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Energy Conservation Using Virtual Backbone in Wireless Sensor Network - Survey

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Abstract— Wireless sensor network comprises of sensor nodes. Sensor nodes mainly rely on battery power which cannot be recharged in most of the situations .Thus energy of sensor nodes is a main constraint in wireless sensor network. Algorithms are developing now a day to maintain energy efficient data routing and to reduce the delay in wireless sensor network. In this paper an idea is given about various methods used in certain algorithms which can efficiently constructs a back bone virtually using connected dominating set concepts.

Index Terms— Connected Dominating Set, Energy Efficiency, Maximal Independent Set, Minimum Connected Dominating Set ,Unit Disk Graph, Virtual Backbone, Wireless Sensor Network.

1 INTRODUCTION

Wireless sensor networks is a network of sensor nodes, which are randomly deployed on certain areas where human is hard to reach. Sensor nodes are small in size and are wireless. Main components of a sensor node are 1) Sensor 2) RF transceiver 3) Processor 4) Memory 5) Power source [11].

Sensor nodes can sense, collect, process and forward data from their deployed environment to the base station. Broadcasting in WSN is basically through 1) Source initiated 2) Sink initiated. Routing protocols in wireless sensor networks based on route discovery [8] are 1) Pro-active 2) Re-active 3) Hybrid. The network architecture of sensor nodes can be classified as in Fig. 1.

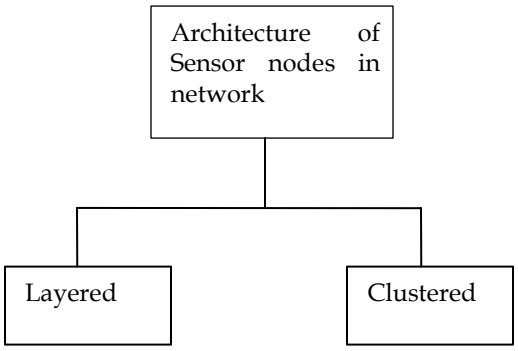

Fig. 1. Sensor Network Architecture

In wireless sensor network there is no physical backbone structure for the data transmission. Since wireless sensor network consists of large number of sensor node, it is important to find algorithms which are optimal in constructing minimum connected dominating set (MCDS) [1] and also considering the remaining energy at each node.

The rest of the paper is structured as follows. Section 2 comprises formation of dominating sets. Prolonging network lifetime using virtual backbone is discussed in Section 3. Identification of dominating nodes is prescribed in section 4. Finally Section 5 is the conclusion of this paper.

2 FORMATION OF DOMINATING SETS

Considering a graph, G (V, E), in which sensor nodes as vertices and subset of these nodes can be a member or at one hop distance from any element of subset formulates a dominating set (DS) [2].All nodes in DS are connected and forms a connected dominating set (CDS) using a Steiner tree. For more efficient WSN communication the size of the CDS should be minimum and it is the minimum connected dominating set (MCDS) and the problem to find MCDS is NP complete problem [9].

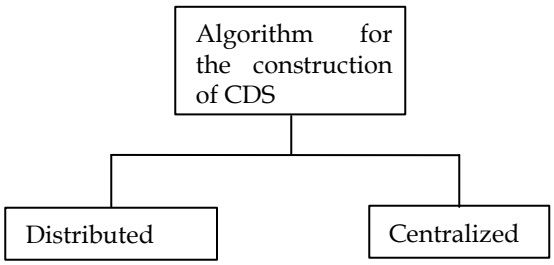

Fig. 2. Categories of algorithm for CDS

CDS [1] is popularly used for constructing virtual backbones for broadcasting operation in WSNs. Unit Disk (UD) [9] Graph is the most suitable model for a wireless sensor net-

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work. An algorithm [1] is proposed to find MCDS from UD Graph. Algorithm for finding a CDS can be divided into distributed and centralized [10] as shown in Fig. 2.

3 PROLONGING NETWORK LIFETIME USING VIRTUAL BACKBONE

In wireless sensor network, energy expended by the sensor nodes is very much greater for transmitting a data than energy expended for computing and sensing [3].WSN is an energy constraint network. The network lifetime can be increased by switching the sensor nodes in anyone of the active, sleep or idle state.

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TABLE1
Overview of discussed algorithms in this paper

Sl.No:	Algorithm name	Architecture	Features	Merits	Demerits
1.	SHORT: Shortest Hop Routing Tree for Wireless Sensor Networks	Centralized	Communication pairs are formed with one elected leader node , which directly connected with base station	Better energy × delay performance.	If source node is far from leader node all nodes have to form communication pairs.
2.	Routing in Ad Hoc Networks Using a Spine	Two level Hierarchical Architecture	Describes a self-organizing and self-structured spine.	Changes within the cluster do not affect the performance of spine in other cluster.	Each spine node should maintain the shortest route information.
3.	Optimal distributed algorithm for minimum connected dominating sets in Wireless Sensor Networks	Distributed	Reduce the congestion during communication and increases the network lifetime.	Has a Time complexity of O (1).	Nodes in CDS will die very soon because of higher loading
4.	Energy-Aware Distributed Algorithm for Virtual Backbone in Wireless Sensor Networks	Distributed	A timeout factor at each node and a calculated weight is also used.	Energy efficiency is maintaining through a weight variable	Degree of nodes used for CDS formation, thus nodes may die due to higher loading.
5.	An Energy-Aware Backbone Construction Algorithm in Wireless Sensor Networks	Distributed	Each node makes decision based on its own information and a CDS is formed.	CDS is constructed using energy aware algorithm and prolong lifetime of sensor network.	Has to adjust certain circumstances to eliminate redundant dominators.

