# Malfunctioning Node Detection of Load-Balanced Data Aggregation Tree in Probabilistic Wireless Sensor Networks

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*Abstract*— In wireless sensor networks sensor nodes periodically sense the monitored environment and send the information to the sink at which the gathered or collected information can be further processed for end-user queries. Data gathering trees capable of performing aggregation operations are also referred to as Data Aggregation Trees which are directed trees rooted at the sink and have a unique directed path from each node to the sink. To maintain the high standard of Wireless sensor network, observation of malfunctioning sensor node is mandatory. The failure of the sensor node is either because of transmission device fault, environment condition and sensor device related problems. To identify the failed sensor node manually in such circumstance is troublesome. The Efficient malfunctioning node detection algorithm presents a new method to detect the sensor node failure or malfunctioning in such circumstance. The proposed work uses the round trip delay time to estimate the confidence factor of Round Trip Delay path. Based on the conviction factor the failed or malfunctioning sensor node is detected. The detection time of proposed method to detect faulty sensor node is in the range of few seconds.

***Key words:*** Load balancing, Data aggregation tree, Malfunctioning node detection

## I. INTRODUCTION

In Wireless Sensor Networks sensor nodes periodically sense the monitored environment and send the information to the sink (or base station), at which the gathered/collected information can be further processed for end-user queries. In this data gathering process, data aggregation can be used to group the data received from different sensors to eliminate redundant transmissions, since the data sensed by different sensors have spatial and temporal correlations .Hence, through this in-network data aggregation technique, the amount of data that needs to be transmitted by a sensor is decreased, which in turn reduces each sensor's energy usage. So that the whole network lifetime is extended.

A WSN consists of nodes with sensing, computing and communication capability connected according to some topology and a sink to communicate with the outside world.

Load balancing research in the WSN MAC layer has traditionally focused on group of networks method, in which the protocol selects top nodes as regional coordinators to bear responsibility for a system task.

A form of dynamic cluster selection is presented in which nodes periodically rotate cluster head responsibilities to balance their energy usage. Sensor nodes probabilistically become cluster heads with probabilities governed by their remaining energy. Balance nodes transmit the data to cluster head first, and cluster heads can be organized hierarchically to assist with delivery back to the sink.

Compared with an arbitrary network of networks, a tree-based network conserves the cost of maintaining a routing table at each node, which is computationally expensive for the sensor nodes with limited resources. For clarification, data gathering trees capable of performing aggregation operations are also to as Data Aggregation Trees, which are directed trees rooted at the sink and have a unique directed path from each node to the sink. Therefore, nodes with the top unused energy assume more often the burden of routing and aggregating messages from their peers.

In WSN if any sensor node fails or malfunctioning the time delays related to this sensor node will be modified. This will create the errors in estimating the round trip time (RTT) times To determine the conviction factor, measurement of threshold and instant round trip delay time of respective path is essential. The round trip time of various round trip paths in WSN is measured for certain sensor conditions. The threshold value and conviction factor utilized here is a powerful tool for failure detection.

RTT time mainly depends upon the numbers of sensor node present in the round trip path and the distance between them. Proposed fault detection technique accuracy can be increased by reducing the RTT time of Round Trip Path. It can be decreased only by reducing the sensor nodes in Round Trip Path because the distance between sensor nodes in WSNs is determined by particular applications and cannot be clearly defined. Selecting less numbers of sensor nodes in the Round Trip Path will reduce the RTT time. The round trip path in WSNs is formed by grouping minimum three sensor nodes.

The main work is to combine the data coming from different sources such as eliminating redundancy, minimizing the number of transmissions and thus saving energy by identifying the failure node.

This paper is organized as follows. In Section II, The network model and problem definition is given. In Section III, The Load balancing in sensor network is described, In section IV, The Distributed Adjustment Algorithm is described. V. The Efficient Malfunctioning node detection algorithm is described. Finally, the simulation results, Performance evaluation and a conclusion are presented in Section VI.

