network lifetime.

In[18], the authors proposed Maximum Lifetime Data Gathering and Aggregation in Wireless sensor network. In this paper data should be collected from all the sensor nodes and transmit to the base station such that the system lifetime is maximized. It suffers from first node failure problem.

Power Efficient Gathering Aggregation in Sensor Information System called PEGASIS is defined in[19]. In this paper they proposed PEGASIS, a near optimal chain based protocol this is an improvement over LEACH. In PEGASIS, each node communicates only with a close neighbor and takes turns transmitting to the base station. This approach is not very efficient, since the transmission distances can be quite long and minimum distance chain is NP complete.

In [24], the authors proposed an algorithm called Energy Efficient Spanning tree algorithm. It constructs the spanning tree based on transmitter and receiver residual energy but it is centralized. This is major disadvantage in this paper.

III. Problem Statement

Consider a network of n sensor nodes, which are randomly placed in a network. Each node generates the data packet and transmits to the base station. All nodes in the network are capable of aggregating one or more incoming packets with its own and send to the base station or any other node.

A. Definition 1

In data gathering round, base station receives sensed data of each sensor through aggregation which reduces the redundancy.

B. Definition 2

The routing tree is constructed, it spans all nodes in the network without cycle. For a node, routing tree contains two pieces of information: to whom the node has to transmit data and to from which sensor it will receive data packet.

C. Definition 3

A routing tree is used for several rounds. We denote the frequency to be number of rounds a routing tree will be used.

D. Definition 4

Wakeup antenna used to activating the sensor nodes from passive mode to active mode while they are sensing information.

E. Definition 5

Energy consumption is based on the how many number of packets send and receive and also based on length of the message. Limit the message size based on the energy level of the sensor node by partitioning.We need to find the energy efficient spanning tree based on transmitter and receiver residual energy in localized manner and balancing the load based on the energy level of the sensor node, and also improve the lifetime of the sensor node in network using sleep scheduling done by wakeup antenna.

IV. Proposed Algorithm

A. Edge Cost Assignment

It is based on the idea of energy efficient spanning tree [24]. To transmit a k bit packet from node i to j the weight assignment is performed as follows

$$_{wij}(k)=\min\{E_i-T_{ij}(k),E_j-R_j(k)\}$$

where E_i is the current energy of node i and $T_{ij}(k)$ is the energy required to transmit a k bit packet from node i to j. the term $R_j(k)$ denotes the energy consumed to receive k bit packet for node j. edge weight assignment is based on both transmitter and receiver residual energy. It avoids the receiving node to become overloaded by receiving too many packets.

Proposed algorithm includes five phases they are

- Relative neighborhood graph construction (RNG)
- Spanning tree Construction Load balancing
- Maximize network life time by using Sleep scheduling algorithm
- Route maintenance

B. Phase 1

In this phase we constructing the visibility graph.

Algorithm 1:

Input: S-> List containing the sensor nodes in the network

Output: Graph G(V,E) containing vertices and edges

Step1: while S is NULL

Step2: for each node n in S

Step3: find the neighbors of n

Step4: select the node having the greater energy and ignore others

Step5: connect the new node with the predecessor

Step6: end for

Step7: end while

By using this algorithm we can able to find the visibility graph It shows the sensor nodes in the network and its neighbors, after that by using this we can able to find least minimum spanning tree.

B. Phase 2

In this phase spanning tree is constructed using the information from RNG based on transmitter and receiver residual energy.

Algorithm2:

Input: Visibility graph G(V,E)

e-> energy level of the current node

e'-> energy level of the other nodes

Output: Localized Minimum spanning tree

Step1: while G is NULL

Step2: for each node n in G

Step3: find the neighbors of node n in G

Step4: check the energy level of that node n

Step5:if(e>e')

Step6:select the node as neighbor

Step7: update the node energy level ie reduce energy level of that node

Step8: construct the spanning tree

Step 9: else reject the node

Step10: end for

Step11:end while

In this phase many number of spanning tree is constructed from those minimum spanning tree is chosen.

C. Phase 3

In phase 3 we balance the load based on the energy level of the node with in the spanning tree, it improves the lifetime of the sensor nodes in the spanning tree. basic concept is by limiting the messages travel through the sensor node we can able to improve the lifetime but it is not possible but we can able to distribute message to all nodes by partitioning.

Algorithm 3:

Input: Spanning tree S

Output: Balanced Spanning tree S' e->energy level of the current node e'->energy level of the other nodes

Step1:for each node in S

Step2: check the energy level of the node in spanning tree

Step3: if(e>e')

Step4:accept message with maximum size

Step5: else

Step6: Partition the message

Step7: Redirect the message to some other node having greater energy

Step8: end for

It balance the load in LMST by measuring the energy level of the node periodically, it improves the performance and lifetime of the sensor nodes in the spanning tree.

