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Cut Detection in Wireless Sensor Networks: A Survey

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Abstract: *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. 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 (that are connected to the special node after the cut) 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 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.*

Keywords: Wireless Sensor Networks, Cut in Wireless Network, Detection and Estimation, Iterative Computation.

1. Introduction

Wireless sensor networks (WSNs) are a promising technology for monitoring large regions at high spatial and temporal resolution. However, the small size and low cost of the nodes that makes them attractive for widespread deployment also causes the disadvantage of low-operational reliability. A node may fail due to various factors such as mechanical/electrical problems, environmental degradation, battery depletion, or hostile tampering. In fact, node failure is expected to be quite common due to the typically limited energy budget of the nodes that are powered by small batteries. Failure of a set of nodes will reduce the number of multihop paths in the network. Such failures 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.

We consider the problem of detecting cuts by the nodes of a wireless sensor network. May source node is a base station serves as an interface between the network and its users. So, cut may or may not separate a node from the source node, when a node is disconnected from the source is u, when a cut occurs in the network that does not separate a node u from the source node, we say that these nodes are connected, but a cut occurred somewhere (CCOS) event has occurred for u. By cut detection we mean 1) detection by each node of 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. Nodes that detect the occurrence and approximation locations of the cuts can then alert the source node or the base station. if a node having the ability to detect the cut, it could simply wait for the network to be repaired and eventually reconnected, so it saves the energy of the multiple nodes after cut. In this paper we propose a distributed algorithm to detect cuts, named the Distributed Cut Detection (DCD) algorithm. The algorithm allows each node to detect DOS events and a subset of nodes to detect CCOS events. The algorithm we propose is distributed and asynchronous: it involves only local communication between nodes, and is robust to temporary communication failure between node pairs. A key component of the DCD algorithm is a distributed iterative computational step through which nodes compute their electrical potentials. The convergence rate of the computation is independent of the size and structure of the network.

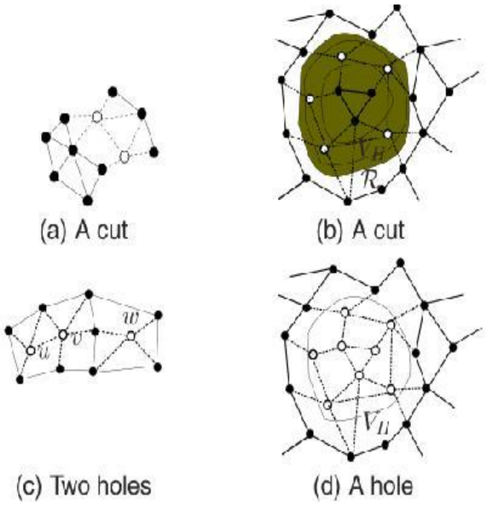

Figure 1: Examples of cut and Holes

2. EXISTING SYSTEM

Wireless Multimedia Sensor Networks (WMSNs) has many challenges such as nature of wireless media and multimedia information transmission. Consequently traditional mechanisms for network layers are no longer acceptable or applicable for these networks. Wireless sensor network can get separated into multiple connected components due to the failure of some of its nodes, which is called a “cut”. Existing cut detection system deployed only for wired networks.

2.1 E-linear cut detection

Cut detection in wireless networks has been proposed, an algorithm that can be employed by a base station to detect an e-linear cut in a network. An e- linear cut is a separation of the network across a straight line so that at least en of the nodes (n is the total number of nodes in the network) are separated from the base station. The base station detects cuts when they occur based on whether it is able to receive messages from specially placed sentinel nodes.

2.2 Flooding based scheme

A flooding based scheme may also be used for detecting separations. Under node to- base flooding approach, every node periodically sends a time-stamped message to the base station. If the base station does not receive a new message from node i for a certain time interval, it can declare that i is disconnected from it. Base station floods the network with time-stamped beacon packets periodically. A node detects that it is disconnected from the base if the length of time during which it hasn’t received a new packet from the base exceeds a threshold value.

Critical node detection: A critical node is one whose removal renders the network disconnected.

2.4 DISADVANTAGES

Algorithm proposed only for detecting linear cuts in the network

In flooding based technique, routes from the nodes to the base station and back have to be recomputed when node failures occur.

