Cut Detection in Wireless Sensor Network using Distributed Source Separation Network (DSSD) and Distributed Cut Detection (DCD) Approach

Prasanna.N and Ravi chand.K

Abstract: A classical problem caused by separation of network is partitioning. Predicting those positioning from where the network get separated into the different partition could be a very useful feature that can be provided to applications in a wireless sensors network environment. A wireless sensor network can get separated into multiple connected components due to the failure of some of its nodes, which is called a "cut". In this article we consider the problem of detecting cuts by the remaining nodes of a wireless sensor network. The algorithm consists of a simple iterative scheme in which every node updates a scalar state by communicating with its nearest neighbors. In absence of cuts, the states converge to values that are equal to potentials in a fictitious electrical network. We propose an algorithm that allows (i) every node to detect when the connectivity to a specially designated node has been lost, and (ii) one or more nodes to detect the occurrence of the cut. The algorithm is distributed and asynchronous: every node needs to communicate with only those nodes that are within its communication range. The algorithm range is based on the iterative computation of a fictitious "electrical potential" of the nodes. The convergence rate of the underlying iterative scheme is independent of the size and structure of the network. Although the algorithm is iterative and involves only local communication, its convergence rate is quite fast and is independent of the size of the network.

1. Introduction

However several challenges have to be overcome to achieve the potential of WSNs. One of the challenges in the successful use of WSNs comes from the limited energy of the individual sensor nodes. Significant current research has therefore been directed at reducing energy consumption at the sensor nodes. In the hardware front, energy efficient component have been developed, and in the software front, power aware routing, low complexity coding, and low power data processing algorithms have been examined. WIRELESS sensor network (WSN) typically consist of large number of small, low-cost sensor nodes distributed over a large area with one or possibly more powerful sink nodes gathering readings of sensor nodes.

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The sensor nodes are integrated with sensing, processing and wireless communication capabilities. Wireless sensor networks (WSNs) have emerged as a promising new technology to monitor large regions at high spatial and temporal resolution. Virtually any physical variable of interest can be monitored by equipping a wireless device with a sensor and a networking these sensor together with the help of their on-board wireless communication capability.

Although these advances are expected to increase the lifetime of the wireless sensor nodes, due to their extremely limited energy budget and environmental degradation, nodes failure is expected to be quite common. This is especially true for sensor networks developed in harsh and dangerous situations for critical applications, such as forest fire monitoring.

In addition, the nodes of a sensor network deployed for defense applications may be subjected to malicious tempering. When a number sensor fail, whether due to running out of energy, environmental degradation, or malicious intervention, the resulting network topology may become disconnected. That is, as a result of failure of a set of nodes, a subject of nodes that have not failed become disconnected from the rest the network.

The state of node converges to a positive value in the absence of a cut. If a node is rendered disconnected from the source as a result of a cut, its state converges to 0. By monitoring its state , therefore, a node can be determine if it has been separated from the source node .In addition nodes that are still connected to the source node. We call it the Distributed source separation Detection (DSSD) algorithm.

Since the algorithm is iterative, a faster convergence rate is desirable for it to be effective. The convergence rate of the proposed algorithm is not only quite fast, but is independent of the size of the network. As a result, the delay between the occurrence of a cut and its detection by all the nodes can be made independent of the size of the network. This last feature makes the algorithm highly scalable to large sensor networks. We consider the problem of detecting cuts by the nodes of a wireless network. We assume that there is a specially designated node in the network, which we call the source node. The source node may be a base station that serves as an interface between the network and its users, the reason for this particular name is the electrical analogy introduced. Since a cut may or may not separate a node from the source node, we distinguish between two distinct outcomes of a cut for a particular node. When a node u is disconnected from the source, we say that a Disconnected from source(DOS) event has occurred for u. When a cut occurs in the network that does not separate a node u from the source node, we say that Connected, but a Cut Occurred Somewhere(CCOS) event has occurred for u. By cut detection we mean 1) detection by each node of a DOS event when it occurs, and 2) detection of CCOS events by the nodes close to a cut, and the approximate location of the cut. By "approximate location" of a cut we mean the location of one or more active nodes that lie at the boundary of the cut and that are connected to the source. Nodes that detect the occurrence and approximate locations of the cuts can alert the source node or the base station.

