OPTIMIZED SENSOR NODES BY FAULT NODE RECOVERY ALGORITHM

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Abstract

This paper proposes fault node recovery algorithm to enhance the lifetime of wireless sensor networks when some of the sensor nodes shut down due to absence of battery power. The proposed algorithm combined Grade diffusion algorithm with genetic algorithm. The algorithm can result replacement of fewer sensor nodes and more reused routing paths. The proposed algorithm increases the number of active nodes, reduces dataloss during transmission, and reduces energy consumption.

Keywords: *Wireless Sensor Networks, Energy Consumption, Fault Node Recovery.*

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1. INTRODUCTION

The Sensor networks are mainly used in fields such as Scientific, Military, Healthcare applications. However Sensor size represents a significant limitation mainly in terms of energy and their life period, for the batteries have to be too tiny. This is the reason why intensive research is being conducted nowadays on how to control sensor energy consumption within network. However power sources in sensor node limit life time of whole system. A sensor Network with Distributed system made up with large number of small sensors, equipments, transmitters and receivers. One of the major problems in these networks is to reduce energy and enhance lifetime of networks. Energy is an important factor important in Wireless Sensor Networks.

This paper proposed Fault Node Recovery algorithm to enhance the lifetime of a wireless sensor network (WSN).when some of the sensor nodes shut down, either because they no longer have battery energy or they have reached their operational threshold. Using the FNR algorithm can result in fewer replacements of sensor nodes and more reused routing paths. Thus, the algorithm not only enhances the WSN lifetime but also reduces the cost of replacing the sensor nodes.

2. RELATED WORKS

The traditional approaches to sensor network routing include the Fault Node Recovery (FNR) algorithm. FNR combines both Grade Diffusion (GD) with Genetic Algorithm (GA) The algorithm proposed in this paper is based on Fault Node Recovery algorithm (FNR). These optimizations will enhance WSN lifetime and reduce replacement cost.

2.1 Directed Diffusion Algorithm

The goal of DD algorithm is to reduce the data relay transmission for power management. The DD algorithm is an query driven transmission protocol. The collected data is transmitted only if it matches the query from the sink node. In the DD algorithm, the sink node provides the queries in the form of attribute-value pairs to the other sensor nodes by broadcasting the query packets to the whole network. Subsequently, the sensor nodes send the data back to the sink node only when it fits the queries.

2.2 Grade Diffusion Algorithm

The Grade Diffusion (GD) algorithm not only creates the routing for each sensor node but also identifies a set of neighbour nodes to reduce the transmission loading. Each sensor node can select a sensor node from the set of neighbour node by using Grade tables. The GD algorithm can select a node with more available energy than the other nodes to perform relay operation. A grade diffusion algorithm is proposed to solve the sensor node's transmission problem and the sensor node's loading problem. In addition to them, the sensor node also can save some backup nodes to reduce energy consumption for re-looking routing. By using this method more than one sensor node's detect the same event is also possible.

2.3 Genetic Algorithm

Genetic Algorithm based on 5 steps namely Initalization, Evaluation, Selection, CrossOver, Mutation. The initial population of candidate solution is generated randomly in this step. In evaluation the fitness value of the candidate solutions are evaluated. In selection method select higher fitness value. In cross over step combines two or more parental solutions to create new offsprings. Mutation randomly modifies a solution.The sensor routing paths are shown in Fig. 1. In Fig. 2, the situation in which the outside nodes transfer event data to the sink node via the inside nodes (the sensor nodes near the sink node) in a WSN illustrate the accommodation measures for