Critical node detection uses relatively lower communication overhead come at the cost of high rate of incorrect detection.

- High false positives
- It should be emphasized that a cut can occur even if there are no critical nodes in network, when multiple non-critical nodes fail.
- Critical node detection algorithms mentioned above are designed to detect critical nodes before any node failure occurs; while the problem we address is detecting a cut after it occurs.
- Unsuitable for dynamic network reconfiguration.
- Single path routing approach

3. PROPOSED SYSTEM.

- DCD algorithm is applicable even when the network gets separated into multiple components of arbitrary shapes, and not limited to straight line cuts.
- DCD algorithm enables not just a base station to detect cuts, but also every node to detect if it is disconnected from the base station.
- CCOS event detection part of the algorithm is designed for networks deployed in 2D regions, the DOS event detection part is applicable to networks deployed in arbitrary spaces.

3.1 ADVANTAGES

- Comes with provable characterization on the DOS detection accuracy
- CCOS events detection can be identified
- DCD algorithm enables base station and also every node to detect if it is disconnected from the base station
- The DCD algorithm is distributed and asynchronous. It is robust to the temporary communication failure between the node pairs. The algorithm is iterative and has a fast convergence rate which makes it independent of size of network. Elimination of redundant information at destination nodeThe source node has the ability to detect the occurrence and location of a cut which will allow it to undertake network repair. The ability to detect cuts by both the disconnected nodes and the source node will lead to the increase in the operational lifetime of the network as a whole.

4. ASSUMPTIONS MADE

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. We can create a topology which consists of 'n' number of nodes. The number of nodes created can be done user preferences.

5. MODULE DESCRIPTION

5.1 DISTRIBUTED CUT DETECTION:

The algorithm allows each node to detect DOS events and a subset of nodes to detect CCOS events. 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 pairs. A key component of the DCD algorithm is a distributed iterative computational step through which the nodes compute their (fictitious) electrical potentials. The convergence rate of the computation is independent of the size and structure of the network.

5.2 CUT

Wireless sensor networks (WSNs) are a promising technology for monitoring large regions at high spatial and temporal resolution. In fact, node failure is expected to be quite common due to the typically limited energy budget of the nodes that are powered by small batteries. Failure of a set of nodes will reduce the number of multi-hop paths in the network. Such failures 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.

5.3 CUTS IN WIRELESS SENSOR NETWORKS

One of the unique challenges in mobile adhoc networking environments is the phenomenon of network partitioning, which is the breakdown of a connected network topology into two or more separate, disconnected topologies.[3] Similarly sensors become fail for several reasons and the network may breaks into two or more divided partitions so can say that when a number of sensor fails so the topology changes. A node may fail due to a variety of conditions such as mechanical or electrical problems, environmental degradation, and battery reduction. In fact, node failure is expected to be quite common anomaly due to the typically limited energy storage of the nodes that are powered by small batteries. Failure of a set of nodes will reduce the number of multichip paths in the network. Such failures can cause a subset of nodes that have not failed to become disconnected from the rest of the network, resulting in a partition of the network also called a "cut". Two nodes are said to be disconnected if there is no path between them. And As we know that sensors has Disconnectivity from the network is normally referred as a partition of the network of cut in the wireless sensor network, which arise many problems like unreliability ,data loss, performance degradation. Because of cuts in wireless sensor network many problems may arise like a wired network means data loss problem arises, means data reach in a disconnected route.

5.4 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.

5.5 NETWORK SEPERATION:

Failure of a set of nodes will reduce the number of multi-hop paths in the network. Such failures can cause a subset of nodes – that have not failed – to become disconnected from the rest, resulting in a "cut". Because of cut, some nodes may separate from the network, that results the separated nodes can't receive the data from the source node.