## II. NETWORK MODEL AND PROBLEM DEFINITION

Round trip time of the Round Trip Path will change due to faulty sensor node. It will be either higher than the threshold value. Failed sensor node is identified by comparing the RTT time of Round Trip Paths with threshold value. The sensor node centered to specific Round Trip Paths with infinity RTT is detected as failed. If this time is highest than the threshold value then this sensor node is detected as

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malfunction. Detection time of failure sensor node depends upon the numbers of RTPs and RTT time.

### A. Network Model:

In the wireless sensor network the each sensor node is allocated with the some energy for the transmission of data to the receiver sensor node. In which it also handles the load balancing by having the parent child relationship .In which a parent consists of the maximum of two children. By this network model we can save the energy and balance the load in the Wireless sensor network.

### B. Problem Definition:

The novel algorithm such as distributed adjustment algorithm (DAA) balances the load between sensor nodes in the probabilistic wireless sensor network model. The problem behind this algorithm is that, while transferring the data from the sender sensor to the receiver node the packet can reach the receiver node or it may be lost due to this there is a chance of packet loss and it is a major problem to identify a malfunctioning sensor node.

## III. LOAD BALANCING IN SENSOR NETWORKS

A node-centric load balancing strategy considers the cumulative load of data traffic from child nodes in a routing tree on their parent candidate nodes. The WSN routing tree is linked to the sink. The load of child sensor nodes includes to the load of each top parent in the data aggregation tree. Hence, the sensor nodes near to the sink or base station will be the most heavily loaded. The goal of node-centric load balancing is to evenly distribute packet traffic generated by sensor nodes across the different branches of the routing tree.

All nodes in the sensor network periodically broadcast their existence, and neighboring information. After collecting this information, the base station constructs the graph G (V, E) (where V is the vertex set while E is the set of all edges). An algorithm is executed on G to construct a load-balanced tree.

The “load” associated with a given sensor node represents the amount of data periodically generated by that sensor node. Load balanced trees can be classified into different categories. We define the “level” to be the distance from a node to the base station. A load-balanced tree could be fully balanced, top-level balanced or hierarchy-balanced.

A fully balanced tree is a tree in which the branches on the same level carry the same total amount of load. A top-level balanced tree is a tree such that each branch at the top level closest to the base station carries the same amount of load. Both fully balanced trees and top-balanced trees are extreme cases of hierarchy-balanced trees, i.e. a tree in which the branches in certain levels carry the same total amount of load. In this paper, our distributed adjustment algorithm of load balancing technique focuses on constructing a load balanced tree over the sensor network.

## IV. DISTRIBUTED ADJUSTMENT ALGORITHM

Assume a node $N_i$ keeps the information of $C_i$ $\mathrm{PC}_{\mathrm{chij}}$, $CPC_{chij}$ j after it received all TREPs from its children, and LBFi≠1. The node $N_i$ attempts to adjust $ST_i$ to obtain a new $LBF_i$ that is closest to 1. The nodes $chi_m$ and $chi_M$ are $N_i$ children.Node $N_i$ first checks whether $LBF_i = \mathrm{nst_{chim}} / nst_{chiM} = 1$ or $\mathrm{nst_{chim}} - nst_{chiM} = 0$ If yes, $ST_i$ is a load-balancing tree; otherwise, $ST_i$ is a non-load-balancing tree, and then $N_i$ attempts to adjust $ST_i$ to form a complete or approximate load-balancing tree. When $ST_i$ is a non-load-balancing tree $N_i$ selects an appropriate and adjustable grandchild $n_{agc}$ from $C_{chiM}$.

Next, $N_i$ adds the information of $n_{agc}$ into agclist, which is a list of adjustable grandchildren. One item of agclist is $(id_{npar} id_{opar}\ id_{npar})$, where $id_{agc}$ is the adjusted grandchild node nagc's ID, $id_{opar}$ is nagc's old parent ID, $id_{npar}$ is nagc's new parent ID. This process is repeated until all adjustable grandchildren are identified.

### A. Algorithm For Tree Adjustment After Node $n_i$ Selected Its Parent Candidate, $n_i$ Adjusts The Tree Of Its Children.

