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Distributed Cut Detection Algorithm in Wireless Sensor Networks.

E Anna Devi*, and J Martin Leo Manickam.

*Research Scholar, School Of Electronics, Sathyabama University, Chennai, Tamil Nadu, India.
Professor, St. Joseph's College of Engineering, Chennai, Tamil Nadu, India.

ABSTRACT

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 paper, the problem of detecting cuts by the remaining nodes of a wireless sensor network is considered. The algorithm proposed here allows every node to detect when the connectivity to the base station has been lost, and uses one or more nodes (that are connected to the base station 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 networks, sensor networks, base station, network separation, detection, iterative computation.

***Corresponding author**

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INTRODUCTION

Wireless sensor networks (WSN) have emerged as an important new technology for instrumenting and observing the physical world. The basic building block of these networks is a tiny microprocessor integrated with one or more MEMS (micro-electromechanical system) sensors, actuators, and a wireless transceiver. These devices can be embedded or scattered in large quantities in a physical space, where they self-organize into an ad hoc multi-hop wireless network, allowing us to observe and monitor the world at an unprecedented spatial and temporal resolution. A rich variety of scientific, commercial, and military applications has been proposed for sensor networks, and many experimental prototypes are under development in academia and industry. Realizing the full potential of the sensor networks, however, requires solving several challenging research problems. Many of these challenges stem from two major limitations of the sensor nodes: low power and low bandwidth. Consequently, a number of proposals have been made for improving the data collection and information processing in sensor networks, including power-aware routing and scheduling in network aggregation, data storage management etc. In this paper, we address a different kind of challenge for sensor networks, which does not seem to have received adequate attention. How to monitor the sensor network itself, and how to detect when the network has suffered a significant "cut"?

After all, if sensor networks are to act as our remote "eyes and ears," then we need to ensure that any significant failure (natural or adversarial) suffered by the network is promptly and efficiently detected. Tracking the operational health of the infrastructure is important in any communication network, but it is especially important in sensor networks due to their unique characteristics, and the need to perform this duty with very little overhead.

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 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 [2].The DOS detection part of the algorithm is applicable to arbitrary networks; a node only needs to communicate a scalar variable to its neighbors. The CCOS detection part of the algorithm is limited to networks that are deployed in 2D euclidean spaces, and nodes need to know their own positions. The position information need not be highly accurate. The proposed algorithm is an extension of partially examined the DOS detection problem [3].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.

CUT" IN WSN AND NEED FOR DETECTION

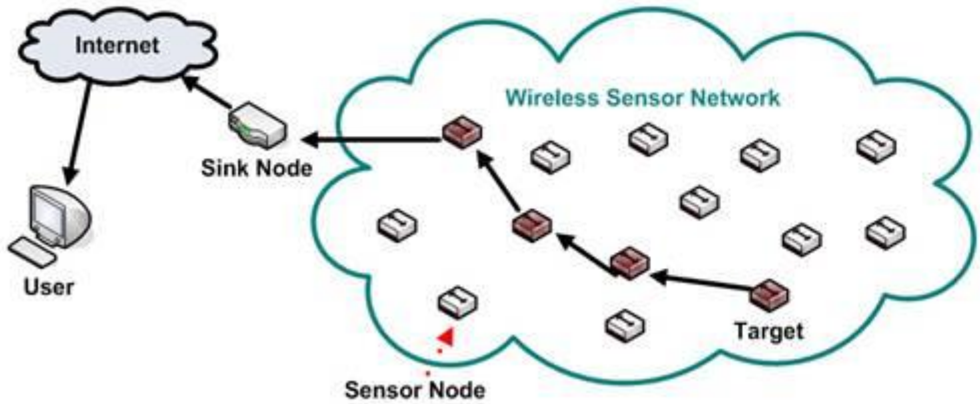

Fig 1. Wireless sensor nodes deployed in open environment.

Failure of a set of nodes will reduce the number of multi hop paths in the network such failure 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. If a sensor node which 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

DISTRIBUTED CUT DETECTION ALGORITHM

DOS

Time is measured with a discrete counter k = -∞. . .-1,0,1, 2, . . . We model a sensor network as a time-varying graph G(k)=(V(k), E(k)), whose node set V(k) represents the sensor nodes active at time k and the edge set E(k) consists of pairs of nodes (u, v) such that nodes u and v can directly exchange messages between each other at time k. By an active node we mean a node that has not failed permanently. All graphs considered here are undirected, i.e., (i, j) = (j, i). A path from i to j is a sequence of edges connecting i and j.

