Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 8, Issue, 06, pp.32501-32505, June, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

SENSOR NODE FAILURE DETECTION USING ROUND TRIP PATH AND DELAY

***Swapna M. Patil and Panchshila G. Sabale**

Department of Electronics and Telecommunication, Government College of Engineering, Jalgaon, India

ARTICLE INFO

Article History:
Received 23rd March, 2016
Received in revised form
10th April, 2016
Accepted 18th May, 2016
Published online 15th June, 2016

Key words:

Faulty sensor node, Quality of service, Round trip delay, Round trip paths, WSNs

ABSTRACT

A now-a-days, application of wireless sensor networks (WSNs) has been increased due to its vast potential to connect the physical world to the practical world. Also, advancement in microelectronic fabrication technology reduced the cost of manufacturing convenient wireless sensor nodes and now it becomes a trend to deploy the large numbers of wireless sensors in WSNs so that to increase the quality of service (QoS). The QoS of such WSNs is mainly affected by the faulty or malfunctioning sensor nodes. Probability of sensor node failure increases if number of sensor node increases in the network. For maintaining the better QoS under failure conditions such faulty sensor node should be detected and it should be removed. In this proposed method, faulty sensor node is detected by calculating the round trip delay (RTD) time of round trip paths and comparing them with threshold value. This proposed method is tested with three sensors Nodes designed using microcontroller, sensor and ZigBee. The main server section which will display the failure sensor node is also designed using microcontroller and ZigBee.

Citation: Swapna M. Patil and Panchshila G. Sabale. 2016. "Sensor node failure detection using round trip path and delay", *International Journal of Current Research*, 8, (06), 32501-32505.

INTRODUCTION

Wireless Sensor Network (WSN) contains number of sensor nodes. sensor nodes (Akyildiz *et al.*, 2002) are used in many areas like to monitor the status of weather, military applications, earthquake, forest surveillance etc in our day today life therefore it is very important in our life. Due to the rapid advancement in the electronic fabrication technology cost of sensor node has been reduced and hence large number of portable and light weighted sensor nodes used to increase the quality of service (QoS) of such Wireless Sensor Network. Sensor node consists of microcontroller, sensor, zigbee and power supply. Sensed data is transmitted from one sensor node to next sensor node and then display the real time parameter of all sensor node on the LCD of main sever station. If number of sensors in a WSN increases the probability of sensor node failure will also increase because the nodes are battery powered and batteries are non – rechargeable. The node batteries cannot be replaced ultimately. This will eventually degrade the quality of service of WSNs. Sensor network can become failure due to various reasons such as sensor failure, battery failure, environmental effect, and hardware or software malfunctions etc. Quality of service (QoS) can be improved by discarding the data from such faulty sensor node. Therefore detection of faults in WSNs is important because node failures degrade performance of WSNs.

Corresponding author: Swapna M. Patil
Department of Electronics and Telecommunication, Government college of engineering, Jalgaon, India

In this method we will detect the faulty sensor nodes in a WSN by a method of measuring the Round Trip Delay time of Round Trip Paths formed by combination of nodes. Round trip delay (RTD) is the time required for a signal to travel from a specific source node to other through a path and back again (Karn, Phil and Craig Partridge, 1987; Sessini, Phillipa, and AnirbanMahanti, 2006). RTD time may be vary based upon number of nodes in the WSNs. RTD time of round trip path is measured and it will be compared with a threshold value and faulty nodes will be detected. Round trip delay time of the round trip path will be change due to the faulty sensor node. If RTD time of discrete path (Mistry, 2009; and Shwe *et al.*, 2009) is greater than threshold value then this senor node is detected as faulty node.