:$n_i$ set agclist as NULL, where one item of agclist is <$id_{agc} id_{opar} id_{npar}$>

1) STEP 1. $n_{agc}$ is an adjustable grandchild, $NLBF_i$ is the new $LBF_i$,$TLBF_i$ is test $LBF_i$
2) STEP 2.$chi_m$, $chi_M$ $\in$ $C_i$
3) STEP 3and 4.
4) if $n_i$ has received all TREPs from its children then
5) STEP 5.$n_i$ finds $chi_m$ and $chi_M$ from $C_i$ and sets $n_{agc}$ as NULL ,$nst_{agc}$ as 0
6) STEP 6. $LBF_i \leftarrow nst_{chim} / nst_{chiM}$
7) STEP 7. $NLBF_i \leftarrow LBF_i$
8) STEP 8. If $LBF_i$= 1 or $nst_{chim} - nst_{chiM}$ = 1 then
9) STEP 9. $ST_i$ is a load balancing tree and exit this algorithm
10) STEP 10. Else
11) STEP 11. $n_i$ finds an adjustable node $n_{agc}$ from the children of $chi_M$
12) STEP 12.For each $chi_x$ in $C_{chi\ M}$
13) STEP 13.For each PC in $pc_{chix}$ of $CPC_{chiM}$
14) STEP 14. If PC=$chi_m$ and $nst_{chix} > nst_{agc}$ then $nst_i$ is the number of sensor nodes in $ST_i$
15) STEP 15. $TLBF_i$ =Min($nst_{chim}$+$nst_{chix}$,$nst_{chiM}$-$nst_{chiX}$) / Max ($nst_{chim}$+$nst_{chix}$,$nst_{chiM}$-$nst_{chiX}$)
    If $TLBF_i > NLBF_i$ then
16) STEP 16. $NLBF_i \leftarrow TLBF_i$ , $n_{agc} \leftarrow chi_x$ ,$nst_{agc} \leftarrow nst_{chi}$
17) STEP 17.If $nst_{agc}$ not equal to 0 then
18) STEP 18.$n_i$ changes the $n_{agc}$ parent to $chi_m$ in TTi
19) STEP 19. $n_i$ adds ( $n_{agc}$, $chi_m$, $chi_M$) to agclist
20) STEP 20. The process is repeated from step 5.

## V. EFFICIENT MALFUNCTIONING NODE DETECTION ALGORITHM

To maintain the high standard of Wireless sensor network, observation of malfunctioning sensor node is mandatory. The failure of the sensor node is either because of transmission device fault , environment condition and sensor device related problems. To identify the failed sensor node manually in such circumstance is troublesome. The Efficient malfunctioning node detection algorithm presents a new method to detect the sensor node failure or malfunctioning in such circumstance. The proposed work uses the round trip delay time to estimate the confidence factor of Round Trip Delay path. Based on the conviction factor the failed or

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malfunctioning sensor node is detected. The detection time of proposed method to detect faulty sensor node is in the range of few seconds.

*A. Algorithm for Finding the Malfunctioned Sensor Node in Wireless Sensor Network:*

1) STEP 1: Initialize all Sensor nodes in the Network.
2) STEP 2: Select 3 sensor nodes for round trip path (m=3).
3) STEP 3:Determine the number of round paths in WSN
4) STEP 4: Set the counter for round trip paths.
5) STEP 5: Select the round trip path
6) STEP 6: Know calculate the instantaneous round trip delay (RTD) time of this path by using the equation
$$\tau_{RTD=}\tau(i,j) + \tau(k,i)$$
The round trip delay time for the path consisting three sensors i,j and k
7) STEP 7: Estimate conviction factor of respective round trip path by using formula condition
$$\Delta_{\mathrm{RTD}} = \begin{pmatrix} 1, & \tau_{RTD<\tau_{RTD\,-Tr}} \\ 0\,, & \text{otherwise} \end{pmatrix}$$
$\tau_{RTD\ -Tr}$-The threshold time for respective round trip path
$$\Delta_{\mathrm{RTD}} = \text{ Conviction factor}$$
8) STEP 8: Go to step 4, decrement the counter for RTD path and Repeat till step 7 to determine the conviction factor of all paths in the WSN.
9) STEP 9: Complete the look-up table entries for all RTD paths.
10) STEP 10: Stop.

