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EFFICIENT WAY TO DETECT FAULT NODE USING ROUND TRIP DELAY

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ABSTRACT

In recent years, Wireless sensor nodes are used in various applications to gather information. The sensor nodes which are deployed in the sensing area are prone to failure due to various reasons like malfunctioning, out of range, energy dissipation and so on. These sensor nodes have to identified and recovered to maintain the good quality of service (QoS). In this paper, the concept of RTT is implemented which is used to calculate the round trip time (RTT). Based on the RTT calculated, a fault node can be identified easily with the help of round trip delay (RTD). Finally, a recovery algorithm is proposed to recover the fault node in the WSN. When the defect node is identified and recovered, the QoS is improved which is shown below in the experimental analysis. The implementation of sensor nodes is carried out with the help of NS2 simulator.

INTRODUCTION

Wireless Sensor Network (WSN) is a wireless network, which consists of thousands and thousands of sensor nodes that are densely deployed in the required area to monitor the status of the environmental conditions such as weather, earthquake, forest-fire, etc. In real world applications, WSN are used in military applications, positioning and tracking, localization of sensor nodes, etc (Warneke *et al*., 2001). These sensor nodes used to communicate with their neighbour nodes using radio signals. Now-a-days, WSN plays vital role in the industry applications like industrial process monitoring, control machine and in the civilian applications like health care monitoring, habitat monitoring, home automation and traffic control. Even though there are huge advantages of using sensor nodes in various applications, we could also find some disadvantages since, the sensor nodes are smaller in size and contains non-rechargeable batteries. This leads to battery constraint and reduces the lifetime of the network. They also have limited processing speed, the capacity of sensor node is less and also communication bandwidth is a problem (Meyer and Rakotonirainy, 2003). To increase the quality of service (QoS) and also to obtain accuracy, large number of portable wireless sensors are deployed in the environment.

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But, the accuracy and QoS will be affected due to failure of sensor nodes. Sensor nodes failure is not only due to energy depletion, but also owing to various other factors like environmental changes, failure of links, out of coverage area and so on. This causes the certain part of the network to stop functioning properly and it leads to reconstruction of new topology, network partitioning and connectivity loss. In these situations, data loss will be more and QoS will not be obtained. In this paper, to maintain the better QoS even under the situation of nodes failure, it is indispensable in most WSN applications to identify the faulty nodes available in the networks and it should be recovered within a short span of time (Warneke *et al*., 2001; Natallia Kokash). The paper is classified into five sections. In Section I, a general brief introduction about Wireless Sensor Networks (WSNs) is given. We also specify why fault occurs in it and due to what reasons a sensor node becomes failure is also stated. Section II is about the related works done for fault identification and fault recovery. Section III is about the proposed algorithm for identifying fault node and the reasons for fault occurrence. The different techniques for finding the fault node are surveyed and the efficient method to find failure node is RTD time measurement is used in the proposed system. Also the recovery algorithm is stated in this section for faulty sensor node recovery. By using open source NS2 software, the implementation of sensor nodes is done in Section IV as

Experimental Analysis. Finally, we conclude our paper by stating the efficient method for fault identification and fault recovery in Section V.

RELATED WORKS

In sensor networks, to increase the lifetime of the node and QoS is a great challenge for the researcher. Lot of papers have been published to minimize the energy utilisation of the node in-order to extend the life of the node. But there are various reasons for the energy loss in the node. To get better performance, the sensor nodes are formed as small cluster using their physical proximity. In every cluster, a cluster head is elected for the coordination of all nodes in that cluster. Due to low power transmission, energy loss at each nodes, etc. and there are certain issues in designing WSN (Jamal *et al*., 2009). The Distributed Fault detection algorithm (Vennira Selvi and Manoharan, 2013) is used to detect the failure nodes by comparing the result of the sensing information with the neighbouring nodes to enhance the accuracy of diagnosis. Some faults in communication and sensor reading may happen which can be tolerated to some extend by using time redundancy. To reduce the delay in time redundancy the interval in the sliding window is increased. Sensor nodes that are permanently failed in the network are identified with high accuracy. This algorithms works well if the node is permanently failed.