Related Works

Single-Link Failure Detection in All-Optical Networks based on Monitoring Cycles (MCs) and Monitoring Paths (MPs) for identification of the link failure (Satyajeet *et al.*, 2009) and it was used to detect the network failure. Three edge connectivity is used in WSNs, separate wavelengths for monitoring cycles and locations are the draw backs ofthis method. cluster-based recovery algorithm (AbolfazlAkbari, 2011), which is energy-efficient and responsive to network topology which changes due to failure or malfunctioning of sensor node. Cluster head failure-recovery mechanism recovers the connectivity of the cluster in almost less time than that of the time taken by the fault-tolerant clustering. Path redundancy technique (Mojoodi,

2011) was not widely used as it consumed more energy because of the redundancy. The network speed and the number of correct results throughout the lifespan of the network decrease on using this method. Ravindra N Duche and Sarwade, (2012) proposed method is used to detect the sensor node failure or malfunctioning. This method used confidence factors (Duche, 2012) to detect faulty node. Confidence factor of round trip path in network is evaluated by using the round trip delay (RTD) time. This method detects the failure of sensor node present in symmetrical network conditions. The confidence factor of round trip path is calculated based on threshold and instantaneous round trip delay time. It were stored in lookup table and then by analyzing the status of confidence factor of all paths from the look-up table, failed or malfunctioning sensor node was detected easily. This method was able to detect only one faulty node present in any path in an easy and efficient way. That was the drawback of this method. Therefore this method has to be modified to optimize the number of round trip paths and the number of sensor nodes in the corresponding paths. NevidhithaBonnita *et al*. (2015) proposed discrete clustering approach (NevidhithaBonnita *et al*., 2015) to detect the faulty sensor node. Detection of faulty node was based on discrete RTPs. RTD times of discrete RTPs were compared with threshold time to determine failed sensor node. Software tool NS2 was used to implement RTDT protocol. Faulty sensor node was detected by simulating circular topology WSNs with RTDT protocol. Analysis time to detect faulty node was very much optimized by using the discrete RTPs. The sensor node more than threshold value was detected the failure sensor node. Senor node was detected as faulty node If calculated time is higher than the threshold value. Detection time depends upon the numbers of RTPs and RTD time. It detects the faulty node but it does not address recovering process of failure node.

Proposed Method

In the proposed method the sensor node failure detection is based on round trip path and round trip delay. Round trip delay is the time required to transfer the sensed data to next sensor node though a specific path and back again to the same sensor node. Faulty sensor node is detected by measuring Round trip delay (RTD) time of discrete round trip path it may be infinity or higher than threshold value. If the round trip delay time is infinity then the sensor node is detected as failed and if the round trip delay is higher than the threshold value then sensor node work as a malfunctioning (Minnu Suresh, 2016).

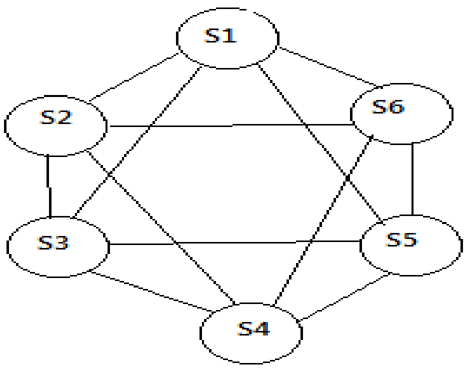

Fig.1. Circular topology WSN with six sensor nodes

The sensor node common to particular round trip paths with infinity round trip delay time is detected as failed. As round trip delay time calculation is mainly based on number of sensor nodes present in a RTD path. If the sensor node increases in a path then round trip delay time also increases. RTD time depends on the number of sensor nodes present in the round trip path and distance between sensor nodes. Therefore fault detection method can be improved after reducing the number of senor nodes in round trip path which will decrease round trip delay time of round trip path.

Round trip path is formed by grouping minimum three sensor nodes. The minimum round trip delay time of round trip path is given as:

$\tau RTD = \tau_1 + \tau_2 + \tau_3$............(1)

Here $\tau_1$is the time delay between nodes 1 and 2, $\tau_2$is the time delay between nodes 2 and 3, τ_3 is the time delay between nodes 3 and 1. Sensor nodes are arranged in circular topology as shown in Fig.1. So that three consecutive sensor nodes in an RTP will be almost at equal distances from each other. That means $\tau_1 = \tau_2 = \tau_3 = \tau$. Therefore the minimum round trip delay time is:

$\tau RTD = 3\,\tau$ ....(2)

Round trip delay time depends on the distance between the node pairs. Efficiency of the proposed method can be increased after reducing the round trip paths in WSN.