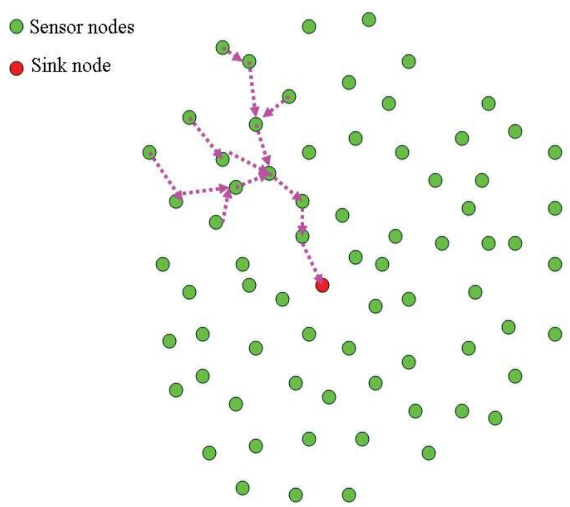

Fig. 1.Wireless sensor node routing

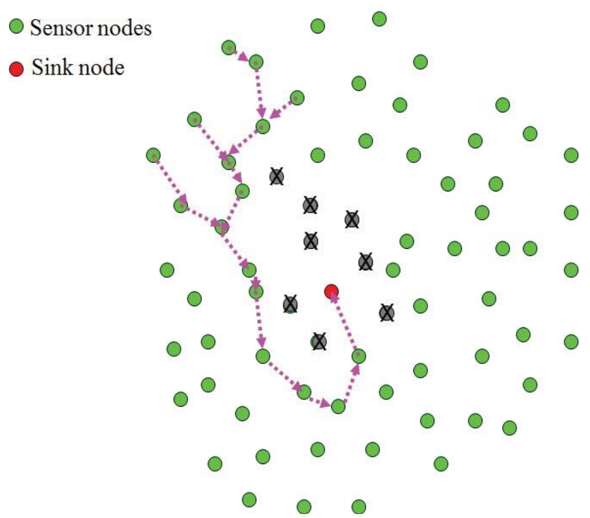

Fig. 2. Wireless sensor node routing path when some nodes are not functioning.

In Fig. 2, the situation in whichthe outside nodes transfer event data to the sink node via the inside nodes (the sensor nodes near the sink node) in a WSN illustrate the accommodation measures for non-working nodes. The inside nodes thus have the largest data transmission loading, consuming energy at a faster rate. If all the inside nodes deplete their energy or otherwise cease to function, the event data can no longer be sent to the sink node, and theWSN will no longer function.

2.4. Fault Node Recovery Algorithm:

This paper proposes a Fault Node Recovery(FNR) algorithm for WSNs based on the Grade Diffusion algorithm combined with Genetic algorithm. The FNR algorithm creates the grade value, routing table, neighbour nodes, and payload value for each sensor node using Grade Diffusion algorithm. The sensor nodes transfer the event data to the sink node according to the GD algorithm when events appear. Then is calculated according to in the FNR algorithm The algorithm will be invoked and replace non functioning sensor nodes by functioning nodes selected by the Genetic algorithm.

The power consumption of the sensor nodes in WSN's are unavoidable. However this paper proposes an algorithm to search for and replace fewer sensor nodes and to reuse the most routing paths. The current paper proposes a Partial Scram Optimization algorithm based on.

3. PROPOSED SYSTEM

This paper proposes a fault node recovery (FNR) algorithm for WSNs based on the grade diffusion algorithm combined with the genetic algorithm. The flow chart is shown in Fig. 3. The FNR algorithm creates the grade value, routing table, neighbor nodes, and payload value for each sensor node using the grade diffusion algorithm. In the FNR algorithm, the number of nonfunctioning sensor nodes is calculated during the wireless sensor network operation, and the parameter B is calculated .In Fig. 3, the FNR algorithm creates the grade value, routing table, a set of neighbor nodes, and payload value for each sensor node, using the grade diffusion algorithm.