In terms of these definitions, a cut event is formally defined as the increase of the number of components of a graph due to the failure of a subset of nodes (as depicted in Fig. 1). The number of cuts associated with a cut event is the increase in the number of components after the event. The problem we seek to address is twofold. First, we want to enable every node to detect if it is disconnected from the source (i.e., if a DOS event has occurred). Second, we want to enable nodes that lie close to the cuts but are still connected to the source (i.e., those that experience CCOS events) to detect CCOS events and alert the source node.

There is an algorithm-independent limit to how accurately cuts can be detected by nodes still connected to the source, which are related to holes. Fig. 1 provides an example

CCOS

The algorithm for detecting CCOS events relies on finding a short path around a hole, if it exists, and is partially inspired by the jamming detection algorithm proposed in. The method utilizes node states to assign the task of hole-detection to the most appropriate nodes. When a node detects a large change in its local state as well as failure of one or more of its neighbors, and both of these events occur within a (predetermined) small time interval, the node initiates a PROBE message. Each PROBE message p contains the following information

EXISTING SYSTEM

E-LINEAR CUT DETECTION:

E-Linear cut detection is 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 end 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 [1].

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[2]. 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.

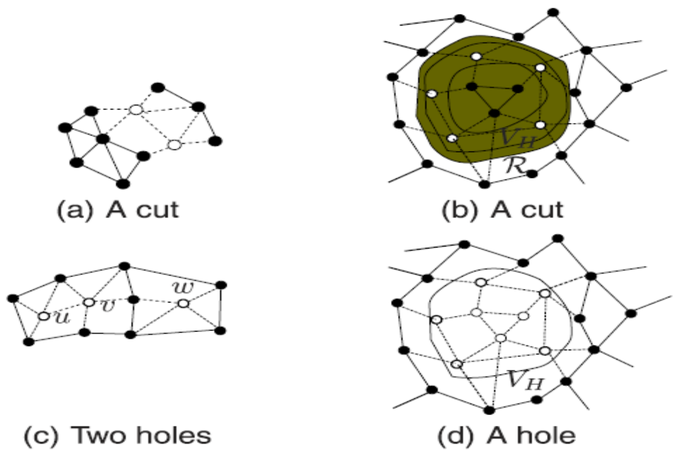

Fig. 2. Examples of cuts and holes.[1]

In Fig.2 filled circles represent active nodes and unfilled filled circles represent failed nodes. Solid lines represent edges, and dashed lines represent edges 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

CRITICAL NODE DETECTION:

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

SINGLE PATH ROUTING APPROACH:

At the time of sending packets it choose only a single path.. Unsuitable for dynamic network reconfiguration: At the time of network reconfiguration it is not suitable for creating network of increasing or decreasing no. of sensor nodes [4].

DRAWBACK OF EXISTING SYSTEM

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.

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

DISTRIBUTED CUT DETECTION

COS DETECTION

Every node checks its energy level, if the energy level goes below a threshold then it intimates to the base station. Every node i maintains a binary variable DOSi(k) , which is set to 1 if the node believes it is disconnected from the source and 0 otherwise. The node that is about to die informs the neighbor nodes and the base station.

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CCOS DETECTION

When a node detects a large change in its local state as well as failure of one or more of its neighbors, and both of these events occur within a (predetermined) small time interval, the node initiates a PROBE message.

The probe contains,

1. A unique probe ID
2. Probe centroid Cp
3. Destination node
4. Path traversed
5. The angle traversed by the probe around the centroid

In DOS algorithm 100 nodes are initialized, these nodes group together as clusters. This is shown in figure 3. They are marked by different colors. Each cluster will have a cluster head. These nodes perform the functions of data collection and forwarding to neighbor nodes. The data collection is shown by figure 4. The cluster heads has overload because it does the function of data collection, consolidating and forwarding to base station. So it loses its energy very easily so it may fail very quickly. The failure and detection of failure is shown in figure 5. So the nodes that are failed are marked in white color. Then by using DOS and CCOS detection, the cuts or failure of the nodes have been detected quickly.

