SENSOR NODE FAILURE DETECTION USING ROUND TRIP DELAY IN WIRELESS SENSOR NETWORK

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Abstract

In these days, the application of Wireless Sensor Networks (WSNs) have been increased .Advance in microelectronic fabrication technology also reduces the manufacturing cost. Detecting node failures in Wireless Sensor Networks is very challenging because the network topology can be highly dynamic, the network may not always connected and the resources are limited . It becomes trend to deploy the large number of portable wireless sensors in Wireless Sensor Networks, in order to increase the Quality of Service (QoS). The QoS is mainly affected by the failure of sensor node .The sensor node failure increases with the increase in number of sensors in Wireless Sensor Networks. In order to maintain better QoS in such failure condition, Identifying and Detaching such faults are essential. In the proposed method the faulty sensor node is detected by measuring the Round Trip Delay (RTD) time of Discrete Round Trip paths and comparing them with threshold value. In proposed method, Scalability is verified by simulating the WSNs with large numbers of sensor nodes in NS2. The RTD time results derived in hardware and software implementation are almost equal, justifying the real time applicability of the investigated method.

keywords—Faulty sensor node, round trip delay, round trip paths, Wireless Sensor Networks.

1. Introduction

Wireless sensor networks(WSNs) with large numbers of portable sensor nodes has potential applications in variety of fields includes supervision, home security, military operations, medical, environmental and industrial monitoring. Large number of portable sensor node can be deployed in the field in order to increase the quality of service (QoS) of such wireless sensor networks.

MANET (Mobile Ad hoc Network) is a self organized and self configurable network where the mobile nodes move randomly. All device in a MANET is free to travel separately in any way and will therefore change its links to other devices frequently. Each must forward traffic unrelated to its own use, and therefore be a router.

The main challenge in building a MANET is equipping every device to continuously keep up the information required to properly route traffic. Such networks might function via themselves or connected to the larger internet. They may contain one or multiple and different transceivers between nodes.

In simple words MANET is used in such areas where the permanent infrastructure does not exist before. Like earthquake hit areas where the fixed infrastructure has been destroyed, in flooded areas, fire or explosion hit areas, train or air plane crash. A very common use of MANET is during business conferences. The topology of the network changes every time by getting in and out of the mobile nodes in the network.

2.ROUND TRIP TIME

Round Trip Time(RTT)is the time taken by a packet data to travel through a Round Trip Path(RTP)[1] and to come back to the sender node. Under normal condition, i.e., in the absence of any faulty node, each RTP value has a threshold RTT value. In the presence of a faulty node, the RTT value changes. The new RTT value is compared with the threshold value. By this comparison, the node common to the RTPs with higher RTT value is concluded as faulty node. The faulty node can be either dead (infinity RTT value) or malfunctioning (RTT value greater than the threshold value).

A Round trip path

The fault detection is performed in a network with ten sensor nodes arranged in a circular topology. The RTPs are selected in such a way that each RTP contains three sensor nodes. And hence each node will be present in such three RTPs. To find whether a node is faulty, we have to compare only such three RTPs. If we form RTP with more than three nodes, a single node will be present as many RTPs as the number of nodes in the RTP. Hence comparison of all such RTPs is time consuming. So we select number of nodes as three for each RTP.

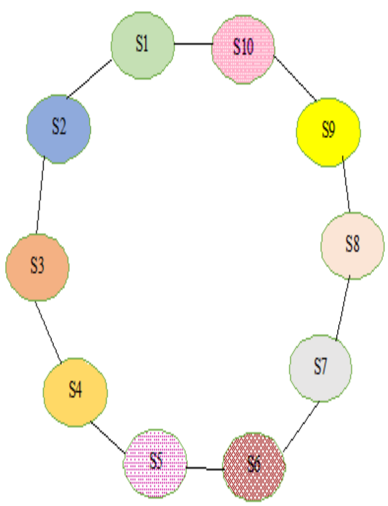


Fig. 1. Circular Topology with ten Sensor Nodes.