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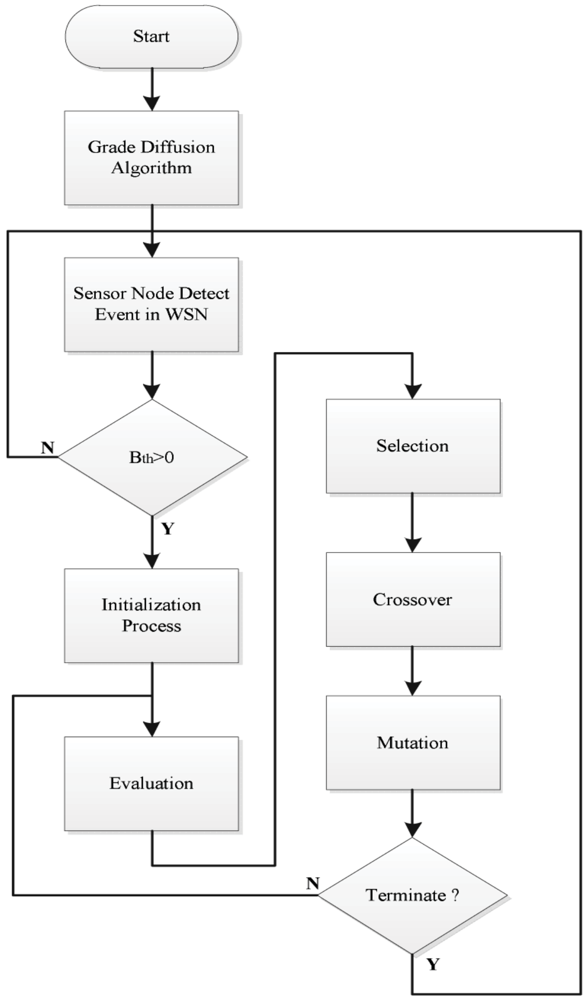


Fig. 3.System Architecture

3.1 Initialization

In the initialization step, the genetic algorithm generates chromosomes, and each chromosome is an expected solution. The number of chromosomes is determined according to the population size, which is defined by the user. Each chromosome is a combination solution, and the chromosome length is the number of sensor nodes that are depleted or nonfunctioning. The elements in the genes are either 0 or 1. A 1 means the node should be replaced, and a 0 means that the node will not be replaced.Fig. 4 represents a chromosome. The chromosome length is 10 and the gene is 0 or 1, chosen randomly in the initialization step. In this case, there are 10 sensor nodes not functioning, and their node numbers are 9, 7, 10, 81, 23, 57, 34, 46, 66, and 70.

9	7	10	81	23	57	34	46	66	70
0	0	1	0	1	1	0	1	1	0

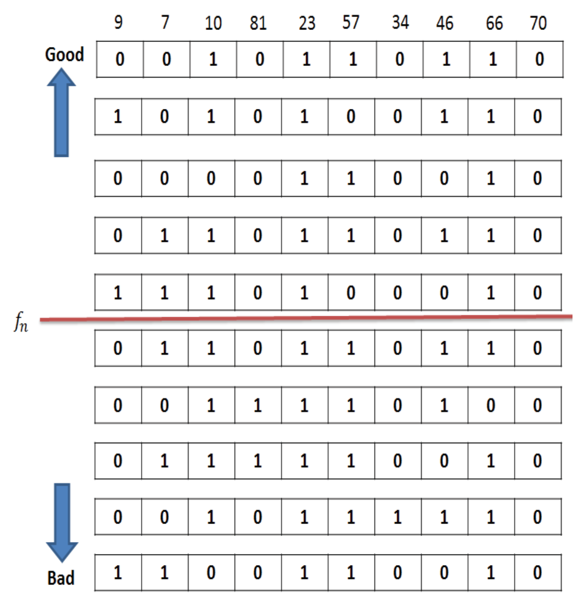
Fig. 4.Chromosome and its gene

3.2 Evaluation

In general, the fitness value is calculated according to a fitness function, and the parameters of the fitness function are the chromosome's genes. However, we cannot put genes directly into the fitness function in the FNR algorithm, because the genes of the chromosome are simply whether the node should be replaced or not. In the FNR algorithm, the goal is also to reuse the most routing paths and to replace the fewest sensor nodes. Hence, the number of routing paths available if some nonfunctioning sensor nodes are replaced is calculated.

3.3 Selection

The selection step will eliminate the chromosomes with the lowest fitness values and retain the rest. We use the elitism strategy and keep the half of the chromosomes with better fitness values and put them in the mating pool. The worse chromosomes will be deleted, and new chromosomes will be made to replace them after the crossover step. The process is showninFig.5.



9	7	10	81	23	57	34	46	66	70
0	0	1	0	1	1	0	1	1	0
1	0	1	0	1	0	0	1	1	0
0	0	0	0	1	1	0	0	1	0
0	1	1	0	1	1	0	1	1	0
1	1	1	0	1	0	0	0	1	0
0	1	1	0	1	1	0	1	1	0
0	0	1	1	1	1	0	1	0	0
0	1	1	1	1	1	0	0	1	0
0	0	1	0	1	1	1	1	1	0
1	1	0	0	1	1	0	0	1	0

Fig. 5 Selection step.