## VI. SIMULATION RESULT

The performance considers the number of nodes taken for simulation with time. The detection of mal functioning sensor node is identified in short Period of time by using Efficient mal functioning node detection algorithm in order to transfer the data packet to the receiver node to avoid the packet loss to improve the throughput and it is shown in the fig 6.1

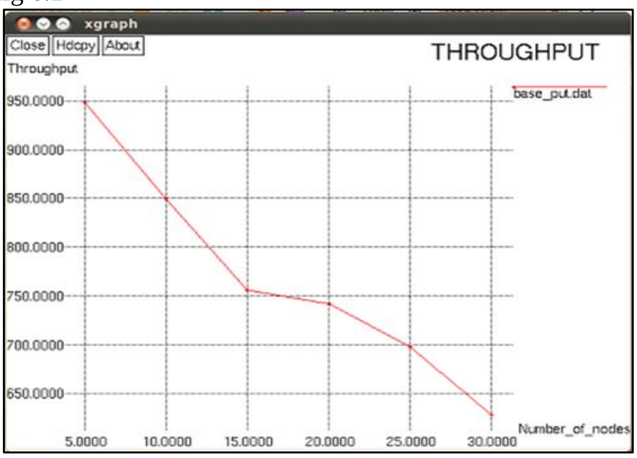


Fig. 6.1: Throughput of Efficient Malfunctioning Node Detection Algorithm

*A. Performance Evaluation:*

The performance of the efficient malfunctioning node detection algorithm is used to find the malfunctioned sensor node to transmit the data packet to the receiver node to avoid the packet loss and to improve the throughput.


Fig. 6.1.1: Level 0 Data flow diagram

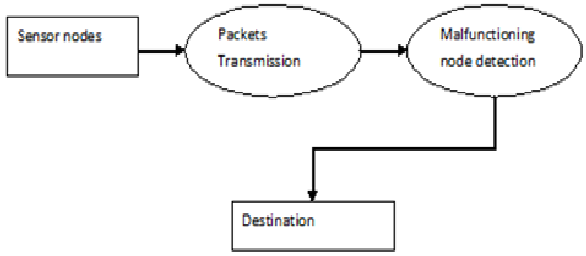


Fig. 6.1.2: Level 1 Data flow diagram

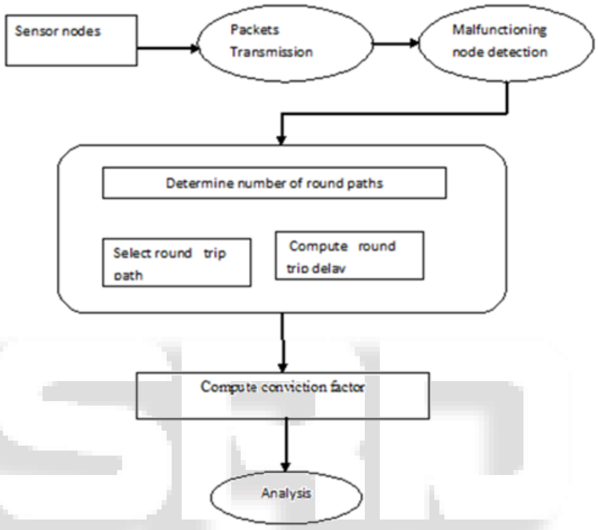


Fig. 6.1.3: Level 2 Data flow diagram

It is difficult to conclude the failure or malfunctioning of sensor node more than one if they belong to identical round trip path. This is because of the reason that instant RTT time for all paths will be either infinity or more than threshold value Which will tend to set the confidence factors of all round trip paths in WSN equal to '0'. If the faulty sensor nodes belong to different round trip paths in network then they will be detected by this way. This is because of the conviction factors of all round trip paths in WSN will not tend to be '0'otherwise'1'.

