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A Study on Fault Node Recovery Algorithms in Wireless Sensor Networks

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Abstract: ***Recovery from node fault is now a day's getting more attention in the sense of wireless sensor network. Direct diffusion algorithm, grade diffusion algorithm, reduce identical event transmission algorithm and reduce identical composite event transmission algorithm were used as the traditional approaches for identifying the node fault. The fault node recovery algorithm is a combination of grade diffusion algorithm and genetic algorithm. This algorithm increases the number of alive nodes and reduces the data losses and also reduces the rate of energy consumption. In this article we overview all the traditional approaches for fault node detection and replacement. Merits and demerits of all the traditional approaches are also described here.***

Keywords: grade diffusion algorithm, direct diffusion algorithm, genetic algorithm, fault node recovery algorithm, wireless sensor network.

I. INTRODUCTION

A Wireless Sensor Network [2] is a self-creating network composed of small sensor nodes[4] communicating among themselves using radio signals, and they can monitor, sense and understand the physical world. WSN [11] provides a connection between real physical world and virtual world. Many applications [10] are there for wireless sensor network such as industry, science, transportation, civil infrastructure, and security[8]. A sensor node [4] is a node in wireless sensor network that is capable of performing some processes such as gathering information and communications with connected nodes in a network. In some cases these nodes became fault[11]. Node fault may occur due to many reasons such as reduction in battery life time that is hardware failure, communicating link failure, malicious attack. [3]Each sensor node in a network has their own low level of battery energy. This energy cannot be recharged .so the hardware failure leads to node fault. When the energy of a sensor node is depleted, failed nodes will not transfer data [11] .Thus the other sensor nodes in the network will be burdened with increased transmission processing.

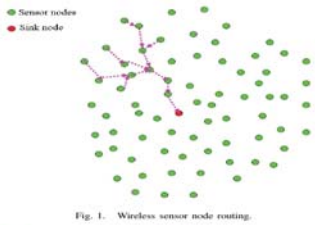

Fig. 1. Wireless sensor node routing.

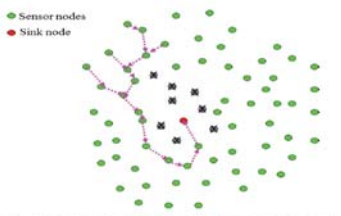

Fig. 2. Wireless sensor node routing path when some nodes are not functioning.

Many traditional approaches were proposed for overcome this node fault. But each approach has its own drawbacks. Some of the traditional approaches are direct diffusion algorithm [5], grade diffusion algorithm etc. A new approach proposed for fault node recovery and replacement is fault node recovery algorithm. This is a combination of traditional grade diffusion algorithm and genetic algorithm [3].Genetic algorithm is a directed random search technique based on the natural genetics. This genetic algorithm is used because the conventional search techniques are not capable of optimizing non linear functions with multiple variables.

In grade diffusion algorithm [1] creates the routing for each sensor node and also identifies a set of neighbour nodes to reduce the transmission loading. Each node selects a sensor node from the set of neighbour nodes when its grade table lacks a node able to perform the data transfer. The GD algorithm also records some information regarding the data packet transfer. A sensor node can select a node with a lighter loading or more available energy than the other nodes to perform the extra data transfer operations. That is, the grade diffusion algorithm updates the routing path and the event data is then sent to the sink node quickly and correctly. Then, the sensor nodes transfer the event data to the sink node, according to the proposed algorithm, when suitable events occur.

Here according to the proposed algorithm, a routing table is prepared for all the nodes based on the grade diffusion algorithm, then after detecting node fault, fault nodes are replaced by using the genetic algorithm. There are 5 steps for genetic algorithm: Initialization, Evaluation, Selection, Crossover, and Mutation.

II. FAULT NODE RECOVERY APPROACHES

a) Directed diffusion for wireless sensor networks.

