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Distributed Cut Detection in Wireless Sensor Network

Sangeetha .V[1], Prof. B. Murali[2]

M.Phil. Research Scholar, Department of Computer Science, PSG College of Arts & Science, Coimbatore, India[1]

Associate Professor & Head, Department of Computer Science, PSG College of Arts & Science, Coimbatore, India[2]

Abstract: A wireless sensor network (WSN) is a deployment of a large number of small, inexpensive, self powered devices that can sense, compute, and communicate with other devices for the purpose of gathering local information about a physical environment. An distributed algorithm to detect "CUT" in Wireless sensor networks has been proposed here, which identifies the failure of a node or a set of nodes that separates the network in to two or more components. Algorithm is iterative and asynchronous.

Keywords: CCOS, CUT detection, DOS, network separation, Wireless sensor network.

I.INTRODUCTION

A wireless sensor network can get separated in to multiple components due to failure of a node or a group of node. This is called a CUT. When a node 'u' is disconnected from the source, it is called as Disconnected from Source (DOS). When a cut occurs in the sensor network that does not separate a node 'u' from the source node, then it is called as Connected, but a Cut Occurred Somewhere (CCOS).

Due to this event there are two detection possibilities:

i. Detection by each node of DOS event.
ii. Detection of CCOS event by the node which are close to cut.

This paper, deals with distributed algorithm to detect CUT, as a Distributed Cut Detection (DCD) algorithm. The DCD algorithm allows sensor node to detect DOS events and set of a node to detect CCOS events. DCD algorithm is distributed, asynchronous and iterative. Wireless sensor network consisting large no. of nodes in network, have low cost and low power nodes in it.

II. DISTRIBUTED CUT DETECTION IN WSN

The algorithm 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 electrical potential. The convergence rate of the computation is independent of the size and structure of the network.

A.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.

B.SOURCE NODE

The problem of detecting cuts by the nodes of a wireless network is a specially designated node in the network, known as the source node. The source node acts as 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, two distinct outcomes of a cut for a particular node has been distinguished.

C.CCOS AND DOS

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

III.METHODOLOGY

The past few years had seen a huge amount of research activities in the field of wireless Communication. Emerging from this research thrust are new points of view on how to communicate effectively over wireless channels. Thus the complete mechanism can be divided into the major domain.

1. Wireless Transmission Channel
2. Routing Algorithm
3. Cut Detection

A. Route Discovery

The selection of path for data transmission is done based on the availability of the nodes in the region using the adhoc on demand distance vector routing algorithm. By using the Ad hoc on Demand Distance Vector routing protocol, the routes are created on demand. Thus, AODV maintains the time whenever an entry has been last utilized. A routing table entry is "expired" after certain

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predetermined threshold of time. Consider all the nodes to be in the position. Now the shortest path is determined by implementing the Ad hoc on Demand Distance Vector routing protocol in the wireless simulation environment for sending the messages to the neighbors and the shortest path.

B.Route Maintenance

The next step is the maintenance of the routes which is. The source has to continuously monitor the position of the nodes to make sure that the data is being carried through the path to the destination without loss. If the position of the node changes and the source doesn't make a note of it then the packets will be lost and it has to be resent.

C.Data Transmission

The path selection, maintenance and data transmission are the consecutive process which happens 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 selected is used for data transmission. The data is transferred through the highlighted path.

IV.FAILURE NODE DETECTION IN WIRELESS SENSOR NETWORKS

A. Distributed Cut Detection algorithm to identify Node failure

While transforming the data from the source, some of the nodes stop working, which results in a cut. To avoid and detect this problem a distributed and asynchronous algorithm known as Distributed Cut Detection has been proposed. The algorithm consists of nodes, updating their local state periodically by communicating with their nearest neighbours. The state of a node converges to a positive value in the absence of a cut. If a node is disconnected from the source as a result of a cut, its state converges to 0 (deactive). The state of node determines whether it is connected to source or not. The nodes that are connected to the source will detect that a cut has occurred in the network. The delay between the occurrence of a cut and its detection by all the nodes can be made independent by the size of the network. The algorithm proposed in Distributed Cut Detection is not limited to linear cuts [4], but also solves the issue of redundancy and also enables every node to detect if a cut occurs. The DCD algorithm eliminates the need of routing messages to the source node as it involves only nearest neighbour communication. The assumption made includes (1) The source node never fails, when the sensor network is initially connected, (2) Communication between nodes is symmetric, (3) If a node fails permanently, each of its neighbours can detect its failure within a fixed time period. The failure of sensor nodes should not affect the overall task of the sensor network. This defines the reliability or fault tolerance issue. [9] Fault tolerance is nothing but the ability to sustain sensor network functionalities without any interruption due to sensor node failures. As this is a distributive algorithm whenever there is a cut in the network or is a set of nodes fail in the network, the energy which is used to make the failure nodes function is distributed and consumed among the finely working nodes which increases their reliability and makes the network to function properly until the failure nodes are repaired or restored. This results in effective and reliable functioning of the network. [10]Due to this quality the algorithm is robust to temporary communication failure between the node pairs.