5.6 PROBLEM DEFINITION

When sensor wants to send data to the source node has been disconnected from the source node. Without the knowledge of the network's disconnected state, it may simply forward the data to the next node in the routing tree, which will do the same to its next node, and so on. However, this message passing merely wastes precious energy of the nodes; the cut prevents the data from reaching the destination. Therefore, on one hand, if a node were able to detect the occurrence of a cut, it could simply wait for the network to be repaired and eventually reconnected, which saves on-board energy of multiple nodes and prolongs their lives. On the other hand, the ability of the source node to detect the occurrence and location of a cut will allow it to undertake network repair. Thus, the ability to detect cuts by both the disconnected nodes and the source node will lead to the increase in the operational lifetime of the network as a whole**.**

5.7 PROBLEM SOLUTION

Distributed algorithm to detect cuts, named the Distributed Cut Detection (DCD) algorithm can serve as useful tools for such network repairing methods. The algorithm allows each node to detect DOS events and a subset of nodes to detect CCOS events. The algorithm proposed is distributed and asynchronous: it involves only local communication between neighboring nodes, and is robust to temporary communication failure between node pairs. A key component of the DCD algorithm is a distributed iterative computational step through which the nodes compute their (fictitious) electrical potentials. The convergence rate of the computation is independent of the size and structure of the network.

6. DISTRIBUTED CUT DETECTION ALGORITHM

6.1 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 u from the source node, we say that CCOS (Connected, but a Cut Occurred Somewhere) event has occurred for u. By cut detection we mean (i) detection by each node of a DOS event when it occurs, and (ii) detection of CCOS events by the nodes close to a cut, and the approximate location of the cut.

A .DOS Detection

We say that a Disconnected from Source (DOS) event has occurred for u. The algorithm allows each node to detect DOS events. The nodes use the computed potentials to detect if DOS events have occurred (i.e., if they are disconnected from the source node). The approach here is to exploit the fact that if the state is close to 0 then the node is disconnected from the source, otherwise not. In order to reduce sensitivity of the algorithm to variations in network size and structure, we use a normalized state.DOS detection part consists of steady-state detection, normalized state computation, and connection/separation detection. A node keeps track of the positive steady states seen in the past using the following method. Each node computes the normalized state difference () as follows:

xi(k) – xi(k-1) xi(k)= --------------------, if xi(k – 1)>€ zero Xi(k-1) ∞, otherwise,

Where, zero is a small positive number.

A node keeps a Boolean variable Positive Steady State Reached (PSSR) and updates PSSR(k)← 1 if /( )| < for = k − Tguard , k −Tguard +1,…,k(i.e., for Tguard consecutive iterations),where is a small positive number and Tguard is a Small integer. The initial 0 value of the state is not considered a steady state, so PSSR()=0 for =0,1, … ,Tguard. Each node keeps an estimate of the most recent ―steady state‖ observed, which is denoted by ( ). This estimate is updated at every time k according to the following rule: if PSSR( )=1, then ← ; otherwise ← − 1 . It is initialized as ss(0) = ∞.Every node i also keeps a list of steady states seen in the past, one value for each unpunctuated interval of time during which the state was detected to be steady. This information is kept in a vector ( ), which is initialized to be empty and is updated as follows: If PSSR () = 1 but PSSR(−1) = 0, then is appended to ( ) as a new entry. If steady state reached was detected in both and - 1 (i.e., PSSR( ) = PSSR(− 1) = 1, then the last entry of ( ) is updated to ( ) .

B.CCOS Detection

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. 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. To detect CCOS events, the algorithm uses the fact that the potentials of the nodes that are connected to the source node also change after the cut. However, a change in a node's potential is not enough to detect CCOS events, since failure of nodes that do not cause a cut also leads to changes in the potentials of their neighbors. Therefore, CCOS detection proceeds by using probe messages.

7. SYSTEM IMPLEMENTATION

In this section, we describe the software implementation and evaluation of the DCD algorithm. In software the algorithm was implemented using the java language running on windows xp operating system. The system executes in two phases: the Reliable Neighbor Discovery (RND) phase and the DCD Algorithm phase. In the RND phase each node is connected to the source node. Upon receiving the message, the mote updates the number of beacons received from that particular sender. To determine whether a communication link is established, each mote first computes for each of its neighbors the Packet Reception Ratio (PRR), defined as the ratio of the number of successfully received beacons and the total number of beacons sent by a neighbor. A neighbor is deemed reliable if the PRR >0:8. Next, the DCD algorithm executes. After receiving state information from neighbors, a node updates its state according to (1) in an asynchronous manner and broadcasts its new state. The state is stored in the database.