Evaluations of Round Trip Paths

Consider a wireless sensor network having N sensor nodes. Let m be the number of sensor nodes in a round trip path. Then the total number of round trip paths in a WSN is given by:

$P = N(N \quad m)$..............(3)

Where P is the total numbers of RTPs in WSNs. Total analysis time with P numbers of RTPs is given by:

$\tau ANL(m) = \tau RTD \quad 1 + \tau RTD \quad 2 + \cdots + \tau RTD \quad P$...(4)

All round trip path has only three sensor nodes, therefore RTD time of each RTP will be the same. Hence we can write equation (4) as:

$\tau ANL = P \quad \tau RTD$..................(5)

After putting equation (2) and (3) in equation (5), we will get $\tau ANL = N(N \quad m)3\,\tau$ (6)

After analyzing the above equation we conclude that if the RTPs increase in WSNs. Then analysis time will also be increase therefore we have to optimized the RTPs.

Optimization of round trip path

Optimization of RTPs can be done in two ways to reduce the analysis time. Therefore we have to select proper RTPs which will reduce the analysis time.

Linear selection of RTPs

Instead of considering maximum numbers of RTPs we have to reduce the RTPs. only few paths corresponding to the number of sensor nodes are consider. Select the RTPs equal to the numbers of nodes in WSNs as shown in Fig.2. Here selected RTPs are called as linear RTPs because of its linear relationship between N and P.

$PL = N$ ……………….(7)

Where PL is the number of linear RTPs. the analysis time τANL(L)for linear RTPs is given by:

$\tau ANL = N \quad 3\tau$………....(8)

But if sensor node N increases in the network then linear path will be increase and which will not reduce the analysis time therefore we have to optimize the RTPs.

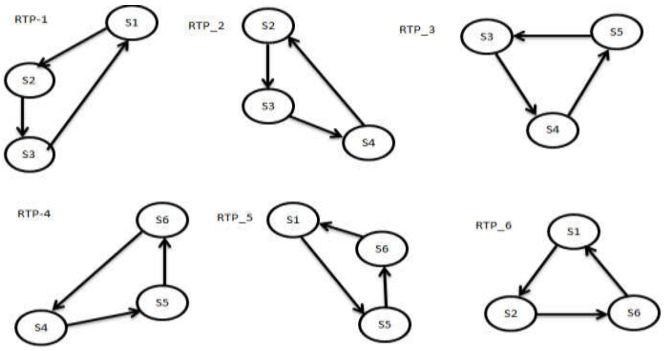

Fig.2. Linear selection of RTPs

Discrete Selection of RTPs

In the above level of optimization the analysis time is restricted up to certain limit still the numbers of RTPs are more. Therefore for minimizing the analysis time we have to minimize the RTPs and this can be achieved by considering discrete RTPs as shown in Fig. 3

Discrete RTPs are selected from sequential linear RTPs by ignoring the two consecutive paths, after each selected linear path. In this way RTPs are selected in discrete selections which are given by:

$PD = Q + C$ ………………(9)

Q and C in above equation are expressed as below
Q= N/m] ……………....(10)

$C = \begin{cases} 0 \text{ if } R=0 \; 1 \text{ otherwise} \end{cases}$ ……….(11)

Where Q is the quotient and m is the numbers of sensor nodes present in RTP. R is remainder, N is numbers of sensor nodes and C is correction factor to be added in wireless sensor networks. Correction factor will be 0 if the value of remainder is 0 otherwise it is 1.

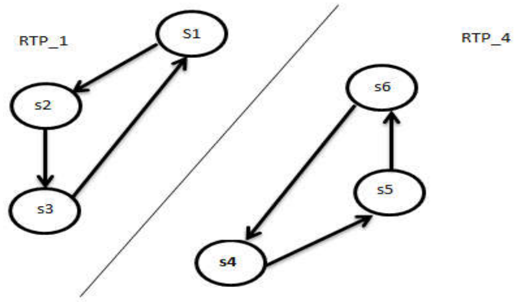

Fig.3. Discrete selection of RTPs

The time taken for the fault detection is given by:

$\tau ANL(D) = (Q + C) \quad 3\tau$…………..(12)

Additional two RTP's are needed along with the discrete RTP's in WSN to locate the fault present at second and third levels .Therefore the total number of RTP's required to find out the fault is given by

$PT = PD + L$…………………….(13)

Here L is the number of sensor nodes in each RTP excluding the source node ie L=m-1.Analysis time is lowest when number of sensor nodes in an RTP path is 3 ie m=3.