2. Distributed Cut Detection in WSN

The algorithm we propose is distributed and asynchronous: it involves only local communication between neighboring nodes , and is robust to temporary communication failure between node pair. A key component of the DCD algorithm is a distributed iterative computational step through which the nodes compute their (fictitious) electrical potential. The convergence rate of the computation is independent of the size and structure of the network

CUT: wireless sensor networks (WSNs) are a promising technology for monitoring large region at high spatial and temporal resolution. In fact node failure is expected to be quite common due to the typically limited energy budget of nodes that are powered by small batteries. Failure of set of nodes will reduce the number of multi-hop paths in the network. Such can cause a subset of nodes- that have not failed- to become disconnected from the rest, resulting in a "cut". Two nodes are said to be disconnected if there is no path between them.

SOURCE NODE: we consider the problem of detecting cuts by the nodes of a wireless network. We assume that there is a specially designated node in the network, which we call the source node. The source node may be a base station that serves as an interface between the network and its users. Since a cut may or may not separate a node from the source node, we distinguish between two distinct outcomes of a cut for a particular node.

CCOS AND DOS: when a node u is disconnected from the source, we say that a DOS(disconnected from source) event has occurred for u. when a cut occurs in the network that does not separate a node , we say that CCOS(connected, but a cut occurred somewhere) event has occurred for u. by cut detection we mean(1) detection by each node of a DOS event when it occurs, and(2) detection of CCOS event by the node close to a cut, and the approximate location of cut.

3. Distributed Source Separation Detection (DSSD):

DSSD known as a distributed source separation detection. Algorithm that allows every node to monitor the topology of the (initially connected) graph and detect if a cut occurs. Or reasons that will be clear soon, one node of the network is denoted as the "source node". The algorithm consists of every node updating a local state periodically by communicating with its nearest neighbors. The state of a node converges to a positive value in the absence of a cut. If a node is rendered disconnected from the source as a result of a cut, its state converges to 0. By monitoring its state, therefore, a node can determine if it has been separated from the source node. In addition, the nodes that are still connected to the source are able to detect that, one, a cut has occurred somewhere in the network, and two, they are still connected to the source node.

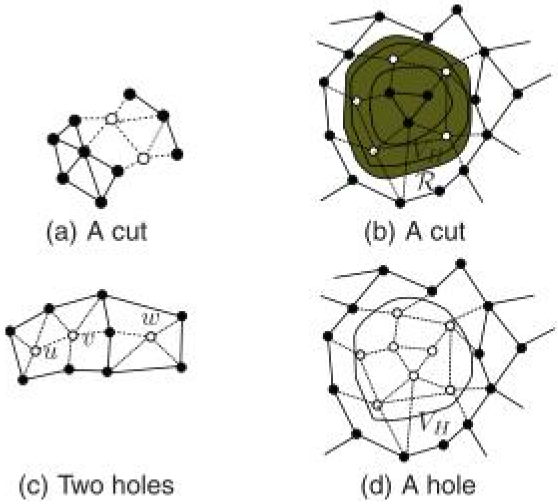

Fig. 3.1. Examples of cuts and holes. Filled circles represent active nodes and unfilled circles represent failed nodes. Solid lines represent edges, and dashed lines represent edges in that existed before the failure of the nodes. The hole in (d) is indistinguishable from the cut in (b) to nodes that lie outside the region R.

We call it the Distributed Source Separation Detection (DSSD) algorithm. Since the algorithm is iterative, a faster convergence rate is desirable for it to be effective. The convergence rate of the proposed algorithm is not only quite fast, but is independent of the size of the network. As a result, the delay between the occurrence of a cut and its detection by all the nodes can be made independent of the size of the network. This last feature makes the algorithm highly scalable to large sensor networks, the challenges posed by the possibility of network partitioning in WSNs has been recognized, the problem of detecting when such partitioning occurs seems to have received.

The reason for the restriction to linear cuts is that their algorithm relies critically on a certain duality between straight line segments and points in 2D, which also restricts the algorithm in to sensor networks deployed in the 2D plane. The algorithm developed in need a few nodes called sentinels that communicate with a base station either directly or through multi-hop paths. The base station detects cuts by monitoring whether it can receive messages from the sentinels. In contrast to the algorithm in the DSSD algorithm proposed. It can detect cuts that separate the network into multiple components of arbitrary shapes. Furthermore, the DSSD algorithm is not restricted to networks deployed in 2D,it does not require deploying sentinel nodes, and it allows every node to detect if a cut occurs.