3.4 Cross Over

The crossover step is used in the genetic algorithm to changethe individual chromosome. In this algorithm, we use the one-point crossover strategy to create new chromosomes.Two individual chromosomes are chosen from the mating pool to produce two new offspring. A crossover point is selected between the first and last genes of the parent individuals. Then, the fraction of each individual on either side of the crossover point is exchanged and concatenated. The rate of choice is made according to roulette-wheel selection and the fitness values.

3.5 Mutation

The mutation step can introduce traits not found in the original individuals and prevents the GA from converging too fast. In this algorithm, we simply flip a gene randomly in the chromosome, as shown in Fig.6. The chromosome with the best fitness value is the solution after the iteration. The FNR algorithm will replace the sensor nodes in the chromosome with genes of 1 to extend the WSN lifetime.

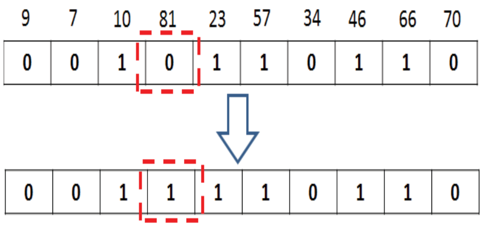


Fig. 6 Mutation step.

4. SIMULATION

A simulation of the fault node recovery algorithm as described in Section 3 was performed to verify the method.The experiment was designed based on 3-D space, using 100 × 100 × 100 units, and the scale of the coordinate axis for eachdimension was set at 0 to 100. The radio ranges (transmissionrange) of the nodes were set to 15 units. In each of thesesimulations, the sensor nodes were distributed uniformly overthe space. There are three sensor nodes randomly distributedin 10 × 10 × 10 space, and the Euclidean distance is atleast 2 units between any two sensor nodes. Therefore, thereare 3000 sensor nodes in the 3-D wireless sensor networksimulator, and the center node is the sink node. The FNR, DD, and GD algorithms were implemented. The active sensor nodes and total data loss after 90000 events are shown in Figs.7 and 8. The active nodes mean that the sensor node has enough energy to transfer data to other nodes. The FNR, DD, and GD algorithms were implemented. The active sensor nodes and total data loss after 90 000 events are shown in Figs.7 and 8. The active nodes mean that the sensor node has enough energy to transfer data to other nodes, but some sensor nodes can be deleted from the active nodes list if their routing tables do not have a sensor node that can be used as a relay node, algorithms because the algorithm can replace the sensor nodes after the number of nonfunctioning nodes exceeds the threshold,by using the GA algorithm. In Fig. 8, the FNR algorithm exhibits smaller data losses because the algorithm can replace fewer sensor nodes and reuse more routing paths if the number of sensor nodes that are nonfunctioning exceeds the threshold. After the simulation, the FNR algorithm had only suffered 11 025 data losses, but the DD and GD algorithm had suffered 912 462 and 913 449 data losses. This new algorithm can reduce data loss by 98.8% compared to the traditional algorithms.