Hardware Implementation

Sensor nodes are implemented using ATMEGA328 microcontroller, XBee Series 2 OEM RF Modules and LM35 temperature sensor. Wireless sensor network implemented using such a sensor node. Sensor nodes are kept at a distance so that it will form a topology. While performing this experiment the baud rate of ZigBee is set to 9600bps and 16 MHz crystal is used for ATMEGA328. Fig.4 gives the detail description of sensor node in this way other sensor nodes are designed.

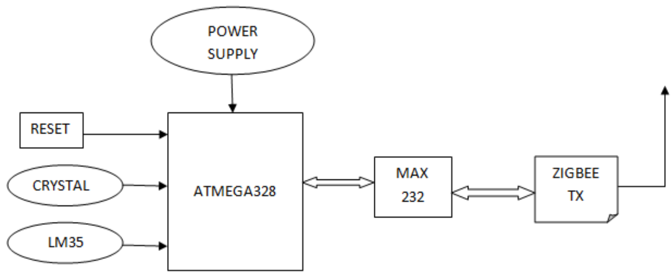

Fig.4. Sensor node

Arduino microcontroller

The Arduino microcontroller is an easy to use yet powerful single board computer that has gained considerable power in the professional market. The Arduino is open-source, which means software is free and hardware is reasonably priced. The board has 14 digital I/O pins and 6 analog input pins. There is a USB connector for communicating to the host computer and a DC power jack for connecting an external 6-20 V power source.

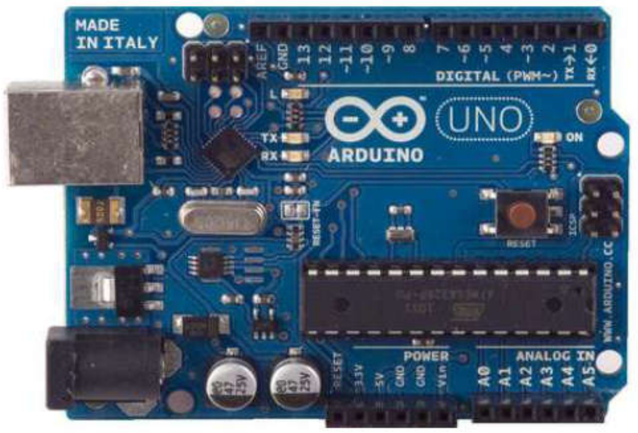

Fig. 5. Arduinouno board

Atmel ATmega328 microcontroller operating at 5 V with 2Kb of RAM, 32 Kb of flash memory for storing programs and 1 Kb of EEPROM. The clock speed is 16 MHz, which translates to about executing about 300,000 lines of C source code per second. It is Available in DIP package. It is high performance low power AVR 8-bit RISC architecture. it has 23 programmable I/O channels, Six 10-bit ADC inputs, Three timers/counters, Six PWM outputs as shown in Fig. 6.

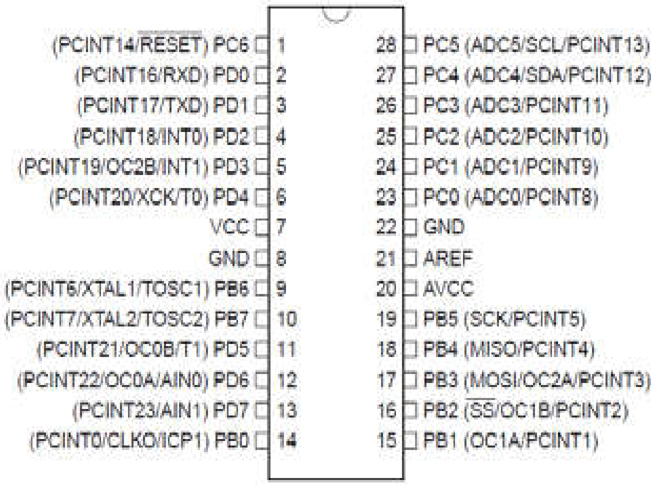

Fig.6. ATMEGA328

XBee Series 2 OEM RF Modules

XBee operate within the ZigBee protocol and it support the low-power wireless sensor networks. The modules require minimal power and provide reliable delivery of data between remote devices. The modules as shown in fig. 7 operate within the ISM 2.4 GHz frequency band