D. Phase 4

In this phase we maximize the network Lifetime by using sleep scheduling algorithm, it uses wake up antenna. Wakeup antenna used for activating the sensor nodes from passive mode to active mode. During the data sensing only we keep the node in active mode otherwise we keep the node in passive mode.

Algorithm 4:

Step1: Initialize all sensor nodes in passive mode

Step2: Collect the sensor nodes that are needed for communication

Step3: sending the wakeup signal for those nodes by using wakeup antenna

Step4: otherwise keep the sensor nodes in passive mode as such

It maximize the sensor nodes lifetime in the network.

E. Phase 5

In this paper we also handles route maintenance it includes node insertion and node deletion based on this spanning tree is updated. Node having the lower energy level is treated as node failure.

Algorithm 5:

Step1: e->energy level of the particular node

Step2: if(e<threshold value)

Step3:remove the particular node and update the spanning tree

Step4: send hello message for new node to all other nodes

Step5: update the spanning tree

V. Implementation Results

In this paper we are concentrating to reduce the Number of Rounds needed for constructing spanning tree as well as the cost is needed for constructing tree and balancing the Load with in the Routing tree it reduces the overhead with in the routing tree and improves the lifetime of the wireless sensor network. In PEDAP they are concentrating only on the construction of routing tree they failed to consider the energy level of the node so lifetime of the sensor node is low. In PEDAP-PA they concentrate only on the transmitter energy level but it is centralized. In L-PEDAP is localized but it failed balance the load with in the spanning tree here the routing tree is constructed based on the transmitter and receiver residual energy.

Table I 100m × 100m network field, BS at (50, 50)

Node	PEDAPPA		L-PEDAP		BEESP-SS	
	LT	T	LT	T	LT	T
50	6128	6127	8249	80	8361	72
60	6429	6419	8224	82	8416	75
70	6847	6846	8254	82	8595	70
80	6928	6920	8505	85	8730	76
90	7140	7139	8557	86	8759	77
100	7177	7150	8539	86	8880	83

Table II 100m × 100m network field, BS at (200, 200)

Node	PEDAPPA		L-PEDAP		BEESP-SS	
	LT	T	LT	T	LT	T
50	3189	3128	3739	37	4525	213
60	3525	3524	4118	41	4973	238
70	3720	3713	4363	43	5346	256
80	3866	3858	4558	45	5643	269
90	3903	3897	4673	46	5882	283
100	4158	4098	4831	48	6111	294

VI. Conclusion

In this paper, we presented balanced, power Efficient data aggregation Protocol with Sleep scheduling algorithm. It improves the performance of the existing protocols such as PEDAP-PA,L-PEDAP and EESP. It balances the load in Localized minimum spanning tree, it improves lifetime of the nodes in the network by using sleep scheduling algorithm, it is localized, it also handles route maintenance. However it is suitable only for homogeneous networks. In Future we will try to implement for heterogeneous networks.

References

[1] Huseyin Ozgur Tan, Member ,IEEE, Ibrahim Korpeoglu, Member, IEEE and Ivan Stojmenovic, Fellow, *IEEE,"Computing Localized Power Efficient Data Aggregation Trees for sensor networks"*,vol 22,March 2011

[2] J.Wuand I.Stojmenovic, "AdHoc Networks," *Computer,*vol.37, no.2,pp. 29-31,Feb.2004.

[3] H.O.Tanand I.Korpeoglu, "Power Efficient Data Gathering and Aggregation in Wireless Sensor Networks," SIGMOD Record, vol.32, no.4,pp. 66-71,2003.

[4] R.Prim, "Shortest Connecting Networks and Some Generalizations," Bell System Technical J., vol.36,pp. 1389-1401,1957.

[5] N.Li,J.C.Hou, and L. Sha,"Design and Analysis of an mst Based Topology Control Algorithm," *Proc. IEEE INFOCOM,* 2003.

[6] H.O.Tan, I.Korpeoglu, and I. Stojmenovic, "A Distributed and Dynamic Data Gathering Protocol for Sensor Networks,"*Proc. 21st Int'l Conf. Advanced Networking and Applications,* pp. 220-227, 2007.

[7] J.Bachrach and C.Taylor, "Localization in Sensor Networks," Handbook of Sensor Networks: Algorithms and Architectures, I.Stojmenovic, ed., pp. 277-310, Wiley, 2005.