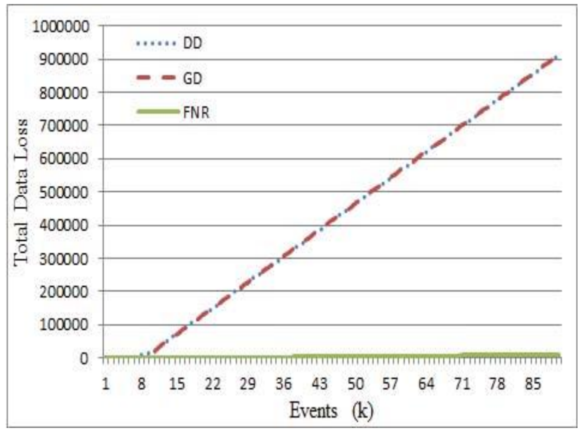


Fig. 7.Number of active nodes

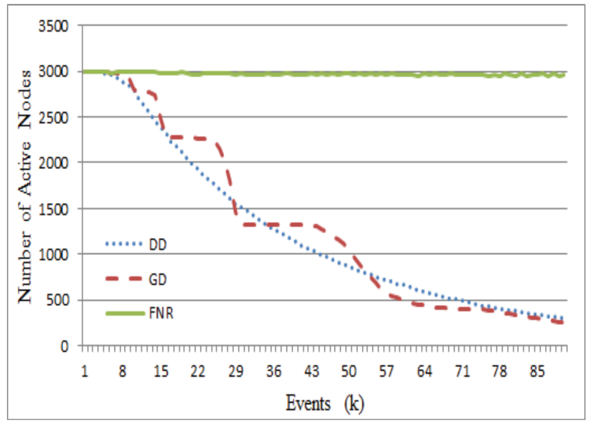


Fig. 8 Total data loss

Fig. 9 compares the average energy consumption of a WSN managed using the FNR algorithm to the average energy consumption using the DD and GD algorithms. The DD and GD algorithms allow the WSN to consume more energy after 8 000 events because the inside nodes are energy-depleted, but the outside nodes continue to attempt to transfer event data to the sink node through the inside nodes until they are also energy-depleted. After 90 000 events, the DD and GD algorithm-managed WSNs had consumed 3495.17 Ws and 3298.29 Ws, respectively. The proposed algorithm increases the WSN lifetime by replacing some of the sensor nodes that are not functioning. In addition to enhancing the active nodes and reducing the data losses, the FNR algorithm reduces the relayed energy consumption by reducing the number of data relayed, as the replaced sensor nodes are usually used the most. After 90 000 events, using the proposed algorithm, the WSN had consumed only 2407.68 Ws, and, compared to using the DD and GD algorithms, exhibited a reduction in energy consumption of 31.1% and 27%, respectively.