Round trip delay time 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 using comparing the RTD time of RTPs among threshold value. The sensor node common to specific RTPs with infinity RTD time is detected as failed. If this time is larger than the threshold value then this senor node is detected as faulty. 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.

B. RTD time estimation

RTD time mainly depends upon the numbers of sensor node p distance between them. In proposed fault detection proced reducing the RTD time of RTP. It can be decreased only by re the distance between sensor nodes in WSNs is determined by determined. Selecting minimum numbers of sensor nodes in th

The round trip path (RTP) in WSNs is formed by combining minimum round trip delay time (τRTD) of RTP with three sens

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

This is the least RTD time of an RTP in WSNs. It is determin which is decided by particular application of WSNs, as it dep sensor nodes. Hence the efficiency of proposed technique ca RTPs in WSNs.

C. Evaluation of round trip paths

Faulty sensor node is detected by comparing the particular RTPs t sensor nodes in the round path will decrease the RTPs formed. B will be present in more RTPs. While detecting faults, compariso This will delay the fault detection process. The numbers of RT given by

$$P = N (N – m(3))$$

Here P is the numbers of RTPs. Analysis time of fault detectio evaluate the RTD times of all RTPs in the WSNs. It is the addition will increase for additional numbers of sensor nodes. Referring op obtained by considering only three sensor nodes. All the RTPs in three sensor nodes (m = 3). Then the round trip delay for all RT numbers of sensor nodes used to form RTP will create substan potential round trip paths PM, created by three sensor nodes per R and is given by

$$PM = N (N − 3)$$

Analysis time $\tau ANL(M)$, to detect the faulty sensor node us referring as follows,

$$\tau ANL(M) = N(N − 3) \times 3\tau$$

The fault detection analysis time will increase exponentially with increase in numbers of sensor nodes N in WSNs. Also the highest numbers of RTPs created are not necessary for comparison to detect the fault. Such selection of RTPs is not an adequate solution to hurry up fault detection. Therefore optimization of RTPs in WSNs is necessary to hurry up the fault detection.

D. Optimization of round trip paths

Fault detection by analyzing RTD times of highest numbers of RTPs will require substantial time and can change the performance. Therefore necessary numbers of RTPs has to be selected for comparison point.

E. linear selection of RTPs

In order to reduce the RTPs in the error detection analysis, instead of considering highest numbers of RTPs, only some paths equivalent to the number of sen
select the RTPs equal to the numbers of nodes in WSNs to r
in this way are called as linear RTPs because of the linear re
RTPs created for the WSN. Individual sensor node is present

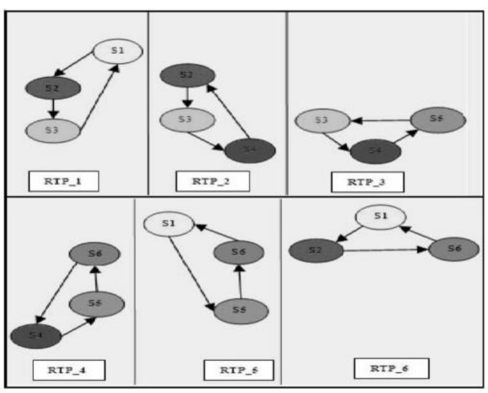


Fig. 2. Illustration of Six Linear RTPs.

Hence comparison of such three linear RTPs is

The linear RTPs in WSNs with N sensor nodes can be written as PL = N (11) where PL is the number of linear RTPs. Measurement of RTD times of such path is essential. The analysis time for linear RTP is given by

$$\tau ANL(L) = N * 3\tau..$$

Linear RTPs selected will be higher for large value of sensor
error detection time in case of big size WSNs. Therefore, furth
is must to increase the efficiency of proposed method.

F. Discrete selection of RTPs

In the initial level of optimization the analysis time is bound u
RTPs are elevated. For WSNs with huge numbers of sens
notably elevated. So again there is need to minimize the RT
optimization, numbers of RTPs are reduced by selecting on
RTPs are chosen from sequential linear RTPs only.