[8] J.Hightowerand G.Borriello, "Location Systems for Ubiquitous Computing," Computer, vol.34,no.8,pp. 57-66, Aug.2001.

[9] W.R.Heinzelman, A.Chandrakasan, and H.Balakrishnan, "Energy-Efficient Communication Protocol for Wireless Micro sensor Networks," *Proc. 33rd Ann. Hawaii Int'l Conf. System Sciences,*pp.3005-3014,2000.

[10] V.Rodopluand T. Meng, "Minimum Energy Mobile Wireless Networks, "IEEE J.Selected Areasin Comm., vol.17, no.8, pp.1333-1344, Aug.1999.

[11] S.Singh, M.Woo, and C.S.Raghavendra, "Power-Aware Routing in Mobile Ad Hoc Networks," *Proc. Int'l Conf. Mobile Computing and Networking,* pp. 181-190,1998.

[12] S. Singh, M. Woo, and C.S. Raghavendra, "Power-Aware Routing in Mobile Ad Hoc Networks," *Proc. Int'l Conf. Mobile Computing and Networking,* pp. 181-190, 1998.

[13] I. Stojmenovic and X. Lin, "Power-Aware Localized Routing in Wireless Networks," *IEEE Trans. Parallel and Distributed Systems,* vol. 12, no. 11, pp. 1122-1133, Nov. 2001.

[14] J.-H. Chang and L. Tassiulas, "Energy Conserving Routing in Wireless Ad-Hoc Networks," Proc. IEEE INFOCOM '00, pp. 22-31, Mar. 2000. [15] J. Chang and L. Tassiulas, "Maximum Lifetime Routing in Wireless Sensor Networks," *Proc. Advanced Telecomm. and Information Distribution Research Program Conf., 2000.*

[16] C.E. Perkins and E.M. Royer, "Ad-Hoc On-Demand Distance Vector Routing," *Proc. Second IEEE Workshop Mobile Computing Systems and Applications,* p. 90, 1999.

[17] C. Intanagonwiwat, R. Govindan, and D. Estrin, "Directed Diffusion: A Scalable and Robust Communication Paradigm for Sensor Networks," *Proc. Int'l Conf. Mobile Computing and Networking,* pp. 56-67, 2000.

[18] K. Kalpakis, K. Dasgupta, and P. Namjoshi, "Maximum Lifetime Data Gathering and Aggregation in Wireless Sensor Networks," Proc. 2002 *IEEE Int'l Conf. Networking* (ICN '02), pp. 685-696, Aug.2002.

[19] S. Lindsey and C.S. Raghavendra, "Pegasis: Power-Efficient Gathering in Sensor Information Systems," *Proc. IEEE Aerospace Conf.,* Mar. 2002.

[20] C.Hua and T.-S.P. Yum, "Optimal Routing and Data Aggregation for Maximizing Lifetime of Wireless Sensor Networks," *IEEE/ACM Trans. Networking,* vol. 16, no. 4, pp. 892-903, Aug. 2008.

[21] S.Upadhyayula and S.K.S. Gupta, "Spanning Tree Based Algorithms for Low Latency and Energy Efficient DataAggregation Enhanced Converge cast (DAC) in Wireless Sensor Networks," *Ad Hoc Networking,* vol. 5, no. 5, pp. 626-648, 2007.

[22] I.S.-J. Park and I.-R.Sivakumar, "Energy Efficient Correlated Data Aggregation for Wireless Sensor Networks," *Int'l J. Distributed Sensor Networks,* vol. 4, no. 1, pp. 13-27, 2008.

[23] M.D. Penrose, "The Longest Edge of the Random Minimal Spanning Tree," *The Annals of Applied Probability,* vol. 7, no. 2,pp. 340-361, 1997.

[24] S. Hussain and O. Islam, "An Energy Efficient Spanning Tree Based Multi-Hop Routing in Wireless Sensor Networks," *Proc. IEEE Wireless Comm. and Networking Conf.* (WCNC '07), pp. 4383-4388, Mar. 2007.

[25] Y. Wu, S. Fahmy, and N.B. Shroff, "On the Construction of a Maximum-Lifetime Data Gathering Tree in Sensor Networks: Np completeness and Approximation Algorithm," *Proc. IEEE INFOCOM*, pp. 356-360, 2008.

[26] F.J. Ovalle-Martinez, I. Stojmenovic, F. Garcia-Nocetti, and J.Solano-Gonzalez, "Finding Minimum Transmission Radii for Preserving Connectivity and Constructing Minimal Spanning Trees in Ad Hoc and Sensor Networks," *J. Parallel and Distributed Computing,* vol. 65, no. 2, pp. 132-141, 2005.