Ding *et al*. (2005) proposed a technique to detect fault node by finding the difference between the fault node reading and its neighbour's node readings is above the threshold with an assumption that neighbouring nodes have similar readings. Krishnamachari *et al*. (2004) proposed a distributed bayesian scheme for detecting and correcting by taking the possibility of sensor measurement faults. In FEED (Mohammad Mehrani *et al*., 2011), the entire network is divided into clusters with cluster heads, pivot cluster heads and some supervisor nodes. The cluster head is chosen by considering four different parameters like density, energy, centrality and distance. The supervisor node are used for detecting and replacing the failed cluster head and pivot cluster head and also try to achieve fault tolerant clustered network. By selecting three types of cluster head to handle a fault cluster head the energy consumption of FEED can be increased.

PROPOSED ALGORITHM

The proposed algorithm is used to detect the working and faulty sensor node. The discrete RTPs (Ravindra Navanath Duche and Nisha P. Sarwade, 2014) with three sensor nodes explained in generalized RTD time model are used to determine the fault in WSNs. Algorithm is executed in two phases, first phase is used to decide the threshold value of RTD time and fault is detected in the second phase. In the first phase all sensor nodes in WSNs are considered as working properly. Discrete RTPs are selected by incrementing the source node value by three and their respective RTD times are measured by using the subroutine. The highest value of RTD time measured during the execution of first phase is selected as the threshold RTD time for all discrete RTPs in WSNs. In the second phase of fault detection, instantaneous RTD time of discrete RTPs is compared with the threshold time. Discrete RTPs whose RTD time is found to be greater than threshold time is then analyzed in detail. This particular discrete RTP is examined in three stages to locate the exact position of fault. Let SX be the source node of this particular discrete RTP with sequence of sensor nodes as SX–SX+1– SX+2. Faulty sensor node in the WSNs can be present at position SX or SX+1 or SX+2 in RTP. Hence, RTPs formed by these sensor nodes have to be examined to locate the fault. RTPs formed by second and third node in this particular discrete RTP have the sensor node sequence as SX+1–SX+2– SX+3 and SX+2–SX+3–SX+4 respectively. The RTD times of these RTPs are measured sequentially. On the basis of this RTD time, these RTPs are compared to detect the faulty sensor node. Detected faulty sensor node, which can be either failed or malfunctioning, is verified by comparing the RTD times of respective RTPs with threshold time.

EXPERIMENTAL ANALYSIS

Round Trip Delay And Paths Analysis

The proposed concept is implemented in ns2 which is explained in the subsequent sections. The Round Trip delay of the RTP will change due to faulty sensor node. It will be either infinity or higher than the threshold value. Faulty sensor node is detected by comparing the RTD time of RTPs with threshold value. The sensor node common to specific RTPs with infinity RTD time is detected as failed. If this time is higher than the threshold value then this sensor node is detected as malfunctioning. Detection time of faulty sensor node depends upon the numbers of RTPs and RTD time. Therefore, RTD time measurement and evaluation of RTPs is must to minimize the detection time. A. RTD Time Estimation RTD time mainly depends upon the numbers of sensor node present in the round trip path and the distance between them. The accuracy can be increased by reducing the RTD time of RTP. It can be decreased only by reducing the sensor nodes in RTP because the distance between sensor nodes in WSNs is determined by particular applications and can't be decided. Selecting minimum numbers of sensor nodes in the RTP will reduce the RTD time. The round trip path (RTP) in WSNs is formed by grouping minimum three sensor nodes (Duche and Sarwade, 2012). Hence the minimum round trip delay time (τRTD) of RTP with three sensor node is given by

$$\tau RTD = \tau 1 + \tau 2 + \tau 3 \quad (1)$$

where τ1, τ2 and τ3 are the delays for sensor node pairs (1,2), (2,3) and (3,1) respectively (Pirinen *et al*., 2004). Circular topology with twelve sensor nodes is shown in Fig. 1.

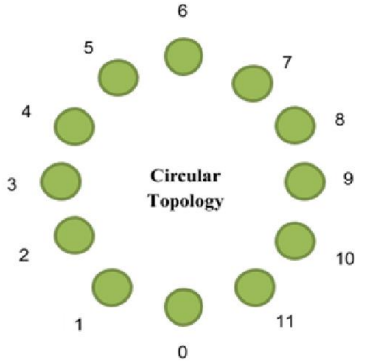

Fig. 1. Circular Topology of 12 nodes

On the basis of this RTD time, these RTPs are compared to detect the faulty sensor node. Detected faulty sensor node, which can be either failed or malfunctioning, is verified by comparing the RTD times of respective RTPs with threshold time. The algorithm used for detecting fault node using RTP is given below.