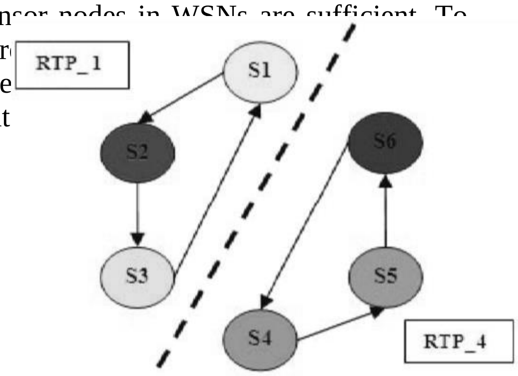


Fig. 3. Illustration of Two Discrete RTPs.

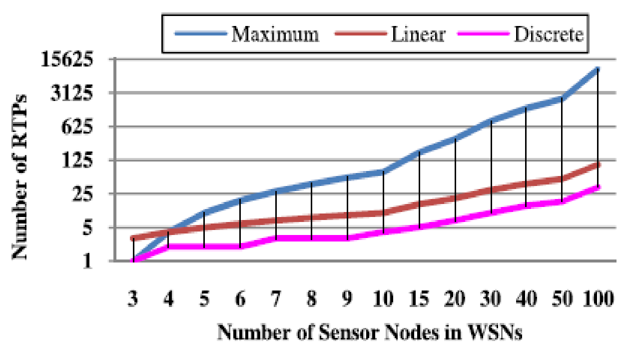


Fig. 4. Maximum, linear and discrete RTPs formed for different values

They are selected by ignoring the two successive paths, follov
way RTPs are selected in discrete steps of three as every R
equation to select the discrete RTPs in WSNs is given by

PD= Q + C

3.ALGORITHM TO SENSE FAULTY SENSOR NODE

The algorithm to sense the working as well as faulty sensor node is explained below. The discrete RTPs with three sensor nodes explained in comprehensive RTD time form above are used to determine the fault in WSNs. Algorithm is executed in two phases, first phase is used to choose the threshold value of RTD time and error is detected in the second phase. In the first phase every sensor nodes in WSNs are taken as functioning properly. Discrete RTPs are selected by incrementing the source node value by three and their particular RTD times are calculated by using the subroutine. The peak value of RTD time precise during the implementation of first phase is selected as the threshold RTD time for all discrete RTPs in WSNs. In the second phase of error detection, immediate RTD time of discrete RTPs is compared with the threshold time. Discrete RTPs whose RTD time is established to be larger than threshold time is then analyzed. This chosen discrete RTP is examined in three stages to place the accurate position of fault. Let *SX* be the source node of this exacting discrete RTP with direct of sensor nodes as SX–SX+1– SX+2. Faulty sensor node in the WSNs can be present at place SX or SX+1 or SX+2 in RTP. Hence RTPs formed by these sensor nodes have to be examined to place the fault. RTPs created by second and third node in this exacting discrete RTP have the sensor node sequence as SX+1–SX+2–SX+3 and SX+2–SX+3–SX+4 correspondingly. The RTD times of these RTPs are calculated consecutively. On the basis of this RTD ti
sensor node. Detected faulty sensor node, which can
the RTD times of particular RTPs with threshold ti
locate the fault is as follows. In the initial stage RTP
RTP_X+1 is same to threshold, provided that RTP_X
node S*X* is determined as faulty.

4.IMPLEMENTATION OF RTD PROTOCOL IN NS2

In this protocol a RTP is formed between the three sequential sensor nodes in circular topology of WSNs. A packet is routed in between these sensor no
path via conveying the addresses of source, forwardir
The circular topology of WSNs with ten sensor nodes (
sensor nodes in circular topology are placed at 1 foot
wireless sensor networks contact path failure reviva
blocking, to measure the optimal establishing**.** Th
constrained to meet latency requirements between two n

Here AODV protocol is implemented for multipath con
as pro-active protocol and main advantage of this route
wireless sensor network. Sensor monitoring all node in
will communicate each other neighbour sensor, and giv
update the energy level of neighbour nodes and also with the help of sensor to replace the low energy node into high energy node with the help of checkpoint recovery algorithm. So it can able to maximize the data transaction speed and data loss. However, a failure of an actor may cause the network to partition into disjoint blocks and would, thus, violate such a connectivity goal.