B. DOS Detection

The DOS detection part of the algorithm is applicable to the arbitrary networks; a node requires communicating a scalar variable to its neighboring nodes. The potential of certain nodes becomes "0 "(deactive) when they are separated from the source node. The state of the node is computed using an iterative scheme that requires only periodic communication among the neighboring nodes. Those nodes keep the state of their neighboring nodes to detect a DOS event, as the name of algorithm says it's disconnected from source. To send packets Shortest path algorithm can be used, it is based on energy at the time of sending packets from source node to destination node, due to throughput or any energy related issue packets are not reaching to destination, as the disturbance is from near to source node. To resolve this problem we use the alternative shortest path. After repairing the cut, packets are transferred from earlier path. Diagram 1(a) shows cut occurred near to the source sensor node.

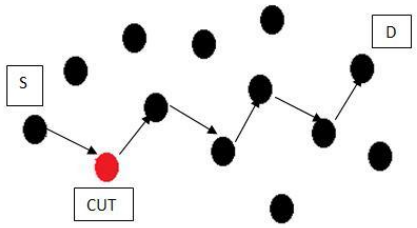

Fig : 1(a)

Due to this it find some another alternative path to transferred a packets to destination sensor node. Diagram 1(b) shows alternative shortest path.

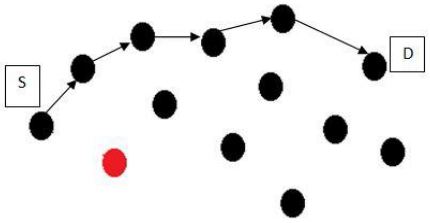

Fig: 1(b)

C. CCOS Detection

The CCOS events are detected when the state of nodes that are connected to the source node changes after the cut. However this is not enough to detect the CCOS event. Therefore the CCOS detection proceeds by using probe messages that are initiated by certain nodes that encounter failed neighbors. These probe messages are forwarded from one node to another in such a way that if a short path exists around a "hole" created by the node failures, the

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message will reach the initiating node. The nodes that detect CCOS event alert the source node about the cut. As the name of algorithm says it's connected but Cut Occurred from Source. At the time of sanding packets cut is occurred somewhere middle in the path. To resolve this problem it uses alternative shortest path.

Cut occurred in respective node, i.e. node not having sufficient energy to pass the packets forward diagram (2) shows cut occurred in between the path. To resolve this, it does the same thing as done in DOS.

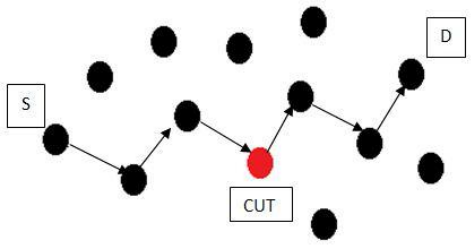

Fig: 2

V. DCD ALGORITHM

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 convergence rate which makes it independent of size of network. It saves on-board energy of multiple nodes and prolongs their lives. The source node has the ability to detect the occurrence and location of a cut which 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.

The algorithm is based on an electrical analogy.

1. DCD algorithm is applicable even when the network gets separated into multiple components of arbitrary shapes, and not limited to straight line cuts.
2. 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.
3. 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.
   - 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.

Algorithm

procedure DCD Consider S=Source node;
neighbors of node S are A, B.
ack=active; dack=inactive
if the node A is active i.e. ack state then
Wait for 500ms.
Send file to node A.
else if the node A is deactive nodefailed i.e. dack state then
file sending to A failed.
if the node B is active i.e. ack state then
Wait for 500ms.
Send file to node B.
else if the node B is deactive nodefailed i.e. dack state then file sending to B failed.

Algorithm description

One of the nodes in the network is active always and it is said to be as "source node". Given an undirected graph G = (V, E), n nodes m edges that describes the sensor network, this algorithm can be used to identify the nodes which is disconnected from the source node. Let G = (V, E) denote the undirected sensor network that consists of all the nodes and edges of G that are active at time k, where k = 0, 1, 2 . . . is an iteration (repetitive) counter. Every node p of node set V maintains a scalar state xp (k) that is iteratively updated. Let the nodes of the graph G execute the DCD algorithm with initial condition as xu (0) =0p V.

1. If no cut occurs or else no node fails then state of every node converges to a positive number.
2. If a cut occurs at a time T > 0 which separates the graph G into N connected components Gs... GN, where the component Gs (Vs., Es) contains the source node, then
   (a) The state of every node disconnected from the source node converges to 0 (deactive) and
   (b) The state of every node in Vs converges to a positive number.

Thus by monitoring the states of the nodes we can know about the status of the network connection. For effectiveness a prototype model by taking small number of nodes and their corresponding edges in the graph G, has been proposed. Thus the nodes can effectively detect the cuts occurred and identify whether they are still connected to source. The algorithm has been modified adding additional parameters to reduce redundant information at destination. It has been designed in a way that once the file is sent from a node, it is sent to its respective neighbors so that each and every node has the information. If there is any node failure from where information cannot be forwarded and a cut is detected, the information at the nodes is combined and then sent to the destination without the occurrence of redundancy.

VI.CONCLUSION

The DCD algorithm enables every node to detect DOS events and CCOS events and determines the approximate location of the cut. The algorithm is assured to detect connection and disconnection to the source node without any error. The algorithm is effective in case of disconnecting probability, network connections and communication overhead. If a component is disconnected due to a cut, it gets reconnected later. The nodes can detect such reconnection from their states. An additional approach to the actual algorithm is by adding additional parameters that solve the occurrence of duplication of information at the destination node and efficiency of the algorithm can be achieved.

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