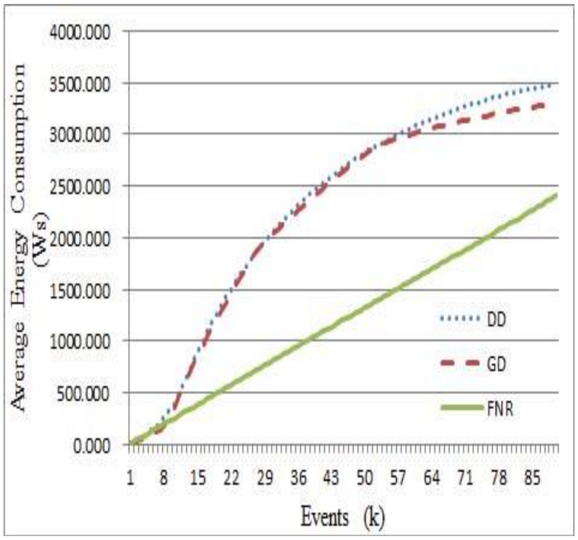


Fig. 9. Average energy consumption

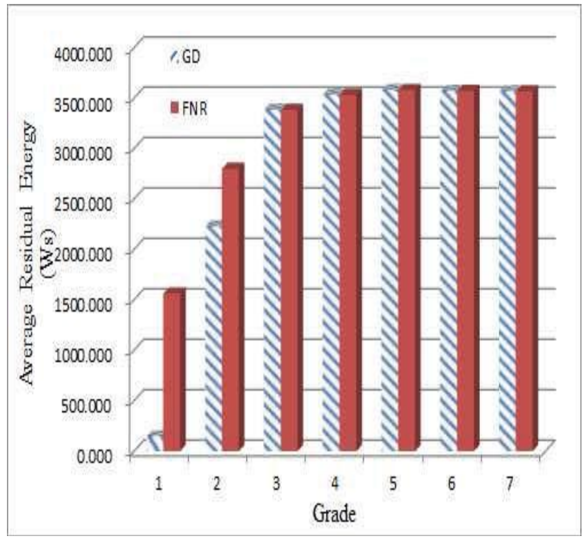


Fig. 11.Average residual energy after 8000 events

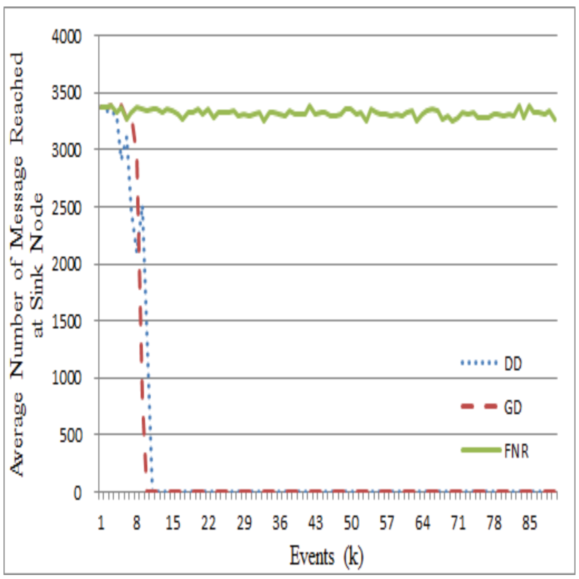


Fig. 10. Average number of messages reaching the sink node

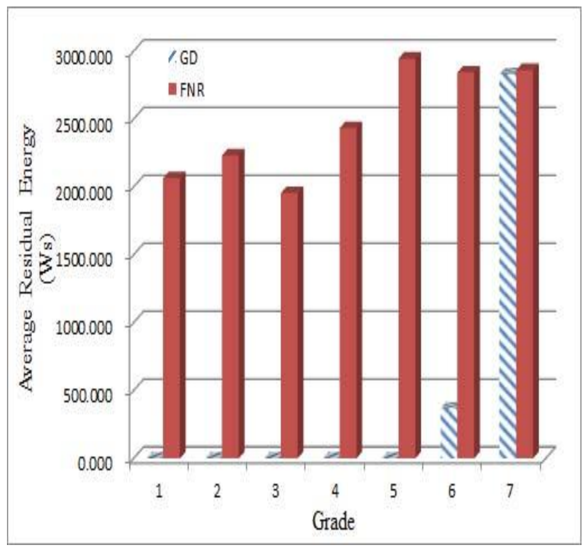


Fig.12 Average residual energy after 90000 events

The average number of messages that reach the sink node when each algorithm manages the network is compared inFig. 10. Using the traditional DD and GD algorithms, the sink node can receive no messages after 8000 events because all of the inside nodes are energy-depleted, and the WSN lifetime is ended. This proposed algorithm replaces energy-depleted sensor nodes to increase the WSN lifetime. Therefore, the average number of messages received using this algorithm is higher than when using the other algorithms.By using this algorithm, the sensor nodes are not onlyreplaced, but the replacement cost is reduced, and more routing paths are reused.

In Fig. 11, using the GD algorithm, after 8000 events the grade 1 sensor nodes only have 145.57 Ws energy remaining, and the other grade sensor nodes still have enough energy to function. Using the FNR algorithm, the grade 1 sensor nodes still have 1568.34 Ws. The grade 1 sensor nodes are near the sink node, and they are relay nodes for the other grade sensor nodes, so they consume their energy rapidly. The FNR algorithm can replace some of the energy-depleted sensor nodes. Hence, the available sensor nodes are more numerous than when using the traditional algorithms. In Fig. 12, the average energy consumption for each grade is calculated after 90 000 events. Using the GD algorithm, the sensor nodes consume their energy rapidly because they try to transfer event data to the sink node using neighbor nodes if the grade 1 sensor nodes are energy-depleted or their routing table is empty. The FNR algorithm has ample energy for each grade sensor node because the algorithm can replace the sensor nodes, but it reuses more routing paths compared to using the traditional algorithm.

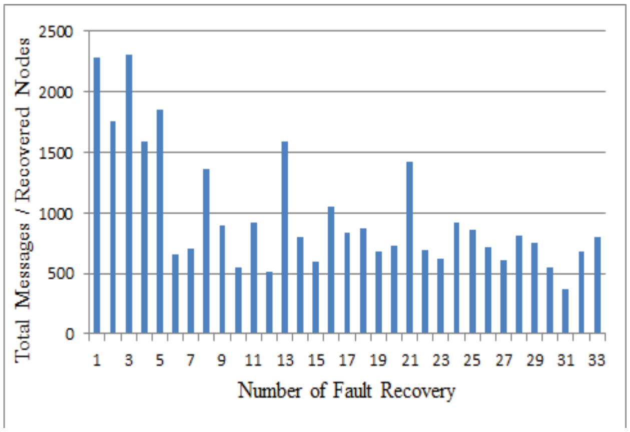


Fig. 13. Rate of total messages to recovery nodes

The FNR algorithm tends to replaces Grade 1 sensor nodes in the first place, since the loading of the Grade 1 sensor nodes is larger than the loading of others.