This is one the traditional approaches for identifying the fault nodes in wireless sensor network. In February 2013 a new approach [5] is explore that is the directed-diffusion paradigm it's for perform distributed sensing of environmental phenomena coordination**.** Directed diffusion is data-centric approach in that all communication is for named data. All nodes in a directed-diffusion- based network are aware of which application is done in that time. This enables diffusion to achieve energy savings by selecting good paths and by caching and processing data in-network.

Directed diffusion is different from all other IP-style communication. In ip style communications each nodes are identified by their end-points and inter-node communication is layered within the network. Here in this method outline the directed-diffusion paradigm, and it explains its key features.

Directed diffusion consists of several elements: interests, data messages, gradients, and reinforcements, An interest message is a query message which specifies what a user wants. Data in sensor networks is a collection or processed information of a physical phenomenon, and event is a short description of the sensed phenomenon. A gradient is direction state created in each node that receives an interest; the sensor network reinforces one or a small number of network routing paths.

Directed diffusion has the potential for significant Energy efficiency. With relatively un optimized path selection, it performs an idealized traditional data dissemin0ation scheme like omniscient multicast, diffusion mechanisms are stable under the range of network dynamics considered.

Analysis and result: here the data delivery cost is high as compared with the omniscient multicast. and it has better energy savings than omniscient multicast routing.

b) An Enhancement Grade Diffusion Algorithm for composite event aggregation

In October 2011 an enhanced version of grade diffusion algorithm [1] is proposed. This paper is for composite event aggregation and is used for solving the problem of composite events in wireless sensor networks. This can remove the required transmission and save energy consumption and can increase the life time of the entire wireless sensor network.

In a WSN multiple sensor nodes detect same event when they are randomly distributed. If they all send same event then each of the nodes consume large amount of energy. In this each sensor node has mainly 4 levels of states they are: sensing state, delay state, query state and receive query state. Based on this states a delay time is evaluated. By analysing we can conclude that we can save sensor node energy and also it can enhance the life time of a sensor network.

Analysis and result: Main merit of this method is this algorithm not only reduces the energy consumption by 53.82%, but also it enhances the sensor node's lifetime by up to 21.67% compared with other traditional approaches. For efficient data packet transmission the sensor node life time is more as prescribed above.

c) Agnostic Diagnosis: Discovering silent failures in wireless sensor network.

K Liu *et al.* proposes [2] a new method for discovering the silent failures in WSN in December 2013. Because of WSN's distributive nature diagnosis in any field is become more crucial. Agnostic diagnosis is a new approach for online light weight failure detection.

Many existing diagnostic approaches are under observation. Silent failures are there always remain undetected. In AD , the correlation among metrics of each sensor node using a correlation graph. This graph is updated periodically using the nodes metrics if any changes occur in the network.

Silent failures could discover using a rule – based method and this is also a sink based framework and requires sinks to collect data from all the sensors. AD identifies anomalies both spatial and temporal domain. And different algorithms are used for both temporal and spatial detection. By using this AD we can reduce both energy consumption and detection delay.

Analysis and result: We analyse this by plot the graph for detection ratio and false alarm ratio for both injecting software bugs and ingress drops. Demerit of this approach is this cannot be used for distributive manner.

d) CGD-GA: A graph based genetic algorithm for sensor network design.

CGD-GA means coarse grain decomposition based genetic algorithm. Jassica A carballido proposes a new method [3] which is based on the definition of the individual's representation and also the design of a graph based function. Here the research field is recognized as a sensor network design which determines the type, amount and location of measuring some devices. This approach is mainly based on genetic algorithm which constitutes an initialization module of a decision support system for sensor network design.

A steady state mathematical model is a set of strongly non –linear algebraic equations, based on this equation system, the SND is designed. SND is usually carried out in two main analysis phases: they are observability and redundancy. Observability analysis (OA) provides information about the industrial processes and this information can be obtained from a mathematical model. And the redundancy analysis is mainly used for finding the redundancy degree to detect measurement errors.

Analysis and result: This algorithm improves the all other observability analysis algorithms in terms of cost, reliability and observability of overall performance. And the cost savings is about 60% and the time needed for completing the task is only 8 hours. It is very lesser as compared with all other previous observability analysis.

e) A ladder diffusion algorithm using ant colony optimization for wireless sensor network.