Virtual backbone in WSNs can reduce unwanted flooding to a great extent. Through the construction of virtual backbone the number of sensors can be lessen which can efficiently transmit the data.

An idea for constructing a virtual backbone using spine nodes in Adhoc networks with a two level hierarchical routing structure is proposed in [7], which is the first centralized algorithm. In the first level spine nodes are selected and this spine node forms the virtual back bone for routing in the second level.

Virtual backbone can be constructed using CDS nodes through which network lifetime can be extended. Shortest Hop Routing Tree (SHORT) [4], is a routing scheme which identifies the shortest hop (closest neighbor) and efficiently creates communication pairs for packet relay. In the above paper the data collection delay is reduced by electing a leader and creating communication pairs of sensor nodes for each given time slot.

There is no physical backbone infrastructure in WSN; In [5] first distributed algorithm is proposed to find MCDS in UD Graph with a timeout factor which is used to identify a node with maximum number of neighbors, i.e. , effective degree .MCDS from dominating sets will be chosen as backbone.

In [6], an algorithm is proposed to construct the CDS in two phases; (1) Maximal Independent Set (MIS) from the network graph (2) select the node to connect the DS (Dominating Set) and a weight variable is also used in this paper, which combines remaining energy and effective degree parameters to extend network lifetime and reduce size of CDS.

An efficient algorithm which uses energy efficiency as the main constraint is discussed in [10], which includes (1) a timeout factor at each sensor node in order to select dominators and (2) a weight variable, which relates to the remaining energy of sensor nodes, is also assigned at each node.

4 IDENTIFICATION OF DOMINATING NODES

Basic steps for the identification of dominating nodes are as follows [10]:

Step 1: Sink initiate data transmission by broadcasting a message.
Step 2: Sensor nodes which receives sink's message will decide to participate in data transmission by calculating its remaining energy.
Step 3: A timer will be initiated and dominating nodes will be identified.
Step 4: Using this dominating nodes a backbone is constructed for data forwarding.

5 CONCLUSION

Researches are going on in developing various applications of WSN. For efficient data forwarding in WSN the sensor nodes participating in data transmission should be minimum and energy utilized by each node has to be minimized. This can be achieved through the construction of backbone among sensor nodes and can reduce delay in data transmission. In this paper various ways of constructing CDS and energy efficient algorithms in wireless sensor network field is emphasized.

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REFERENCES

[1] Constructing Minimum Connected Dominating Set: Algorithmic approach G.N. Purohit and Usha Sharma, International journal on applications of graph theory in wireless ad hoc networks and sensor networks (GRAPH-HOC) Vol.2, No.3, September 2010

[2] A Power Aware Minimum Connected Dominating Set for Wireless Sensor Networks Mritunjay Rai, Shekhar Verma and Shashikala Tapaswi, JOURNAL OF NETWORKS, VOL. 4, NO. 6, AUGUST 2009.

[3] L.M. Feeney, M. Nilsson, "Investigating the Energy Consumption of a Wireless Network Interface in an Ad Hoc Networking Environment", in IEEE INFOCOM, 2001.

[4] Y. Yang, H.H. Wu, H.H. Chen, "SHORT: Shortest Hop Routing Tree for Wireless Sensor Networks", in IEEE International Conference On Communications (ICC '06.), vol. 8, pp. 3450-3454, 2006.

[5] J. Wu, H. Li, "On Calculating Connected Dominating Set for Efficient Routing in Ad Hoc Wireless Networks," Proc. Third Int'l Workshop Discrete Algorithms and Methods for Mobile Computing and Comm. (DIALM '99), pp. 7-14, 1999.

[6] H. Raei, M. Sarram, B. Salimi, F. Adibnya,"Energy-Aware Distributed Algorithm for Virtual Backbone in Wireless Sensor Networks", in IEEE international conference on Innovations in Information Technology, pp 435-439, 2008.

[7] B. Das, R. Sivakumar, V. Bharghavan, "Routing in Ad Hoc Networks Using a Spine",Proc. Sixth Int'l Conf. Computer Comm. And Networks (IC3N '97), p. 34, 1997.

[8] Fundamentals of Wireless Sensor Networks: Theory and Practice Waltenegus Dargie and Christian Poellabauer © 2010 John Wiley & Sons Ltd.

[9] B.N. Clark, C.J. Colbourn, D.S. Johnson, "Unit Disk Graphs",Discrete Math., vol. 86, nos. 1-3, pp. 165-177, Jan. 1990.

[10] Tzong-Jye Liu,Hung-Wei Shen and Chia-Lin Lee. "An Energy-Aware Backbone Construction Algorithm in Wireless Sensor Networks", 2011 IEEE 2nd International Conference on Software Engineering and Service Science (ICSESS), 2011.

[11] I.F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E.Cayirci. A survey on sensor networks. IEEE Communication Magazine, August, 2002, pp.102-114.