Algorithm for detecting fault node using RTP

Step-1: Select any sensor node K_X from WSN with N sensor nodes. The values of X = 1, 2, 3, …….. N ($K_1 <= K_X <= K_2$).
Step-2: RTP_X formed has sensor sequences as $K_X - K_{X+1} - K_{X+2}$.
Step-3: Call subroutine "RTD Time".

RTD Time subroutine

I. If $K_{X+1} = K_N$ then replace K_{X+2} by K_1.
Else if $K_{X+1} > K_N$ then replace K_{X+1} by K_1 and K_{X+2} by K_2 respectively.
II. Measure the round trip delay time of corresponding RTP. Initially it is RTP_X.
III. Return to main program.
Step-4: If $\tau_{RTD\_X} = \tau_{THR}$ then increment K_X by 3($K_X = K_{X+3}$)
If $K_{X+3} > K_N$ then reset K_{X+3} to K_N and go to Step 2.
Else go to Step 2.
Else Call subroutine "RTD Time".
Measure RTD time of RTP_(X+1) having sequence as $K_{X+1} - K_{X+2} - K_{X+3}$.
Step-5: If $\tau_{RTD\_(X+1)} = \tau_{THR}$ then go to Step 7.
Else if $\tau_{RTD\_X} = \infty$ then K_X node is failed (dead).
Otherwise K_X node is malfunctioning.
Step-6: Go to Step 4.
Step-7: Call Subroutine "RTD Time".
Measure RTD time of RTP_(X+2) having sequence as $K_{X+2} - K_{X+3} - K_{X+4}$.
Step-8: If $\tau_{RTD\_(X+2)} = \tau_{THR}$ then go to Step 10
Else if $\tau_{RTD\_(X+1)} = \infty$ then K_{X+1} node is failed (dead).
Otherwise K_{X+1} node is malfunctioning.
Step-9: Go to Step 4.
Step-10: If $\tau_{RTD\_(X+2)} = \infty$ then K_{X+2} node is failed (dead).
Otherwise K_{X+2} node is malfunctioning.
Step-11: If $S_{X+2} > S_N$ then go to Step 4.
Step-12: Stop.

Based on the algorithm mentioned above the RTT is calculated using the TCL coding. The program works well in finding the total RTT between the sender and receiver node which is shown below.

```
#Sender Side #
set sender [new Agent/MyPing]
$ns attach-agent $n0 $sender
#Receiver Side#
set recv [new Agent/MyPing]
$ns attach-agent $n1 $recv
#Connect the sender with receiver#
$ns connect $sender $recv
#Schedule events for the CBR agent
$ns at 0.0 "$sender send"
```

The Screenshot for the RTT calculation is shown in Fig. 2 and it prints the RTT value for sending the packets from the source to destination node. If the time exceeds for sending packets more than the value calculated, we can identify the fault node with the help of calculated Round Trip Delay using Round Trip Path.