This paper is mainly proposes for solve the power consumption problems. The proposed ladder diffusion algorithm [4] employs to route paths for data transfer and transmission in wireless sensor networks, reducing both power consumption and processing time to build the routing table and simultaneously avoiding the generation of circle routes.

In the ladder diffusion algorithm has a ladder diffusion phase, which is a 5 stage process. In the first stage Sink node ''a'' broadcasts the ladder-creating package of grade one. Then in the next stage Sensor nodes ''b'' and ''c'' broadcast the ladder creating package of grade two after that in the next stage Sensor node ''b'', ''d'' and ''e'' broadcast the ladder creating package

of grade three in the next stage Sensor node ‘‘f’’ and ‘‘g’’ broadcast the ladder creating package of grade four And at last Ladder diffusion process terminates.

This creates a back up routing. Route is choose by using route choosing phase, it is also a 5 stage process they are initialization, fitness function ,walking phase , local updating and global updating. Thus this proposed algorithm is to ensure safety and reliability of data transmission, and also our algorithm provides back-up routes to avoid wasted power consumption and processing time, when rebuilding the routing table in the case that part of a sensor node is missing.

Analysis and result: This system reduces power consumption by 52.36% and also increases data forwarding efficiency by 61.11% as compared to the traditional directed diffusion algorithm. The evaluation results of this method show that the LD algorithm can effectively solve the problems related to data packet routing and energy consumption for wireless sensor networks. And one of the demerits of this method is in this approach more time taken for back up routes and this is used only for the missing nodes not for fault nodes.

f) Sensor node failure detection based on round trip delay and paths in wireless sensor network

Ravindra Navanath Duche and Nisha P. Sarwade proposes [6] a new method for detecting fault nodes based on round trip delay and paths. faulty sensor node is detected by measuring the round trip delay (RTD)[6] time of discrete round trip paths and comparing them with threshold value . Necessity of received signal strength measurement in cluster head variation and assigning separate wavelength for each link in other fault detection techniques are overcome here.

Here in the proposed method of fault detection is based on RTD[6] time measurement of RTPs. RTD times of discrete RTPs are compared with threshold time to determine the failed or malfunctioning sensor node in a wireless sensor network. Round trip delay time of the RTP will change due to fault 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. RTD time measurement and evaluation of RTPs is must to minimize the detection time.

RTD time comparison of discrete RTPs is sufficient to detect the faulty sensor node. Scalability of the method has been verified by implementing it to various WSNs. Efficiency of method is excellent in case of discrete RTPs with three sensor nodes.

Analysis and result: time taken for identifying fault node is optimized by using the round trip delay and round trip path calculation.

g) Fast Release/Capture Sampling in Large-Scale Sensor Networks

In this paper we develop a new novel protocol FLAKE [9] to efficiently estimate the global information of large scale wireless sensor networks. FLAKE spreading information of a small number of messages called seeds to the sensor network and issues a query about which nodes receive a seed. FLAKE can be implemented in distributive manner.

Fish-a-Lake protocol[9] employs a multicast algorithm called Bubble-geocast that expands the branches of seed Dissemination that is information spreading based on neighbourhood sizes. One of the advantage of this protocol is it can achieve provable accuracy in the spreading information.

FLAKE is designed based on the process of sampling. In the case of fault node discovery FLAKE is used for find out which nodes are active at the time of packet transferring as earlier as possible.

Analysis and result: As compared with earlier methods the error bound of this FLAKE is very lesser. That is 0.1 to 0.2.and the delay of FLAKE is increases when the error bound is decreases.

h) Hop by hop routing in wireless mesh network with bandwidth guarantees.

Here in this paper we study and [10] identify the problem of bandwidth path with quality of service issues. Here we introduce a new path which collects all the node bandwidth information. it guarantees the packet forwarding consistency.

In the case of fault node discovery hop by hop routing is used for identifying the bandwidth rate while packet data transmission. Here a left isotonicity property for proactive hop by hop protocol.