Fig.7. XBee Series 2 OEM RF Modules

Features

- Indoor/Urban Range up to 133 ft. (40 m)
- Outdoor RF line-of-sight Range up to 400 ft. (120 m)
- Transmit Power Output 2mW (+3dBm)
- RF Data Rate 250,000 bps
- Supply Voltage 2.8 – 3.4 V
- Operating Current (Transmit) 40mA (@ 3.3 V)
- Operating Current (Receive) 40mA (@ 3.3 V)
- Supported Network Topologies Point-to-point, Point-to-multipoint, Peer-to-peer & Mesh.

LM35

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. The LM35 is rated to operate over a 55° to +150°C temperature range Operates from 4 to 30 volts, Less than 60 µA current drain. It is Suitable for remote applications.

Conclusion

In this paper, faulty sensor node in wireless sensor network is detected using round trip path and delay. Detection of faulty sensor node is optimized using the discrete RTPs. The complete network is simulated in real time to measure the RTD time of RTPs. but here various time delays are associated in hardware. Inherent delay can be minimized by adjusting the delay associated with microcontroller and Zigbee devices. The use of discrete RTPs in the proposed method has enhanced the efficiency of fault detection. Efficiency of method is excellent in case of discrete RTPs with three sensor nodes.

REFERENCES

Akyildiz, I. F., Su, W. 2002. Y. Sankarasubramaniam, and E. Cayirci, "Wireless sensor networks: a survey," Computer networks, vol. 38, no. 4, pp. 393–422.

Karn, Phil, and Craig Partridge. 1987. "Improving round-trip time estimates in reliable transport protocols." *ACM SIGCOMM Computer Communication Review. Vol. 17. No. 5. ACM.*

Sessini, Phillipa, and AnirbanMahanti. 2006. "Observations on round-trip times of TCP connections." *simulation series 38.3.*

Mistry, Oly, Anil Gürsel, and Sandip Sen. 2009. "Comparing trust mechanisms for monitoring aggregator nodes in sensor networks." *Proceedings of The 8th International Conference on Autonomous Agents and Multiagent Systems-Volume 2*. International Foundation for Autonomous Agents and Multiagent Systems.

Shwe, Hnin Yu, Xiao-Hong Jiang, and SuslginuHoriguchi. "Energy saving in wireless sensor networks." *Journal of Communication and Computer 6.5 (2009): 20-27.*

Satyajeet S. Ahuja, R. Srinivasan, and M.Krunz, Single –link failure detection in all-optical networks using monitoring cycles and paths, *IEEE/ACM Trans. Netw., vol. 17, no. 4,* Aug. 2009.

Abolfazl Akbari1 , Arash Dana2 , Ahmad Khademzadeh3 and NedaBeikmahdavi, Fault Detection and Recovery in Wireless Sensor Network Using Clustering, *International Journal of Wireless & Mobile Networks (IJWMN) Vol. 3, No. 1,* February 2011.

A.Mojoodi,M.Mehrani, F. Forootan, and R. Farshidi, Redundancy effect on fault tolerance in wireless sensor networks*, Global J. Comput. Sci. Technol., vol. 11, no. 6,* Apr. 2011.

Duche, Ravindra N., and N. P. Sarwade. *"Sensor node failure or malfunctioning detection in wireless sensor network." ACEEE Int. J. Commun 3.1* (2012): 57-61

NevidhithaBonnita. P, Dr.Nalini.N, Mohan.B.A, Failure detection of sensor nodes based on Round Trip Delay and Paths in Wireless Sensor Networks, *International Research Journal of Engineering and Technology (IRJET) e-ISSN:2395 -0056 Volume: 02 Issue: 03,* June-2015.

Minnu Suresh, Manoj R, Faulty node detection in Wireless Sensor Networks, *International Journal of Modern Engineering Research, Vol. 6, Issue: 5,* May 2016, 78.

****