Generalized time model derived is best suited to determine the fault detection analysis time for any combination of m and N sensor nodes in WSNs. The use of discrete RTPs in the proposed technique has improved the efficiency of fault detection. In future work, we are implementing and testing the performance of suggested methods with various

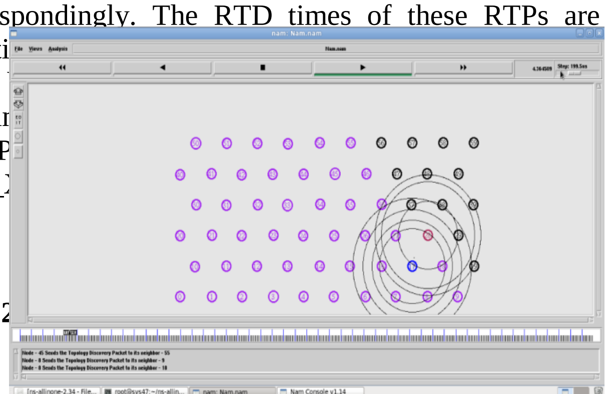
topology of WSNs. This will be useful to validate the complexity and applicability of investigated method to various types of WSNs

5. SOFTWARE ANALYSIS

Circular topology of WSNs having the various sensors nodes (N) are software NS2. In the proposed method the paths are form sensor nodes. RTD protocol is developed and implemented to meas

6.RESULTS AND DISCUSSION

Method described to detect the fault is successfully implemen difficulty in hardware implementation, WSNs with huge numbers verify the suggested method. WSNs with various numbers of sen 100 are implemented and tested in NS2 software. Simulation re numbers of sensor nodes are sufficient to prove the scalability of i the real time applicability of the method. RTD time results obtaine compared to prove the real time applicability of investigated metho



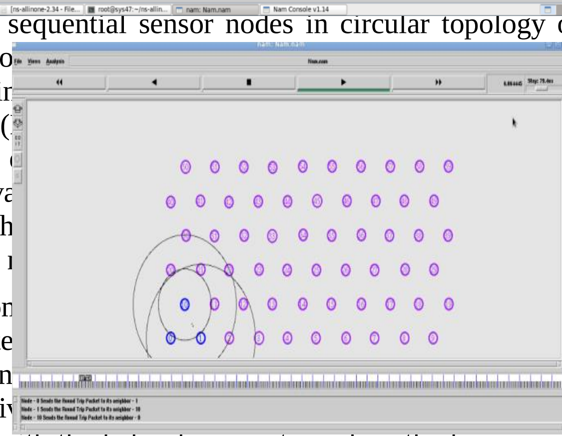


Fig. 5. Message generation packets to its neighbour

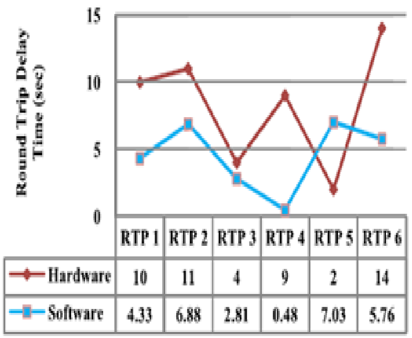


Fig. 7. Round trip transmission of packets

PARAMETERS USED IN SIMULATION

Parameters	Selected parameters values
Number of sensor nodes	6,10,20,30,40,50 and 100
Simulation area	20x20 meters
Simulation time	2.2 sec for nodes
Routing protocol	Rtd
Transmission range	1 meter
Traffic type	Cbr
Packet size	20 ytes

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7.CONCLUSION

The failure detection based on RTT helps to detect the failure nodes in the Wireless Sensor Networks. This method is less time consuming compared to other fault detection mentioned in related works. This method can be tested in network with any number of nodes.