5. CONCLUSIONS AND FUTURE WORK

In real wireless sensor networks, the sensor nodes use battery power supplies and thus have limited energy resources. In addition to the routing, it is important to research the optimization of sensor node replacement, reducing the replacement cost, and reusing the most routing paths when some sensor nodes are nonfunctional. This paper proposes a fault node recovery algorithm for WSN based on the grade diffusion algorithm combined with a genetic algorithm. The FNR algorithm requires replacing fewer sensor nodes and reuses the most routing paths, increasingthe WSN lifetime and reducing the replacement cost. In the simulation, the proposed algorithm increases the number of active nodes up to 8.7 times.

The number of active nodes is enhanced 3.16 times on average after replacing an average of 32 sensor nodes for each calculation. The algorithm reduces the rate of data loss by approximately 98.8% and reduces the rate of energy consumption by approximately 31.1%. Therefore, the FNR algorithm not only replaces sensor nodes, but also reduces the replacement cost and reuses the most routing paths to increase the WSN lifetime. It is of great interest to extend our approach to handle Energy Efficiency in WSN. As with most existing work on Fault Node Recovery Algorithm. Our work is limited in the sense that its consider only. More powerful adversaries may apply Partial Scram Optimization algorithm. Studying the Partial Scram Optimization under this adversarial model is an interesting future direction.

REFERENCES

[1] T. H. Liu, S. C. Yi, and X. W. Wang, “A fault management protocol for low-energy and efficient wireless sensor networks,” *J. Inf. Hiding Multimedia Signal Process*., vol. 4, no. 1, pp. 34–45, 2013.

[2] C. Intanagonwiwat, R. Govindan, D. Estrin, J. Heidemann, and F. Silva,“Directed diffusion for wireless sensor networking,” IEEE/ACM *Trans.Netw*., vol. 11, no. 1, pp. 2–16, Feb. 2003.

[3] E. M. Royer and C. K. Toh, “A review of current routing protocols for ad-hoc mobile networks,” IEEE *Personal Commun*., vol. 6, no. 2,pp. 46–55, Apr. 1999.

[4] H. C. Shih, S. C. Chu, J. Roddick, J. H. Ho, B. Y. Liao, and J. S. Pan,“A reduce identical event transmission algorithm for wireless sensor networks,” *in Proc. 3rd Int. Conf. Intell. Human Comput.Interact.*,2011, pp. 147–154.

[5] Z. He, B. S. Lee, and X. S. Wang, “Aggregation in sensor networks with a user-provided quality of service goal,” *Inf. Sci*., vol. 178, no. 9, pp. 2128–2149, 2008.

[6] S. Corson and J. Macker, Mobile Ad Hoc Networking (MANET): *Routing Protocol Performance Issues and Evaluation Considerations*.NewYork,NY, USA: ACM, 1999.

[7] J. H. Ho, H. C. Shih, B. Y. Liao, and S. C. Chu, “A ladder diffusion algorithm using ant colony optimization for wireless sensor networks,” *Inf. Sci*., vol. 192, pp. 204–212, Jun. 2012.

[8] J. Broch, D. A. Maltz, D. B. Johnson, Y.-C.Hu, and J. Jetcheva A Performance Comparison of Multi-Hop Wireless Ad-Hoc Network Routing Protocols.In *Proceedings of the Fourth Annual ACM/IEEE International Conference on Mobile Computing and Networking (Mobicom’98), Dallas*, TX, 1998.

[9] M. Perillo, and W. B. Heinzelman, Providing application QoS throughintelligent sensor management, Proc. of the 1st IEEE International Workshop *on Sensor Network Protocols and Applications*, pp. 93-101, 2003.