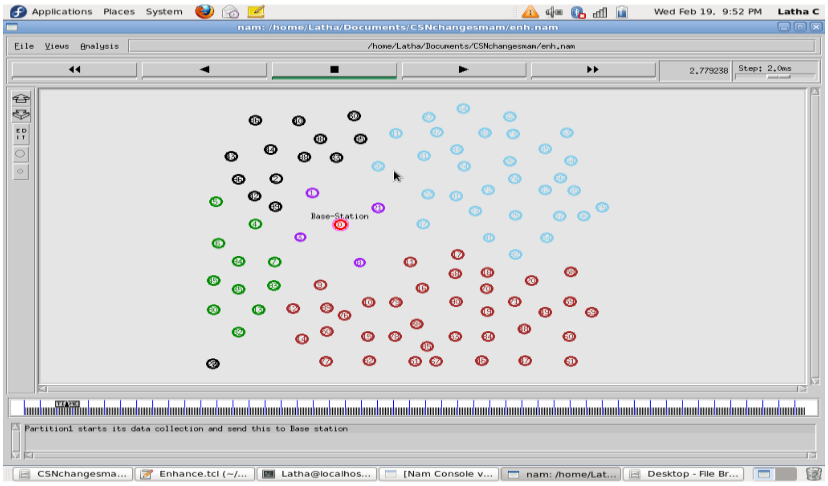

Fig 3: 100 nodes are initialized

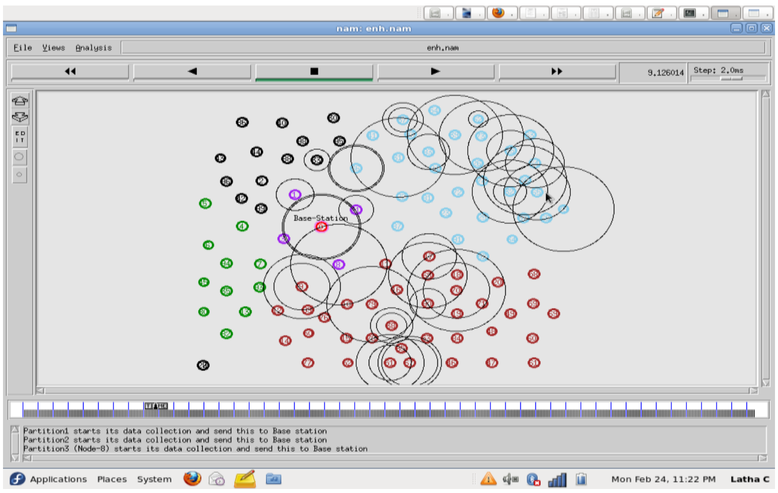

Fig 4 : Nodes perform the function of data collection

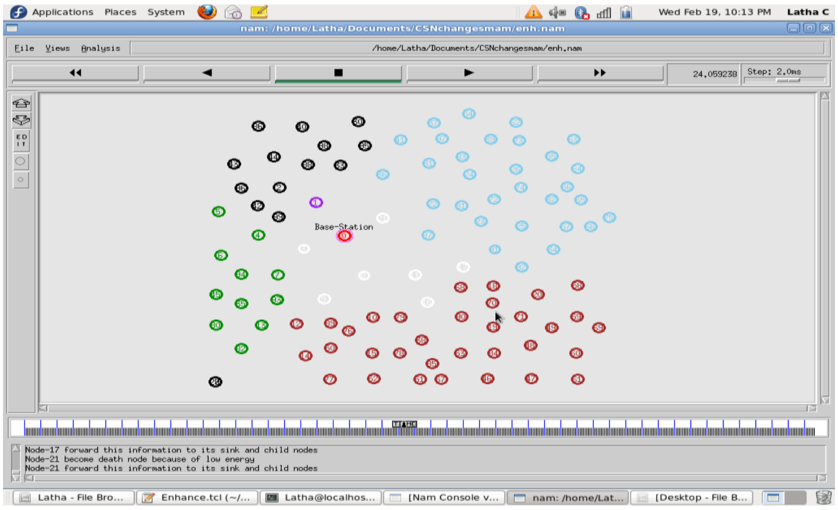

Fig 5: Nodes failed (Marked in white)

CONCLUSION

In this work 100 nodes are deployed. The cluster head nodes fails quickly, because they will lose their energy very easily. Hence the status of the cluster heads is informed to the base station using DOS detection and the location of the failure node is identified using CCOS detection. These two events happen before nodes actually dies, because of which the data loss can be avoided totally, so that the packet delivery ratio will be 100% and packet loss is 0%. This algorithm is very simple and fast to detect cuts in WSN.

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