Even though the proposed algorithm is iterative and involves only nearest neighbor communication, the convergence rate of the algorithm is quite fast and is independent of the size of the network. The assumptions are that the source node never fails, the sensor network is initially connected, and the communication between the sensor nodes is bidirectional. Some sensor nodes may fail or be blocked due to lack of power, have physical damage or environmental interface. The failure of sensor nodes should not affect the overall task of the sensor network. This is the reliability or fault tolerance issue. Fault tolerance is the ability to sustain sensor network functionalities without any interruption due to sensor nodes failures. The reliability fault tolerance of a sensor node is modelled in using the Poisson distribution to capture the probability of not having a failure rate of sensor nodes k and the time period respectively.

4. Methodology

4.1 Route Discovery

The first criterion in wireless medium is to discover the available routes and establish them before transmitting. The selection of path for data transmission is done based on the availability of the nodes in the region using the ad-hoc on demand distance vector routing algorithm. By using the Ad hoc on Demand Distance vector routing protocol, the routes are created on demand, only when a route is needed for which there is no "fresh" record in the routing table.

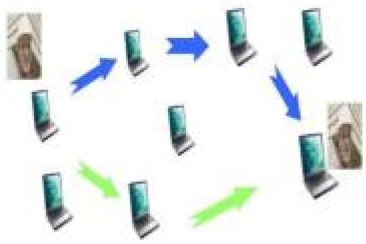

Fig 4.1.1 Route Discovery

4.2 Route Maintenance

The next step is the maintenance of these routes which is equally important. The source has to continuously monitor the position of the nodes to make sure the data is being carried through the path to the destination without loss . In any case, if the position of the nodes change and the source doesn't make a note of it then the packets will be lost and eventually have to be reset.

The modified proposed algorithm

Threshold=50%,success=0,cutoff=10%

A=S;

Repeat

If g(A) >=threshold then

B=A;

Let A be neighbor of B that minimizes

Pc(B,A)=power-cost(B,A)+v(s)f(A);

Send message to A;

Success=1;

Until A=D(* Destination reached*)

Or if success<>1 then

If threshold>cutoff then

Threshold=threshold/2;

Or A=B(*Delivery failed*);

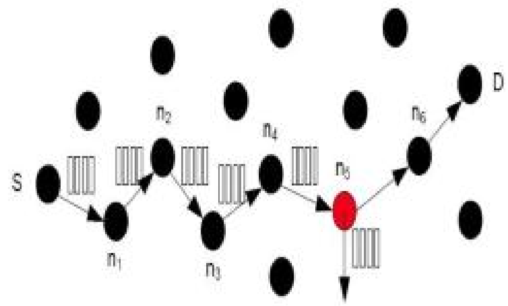

Fig 4.2.2 Route Maintenance

4.3 Data Transmission

The path selection, maintenance and data transmissions are consecutive process which happen in split seconds in real-time transmission. Hence the paths allocated priory is used for data transmission. The first path allocated previously is now used for data transmission. The data is transferred through the highlighted path. The second path selected is now used for data transmission. The data is transferred through the highlighted path. The third path is used for data transmission. The data is transferred through the highlighted path.

4.4 Minimum –energy multicast tree Module

Our main objective is to construct a minimum-energy multicast tree rooted at the source node. We explore the following two problems related to energy-efficient multicasting in WANETs using a source-based multicast rate advantage. Because the problem of constructing the optimal energy-efficient broadcast/ multicasts tree is NP – hard.

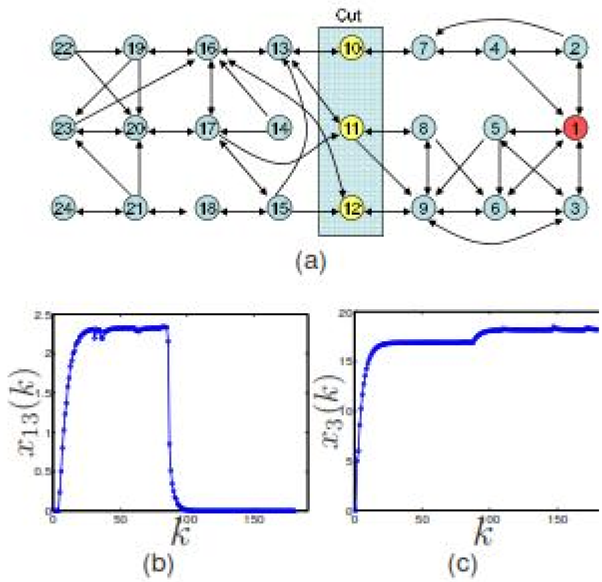

Fig 4.3.3 (a) The network for the outdoor deployment. (b)-(c) The states of nodes 13 and 3,which are disconnected from and connected to,respectively, the source after the cut has occurred.