The process is clearly described with the help of data flow diagram in the figure 6.1.1

## VII. CONCLUSION AND FUTURE WORK

*A. Conclusion:*

The existing method of distributed adjustment algorithm is used in probabilistic network model of the wireless sensor network adding multiple parent candidates in non-balancing sub tree. A node has multiple routes to the sink by multiple parent candidates. When a node detects the difference between energy of the parent candidates, it dynamically selects one parent candidates. The multiple routes can balance the traffic flows. But the proposed method of efficient malfunctioning node detection algorithm will identify the failed node in the wireless sensor network with its round trip time which increases the throughput of the sensor nodes and avoid the problem of occurring the packet loss. Thus the time complexity gets reduced. The Proposed method has to be modified to optimize the number of round trip paths in WSN and the number of sensor nodes in the related paths. This will reduce the detection time of faulty sensor node in WSN.

### *B. Future Work:*

In which the Efficient malfunctioning node detection algorithm optimizes the only the number of round trip paths and the number of sensor nodes representing to this path to reduce the detection time of faulty sensor node in wireless sensor network. In future we can optimize the round trip time of sensor nodes present in the network.

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## REFERENCES

[1] Jing He, Shouling Ji,Yi Pan,Ying Shu Li, “Constructing Load Balanced Data Aggregation Trees in Probabilistic Wireless Sensor Network”, July 2014
[2] Adon Hwang, DarioVlah, H.T.Kung, Pai-Hsiang Hsiao, “Load-Balancing Routing for Wireless Access Networks”, IEEE transaction, December 2008
[3] Agrawal, A.Manjeshwar, IEEE, “Routing protocol for Enhanced Efficiency in Wireless Sensor”, December 2001.
[4] Anandhan.D, Manjula.P, Sivakumar.B, Venkatesan.B, Venkatraman.K, IEEE “Effectual Data Collection in WSN with Path Controlled Mobile Sinks”, Feburary 2012
[5] Chen Shigang, Zhan Zhang, International Conference, “Localized Algorithm for Aggregate Fairness in Wireless Sensor Networks”, April 2006.
[6] Gupta.S.K.S, Schwieber.I, IEEE, “On Tree-Based Convergecasting in Wireless Sensor Networks”, April 2012.
[7] Huseyin Ozg ur Tan and Ibrahim Korpeo, IEEE, “Power Efficient Data Gathering and Aggregation in Wireless Sensor Networks”, December 2003.
[8] Konstantinos Kalpakis, KoustuvDasgupta, and Namjoshi, IEEE, “Efficient Algorithms for Maximum Lifetime Data Gathering and Aggregation in Wireless Sensor Networks”, November 2005.
[9] Kaoru Sezaki.Niwat Thepvilojanapong, Yoshito tobe, IEEE, “Hierarchy-Based Anycast Routing Protocol for Wireless Sensor Networks”, Feburary 2005
[10] Liu.J.S and Lin pp. C.H.P, IEEE, “Power-Efficiency Clustering Method with Power-limit Constraint for Sensor Networks”, April 2003.
[11] Longjiang Guo, Sushil K. Prasad, Yingshu Li, IEEE, “An Energy-Efficient Distributed Algorithm for Minimum-Latency Aggregation Scheduling in wireless Sensor Network”, September 2011.
[12] Mishra.A, Raghuwanshi.S, IEEE, “A Self-Adaptive Clustering Based Algorithm For Increased Energy-Efficiency and Scalability in Wireless Sensor Networks”,October 2003.
[13] Par.J and Sahni.S, IEEE, “Maximum Lifetime broadcasting in Wireless Networks”, December 2005
[14] Raheem Beyah, Shouling Ji, IEEE, “Snap/shot/Continuous Data Collection Capacity for large–Scale Probabilistic Wireless Sensor Networks”, March 2014
[15] Shouling Ji, Zhipeng Cai, IEEE, “Distributed Data Collection and its Capacity in Asynchronous Wireless Sensor Network”, August 2013

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