Analysis and result: The former algorithms for this packet transferring don't do well. But hop by hop routing algorithm identifies the problem and work according to the quality of services.

III. COMPARISON

Wireless sensor network is an emerging trend in computer science field. Fault nodes in network may create many problems such as data loss, time delay. So fault node recovery is an essential task in the case of wireless sensor network. Here we compare different parameters of traditional approaches. We compare energy efficient of different approaches, and the time required for fault node detection, and the cost required for each approaches. By comparing all these approaches we can seen that all the latest approaches such as hop by hop protocol and FLAKE protocol has less error rate and high energy savings efficiency and the time required for fault node detection also less.

Cost of traditional approaches such as ladder diffusion algorithm and direct diffusion algorithm is very high as compared with other approaches. And also here we compare the life time of nodes using different algorithms. By determining round trip path and round trip delay we can save more energy.

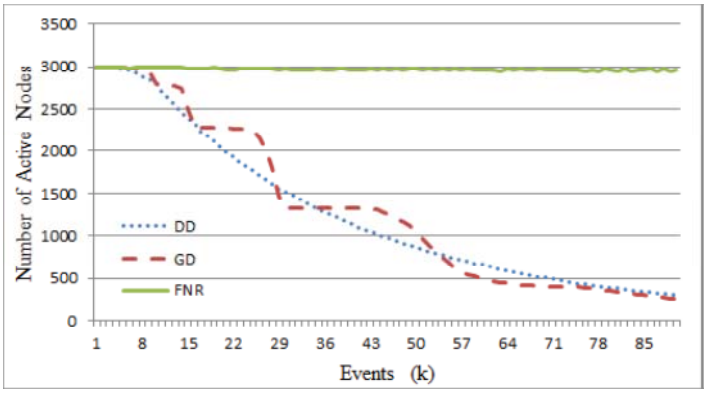

Fig . 1 . Number of active nodes

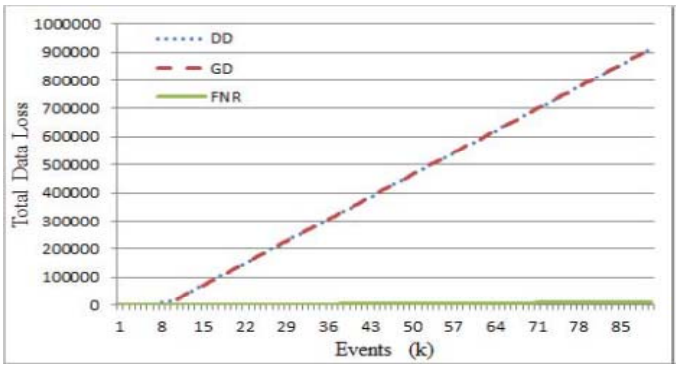

Fig . 2 . Total data loss.

DD – Directed Diffusion

GD - Grade Diffusion

FNR- Fault Node Recovery

TABLE 1

Sl No:	Title	Techniques Employed	Energy Efficiency	Time Required For Datapacket Transfer	Cost
1	Grade diffusion algorithm	Create routing for each node and find out neighbouring nodes.	29.5% energy savings	80.39% lesser time	medium cost
2	A ladder diffusion algorithm using ant colony optimization for wireless sensor network	Using ladder diffusion phase and routing	52.36% energy consumption	61.11% data forwarding	High cost
3	CGD-GA: A graph based genetic algorithm for sensor network design.	Based on genetic algorithm	Not mentioned	Lesser time needed	60% cost savings
4	An Enhancement Grade Diffusion Algorithm for composite event aggregation	Composite event aggregation	Reduce 52.82% energy consumption	Enhance life time 21.67%	Medium cost
5	Directed diffusion	Directed diffusion paradigm and its key features	Better energy savings	Not mentioned	High cost
6	Sensor node failure detection based on round trip delay and paths in wireless sensor network	Based on round trip delay and round trip path	Better energy savings	Time taken is optimized.	Medium cost
7	Hop by hop routing in wireless mesh network with bandwidth guarantees.	Bandwidth with QoS services	Optimal and consistent bandwidth	Satisfies QoS	Less cost
8	Fast Release/Capture Sampling in Large-Scale Sensor Networks	Fish-a-Lake protocol.	Not mentioned	Time delay decreases	Medium cost