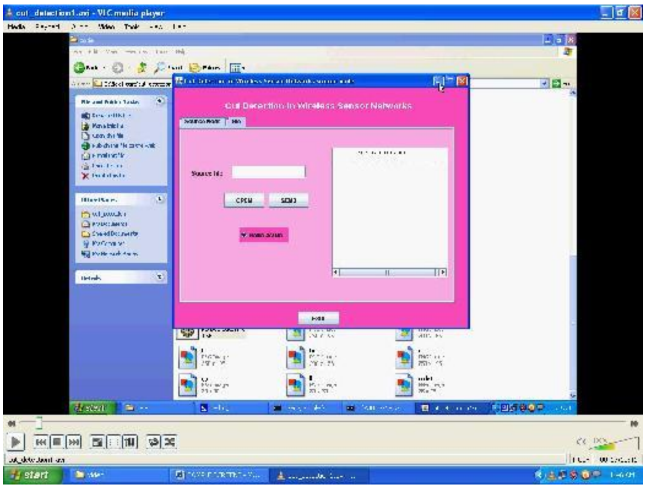

Figure 2: This screen is used for selecting file to send

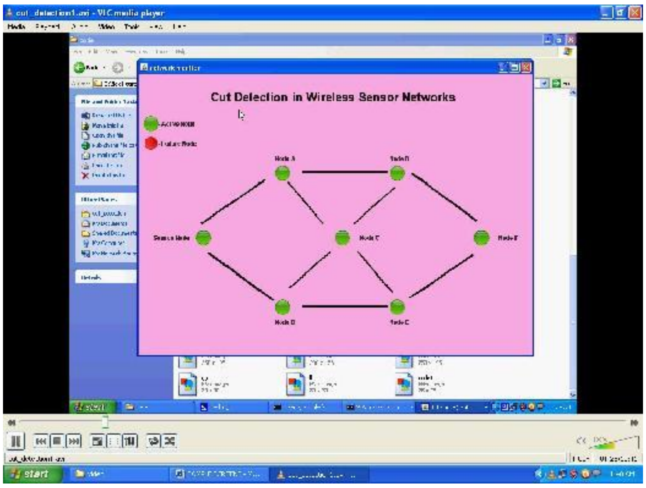

Figure 3: This screen is used for nodes representation

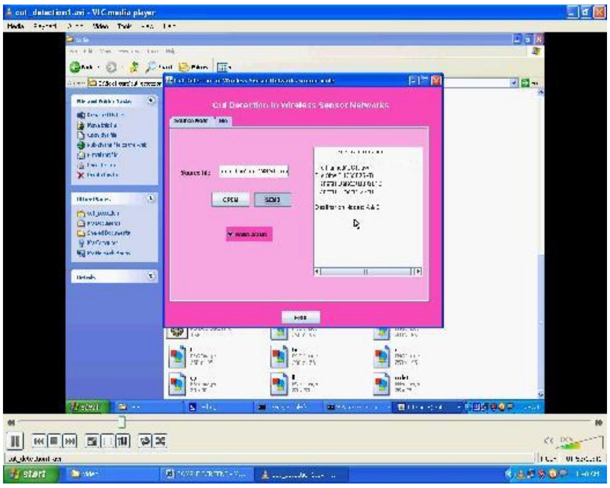

Figure 4 : This screen is used for sending file

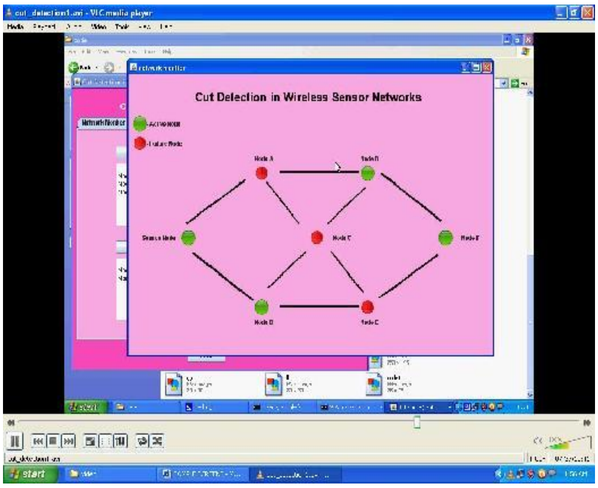

Figure 5: This screen is used for Showing Some Failure Nodes

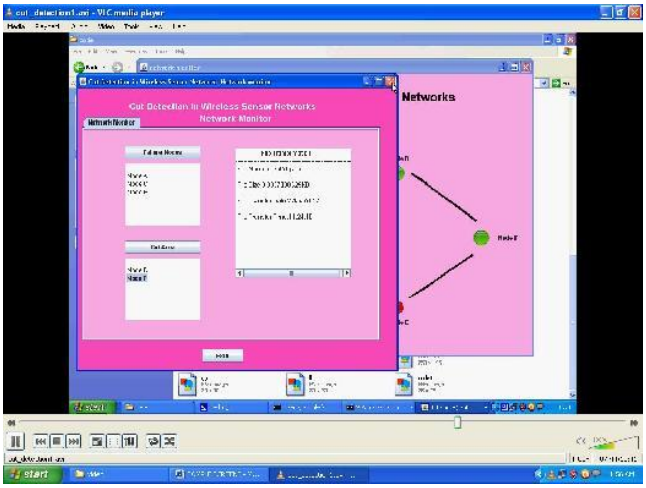

Figure 6: This screen is used for Correcting Failure Nodes

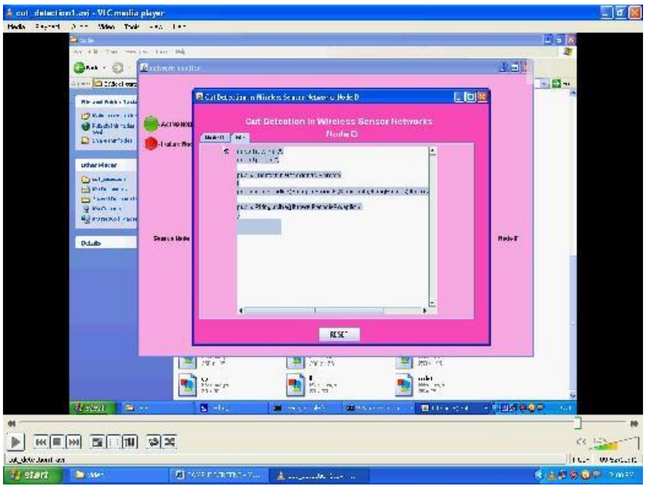

Figure 7: This screen is shows Received File

8.CONCLUSION

The DCD algorithm we propose here enables every node of a wireless sensor network to detect DOS (Disconnected from Source) events if they occur. Second, it enables a subset of nodes that experience CCOS (Connected, but Cut Occurred Somewhere) events to detect them and estimate the approximate location of the cut in the form of a list of active nodes that lie at the boundary of the cut/hole. The DOS and CCOS events are defined with respect to a specially designated source node. The algorithm is based on ideas from electrical network theory and parallel iterative solution of linear equations. Numerical simulations, as well as experimental evaluation on a real WSN system consisting of micaz motes, show that the algorithm works effectively with a large classes of graphs of varying size and structure, without requiring changes in the parameters. For certain scenarios, the algorithm is assured to detect connection and disconnection to the source node without error. A key strength of the DCD algorithm is that the convergence rate of the underlying iterative scheme is quite fast and independent of the size and structure of the network, which makes detection using this algorithm quite fast. Application of the DCD algorithm to detect node separation and reconnection to the source in mobile networks is a topic of ongoing research

SCOPE

A node may fail due to various factors such as mechanical/electrical problems, environmental degradation, battery depletion, or hostile tampering. In fact, node failure is expected to be quite common due to the typically limited energy budget of the nodes that are powered by small batteries. Failure of a set of nodes will reduce the number of multi-hop paths in the network. Such failures can cause a subset of nodes that have not failed to become disconnected from the rest, resulting in a "cut." To make the network error prone, we need to identify the cut occurrence.

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