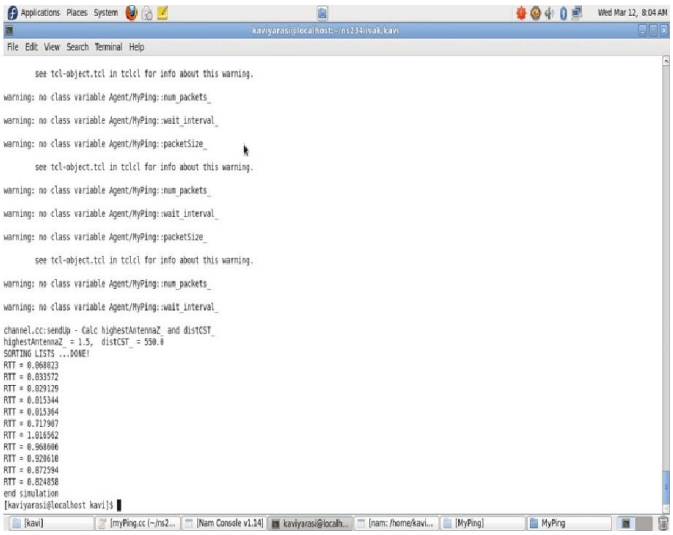

Fig. 2. RTT Calculation

Fault Recovery

If a fault occurs in cluster head, its members should be recovered to other cluster heads. We have done recovery of sensors of faulty cluster head with genetic algorithm. So, the chromosome which represents a solution should show that each member of cluster assigned to which cluster head. A chromosome in the proposed algorithm is a vector which has a size equals to the number of cluster members and the contents of each gene is one of the live cluster heads which could be obtained by generating a random number between 1 and the number of cluster heads. A sample chromosome after fault occurring in cluster head, its nodes should be recovered. The number of faulty cluster head nodes determines the length of each chromosome and the population size that is specified at the first number, chromosomes are produced whose gene contents is a random number between 1 and the number of cluster heads. After producing the primary population, the quality of each chromosome should be evaluated, this is done by fitness function. Fitness function considers three parameters to recover each node to cluster heads where these parameters include the distance of a node being recovered to given cluster head, remained energy of cluster head and the member number of a cluster head for which the current node would be recovered.

Conclusion and Future Work

In this paper, Fault node is identified by using RTD method. Initially, the RTT is calculated for each RTPs and then it is compared with the threshold value. If the RTT is greater than the threshold value, we can find there is fault in the network and the fault node will be identified successfully. The experimental analysis shows the clear information about the calculation of RTT. Once the fault node is detected, genetic algorithm is applied to recover the fault node. In this paper, the malfunctioning and dead failure node is alone identified. In future, the same concept can be applied to clusters. So that, the QoS and life time of the sensor nodes can be increased.

REFERENCES

Ravindra Navanath Duche and Nisha P. Sarwade, "Sensor Node Failure Detection Based on Round Trip Delay and Paths in WSNs", IEEE SENSORS JOURNAL, VOL. 14, NO. 2, FEBRUARY 2014, pg .no 455.

Mohammad Mehrani, Jamshid Shanbehzadeh, Abdolhossein Sarrafzadeh, Seyed Javad Mirabedini, Chris Manford, "FEED: Fault Tolerant, Energy Efficient, Distributed Clustering for WSN", Global Journal of Computer Science and Technology, Global Journals Inc. (USA), Volume 11 Issue 2 Version 1.0 February 2011.

B. Warneke, M. Last, B. Liebowitz, Kristofer, and S.Pister, "Smart Dust: Communicating with a Cubic-Millimeter Computer," Computer Magazine, vol. 34, no.1, pp. 44–51, Jan 2001.

M. Ding, D. Chen, K. Xing, and X. Cheng, "Localized Fault-Tolerant Event Boundary Detection in Sensor Networks", INFOCOM, 2005.

Krishnamachari, B.Iyengar, S, "Distributed Bayesian algorithms for fault-tolerant event region detection in wireless sensor networks" IEEE Trans. Comput. 2004, 53, 241-250.

S. Meyer and A. Rakotonirainy, "A Survey of Research on Context-Aware Homes," Workshop on Wearable, Invisible, Context-Aware, Ambient, Pervasive and Ubiquitous Computing, Adelaide Australia, 2003.

B. Warneke, M. Last, B. Liebowitz, Kristofer, and S.Pister, "Smart Dust: Communicating with a Cubic-Millimeter Computer," Computer Magazine, vol. 34, no.1, pp. 44–51, Jan 2001.

Natallia Kokash "An introduction to heuristic algorithms" University of Trento, Italy.

Jamal N. Al-Karaki Raza Ul-Mustafa Ahmed E. Kamal "DATA AGGREGATION AND ROUTING IN WIRELESS SENSOR NETWORKS: OPTIMAL AND HEURISTIC ALGORITHMS"

G. Vennira Selvi, R. Manoharan, "Cluster Based Fault Identification And Detection Algorithm For WSN- A Survey", International Journal of Computer Trends and Technology (IJCTT), volume 4, Issue 10, Oct 2013, Page 3491

R. N. Duche and N. P. Sarwade, "Sensor node failure or malfunctioning detection in wireless sensor network," ACEEE Int. J. Commun., vol. 3, no. 1, pp. 57–61, Mar. 2012.

T. W. Pirinen, J. Yli-Hietanen, P. Pertil, and A. Visa, "Detection and compensation of sensor malfunction in time delay based direction of arrival estimation," IEEE Circuits Syst., vol. 4, no. 1, pp. 872–875, May 2004.

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