IV. CONCLUSION

This paper is about the literature survey of fault node recovery algorithms in wireless sensor network. Different methods are used for the replacement of fault nodes. This paper deals with some of the different fault diagnosis methods in wireless sensor network. And also discuss about the different algorithms used for the same purpose. By analyzing all these algorithms i can conclude that each of these identifies only the fault for the first time but it may take more time. If we identify which nodes are active and then identify which can receive data packet first. By doing this we can save time. And also reduce the time taken for fault node recovery.

References

1. Hong-Chi Shih, Jiun-Huei Ho, Bin-Yih Liao, and Jeng-Shyang Pan," An Enhancement Grade Diffusion Algorithm for Composite Event Aggregation".
2. Xin Miao, Kebin Liu, Yuan He, Dimitris Papadias, Qiang Ma, and Yunhao Liu, " Agnostic Diagnosis: Discovering Silent Failures in Wireless Sensor Networks", IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS, VOL. 12, NO. 12, DECEMBER 2013.
3. Jessica A. Carballido , Ignacio Ponzoni a,b, Ne´lida B. Brignole , "CGD-GA: A graph-based genetic algorithm for sensor network design", SCIENCE DIRECT.
4. Jiun-Huei Ho, Hong-Chi Shih b, Bin-Yih Lia, Shu-Chuan Chu, "A ladder diffusion algorithm using ant colony optimization for wireless sensor networks" SCIENCE DIRECT.
5. Chalermek Intanagonwiwat, Ramesh Govindan, Deborah Estrin, John Heidemann," Directed Diffusion for Wireless Sensor Networking", IEEE/ACM TRANSACTIONS ON NETWORKING, VOL. 11, NO. 1, FEBRUARY 2003
6. Ravindra Navanath Duche and Nisha P. Sal wade, "Sensor Node Failure Detection Based On Round Trip Delay and Paths in WSNs", IEEE SENSORS JOURNAL, VOL. 14, NO. 2, FEBRUARY 2014
7. Feng-Cheng Chang a, Hsiang-Cheh Huang b,* "A refactoring method for cache-efficient swarm intelligence algorithms," Information Sciences 192 (2012) 39–49.
8. Yangyang Wang1,2, Xiaoling Wu1*, Jin Wang3, Weiping Liu2 , Weimin Zheng1 An improved routing protocol based on OVSF code transmission in wireless sensor networks.
9. Shaoliang Peng, Member, IEEE, Guoliang Xing, Member, IEEE,,Shanshan Li, Weijia Jia, Senior Member, IEEE, and Yuxing Peng "Fast Release/Capture Sampling in Large-Scale Sensor Networks"IEEE TRANSACTIONS ON MOBILE COMPUTING, VOL. 11, NO. 8, AUGUST 2012
10. Ronghui Hou, Member, IEEE, King-Shan Lui, Senior Member, IEEE, Fred Baker, and Jiandong Li, Senior Member, IEEE" Hop-by-Hop Routing in Wireless Mesh Networks with Bandwidth Guarantees" 264 IEEE TRANSACTIONS ON MOBILE COMPUTING, VOL. 11, NO. 2, FEBRUARY 2012
11. Arunanshu Mahapatro and Pabitra Mohan Khilar "Fault Diagnosis in Wireless Sensor Networks".A Survey IEEE COMMUNICATIONS SURVEYS & TUTORIALS, VOL. 15, NO. 4, FOURTH QUARTER 2013.
12. Ameer Ahmed Abbasi, Mohamed Younis, Senior Member, IEEE, and Kemal Akkaya, Member, IEEE." Movement-Assisted Connectivity Restoration in Wireless Sensor and Actor Networks" IEEE TRANSACTIONS ON PARALLEL AND DISTRIBUTED SYSTEMS, VOL. 20, NO. 9, SEPTEMBER 2009