The system executes in two phases, the Reliable Neighbor Discovery (RND) phase and the DCD algorithm phase. In RND phase each remote broadcasts a beacon within a fixed time interval of 5s for 15 such intervals. Upon receiving a beacon, the remote updates the number of beacons received from the particular sender. To determine wheather a communication link is established, each remote first computes for each of its neighbors the Packet Reception Ration(PRP), defined as the ration of the number of successfully received beacons and the total number of beacons sent by a neighbor. Next the DCD algorithm executes, after receving the information from neighbors, a node updates its state in asychronous manner and its new state.

5. Conclusion

Here we proposed cut detection algorithm can also be used for detection of "reconnection", If a componentthat is diconnected due to acut gets reconnected, the nodes can detect such reconnection from their states.The capability of the algorithm to (i) detect cuts in mobile networks andb (ii) detect re-connection after cuts.

The states of the nodes computed by the DSSD and DCD algorithm are affected by even those node failures that do not lead to cuts.Since the electrical potential of a node in a resistive electrical network is function of the network structure which changes due to node failures.This feature raises the possibility of designing algorithms to compute "electrical potentials" of nodes in a wireless network so as to detect structural changes that are more complex than simply cuts. While a protocol that enables nodes to detect cuts is useful, there is also need for protocols that allow a base station to detect when and where a cut occurred.Another related issue that merits investigation is secure cut detection, when some of the nodes may "fail" in a malicious mode,such as when nodes are chacked by an adversary to send incorrect state data.

References

[1] Prabir Barooah,Harshavardhan Chenji,Student, Radu Stoleru, and Tama´s Kalma´r-Nagy," Cut Detection in Wireless Sensor Networks".PARALLEL AND DISTRIBUTED SYSTEMS, VOL. 23, NO. X, XXX 2012

[2] N. Shrivastava, S. Suri, and C. D. T´oth,"Detecting cuts in sensor networks,"in IPSN '05:Proceedings of the 4th international symposiumon Information processing in sensor networks, 2005, pp. 210–217.

[3] A. Cerpa and D. Estrin, "ASCENT: Adaptive Self-Configurings Ensor Networks Topologies," in IEEE Infocom. New York, NY: IEEE, June 2002.

[4] X. Wang, G. Xing, Y. Zhang, C. Lu, R. Pless, and C. Gill, "Integrated coverage and connectivity configuration in wireless sensor networks,"in SenSys03, Los Angeles, California, USA, November 57 2003.

[5] X. J. Du, M. Zhang, K. E. Nygard, S. Guizani, and H.-H. Chen, "Selfhealing sensor networks with distributed decision making," Internationals Journal of Sensor Networks (IJSNET), vol. 2, no. 5/6, 2007.

[6] J. Kleinberg, "Detecting a network failure," Internet Mathematics, vol. 1, pp. 37–56, 2003.

[7] J. Kleinberg, M. Sandler, and A. Slivkins, "Network failure detection and graph connectivity," in the 15th ACM-SIAM Symposium on Dis-crete Algorithms, 2004.

[8] G. Dini, M. Pelagatti, and I.M. Savino, "An Algorithm for Reconnecting Wireless Sensor Network Partitions," Proc. European Conf. Wireless Sensor Networks, pp. 253-267, 2008.

[9] N. Shrivastava, S. Suri, and C.D. To´ th, "Detecting Cuts I Sensor Networks," ACM Trans. Sensor Networks, vol. 4, no. 2, pp. 1-25, 2008

[10] H. Ritter, R. Winter, and J. Schiller, "A Partition Detection System for Mobile Ad-hoc Networks," Proc. First Ann. IEEE Comm.Soc. Conf. Sensor and Ad Hoc Comm. and Networks(IEEE SECON '04), pp. 489-497, Oct. 2004.

[11] M. Hauspie, J. Carle, and D. Simplot, "Partition Detection in Mobile AdHoc Networks," Proc. Second Mediterranean Workshop Ad-Hoc Networks, pp. 25-27, 2003.

[12] P. Barooah, "Distributed Cut Detection in Sensor Networks," Proc. 47th IEEE Conf. Decision and Control, pp. 1097-1102, Dec. 2008.

[13] A.D. Wood, J.A. Stankovic, and S.H. Son, "Jam: A Jammed-Area Mapping Service for Sensor Networks," Proc. IEEE Real Time Systems Symp.,2003