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## An Error Node Regaining Algorithm with Compressive Sensing For Wireless Sensor Networks

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**ABSTRACT:** The error node regaining algorithm is to enhance the lifetime of a wireless sensor network when some of the sensor nodes shut down. Generally wireless sensor node is equipped with low power batteries which are infeasible to recharge. Wireless sensor networks should have enough energy to fulfil the desired requirements of applications. So we propose an algorithm to increase the life time of wireless sensor networks. This algorithm is used to search for and replace fewer sensor nodes and to reuse the most routing paths. Error node regaining algorithm is based on the concept of natural genetic algorithm (GA) which combined with grade diffusion algorithm. It forms the routing table, fellow nodes and load value for each sensor using the GD algorithm. Genetic algorithm will calculate the sensor nodes to replace, reuse the most available routing paths to replace fewest sensor nodes. The energy efficient routing of wireless sensor nodes will lead to sink node mobility and put some sensor node with less residual energy to sleep states. The efficiency of the energy can be enhanced by the spare or compressive sensing feature. This technique is very useful for wireless sensor network with a smaller coverage area.

**KEYWORDS:** Genetic Algorithm, Grade Diffusion Algorithm, Energy Efficiency, Sink Mobility, Sensing Features, Sleep States, Wireless Sensor Networks.

### I. INTRODUCTION

Latest techniques in micro processing, wireless and battery technology and smart sensors have enriched data processing, wireless communication and detection skill. In sensor networks, each sensor node has some degree of wireless computational power to process and transfer the live data to the data collection centre. They are prepared with low cost small capacity batteries which are, non-rechargeable and irreplaceable. Hence, network lifetime is considered as important issues for many applications. Several routing algorithms for the wireless sensor network have been sequentially proposed in recent years. A base station has a higher energy budget than the ordinary sensor nodes because the base station performs the final information aggregation and extraction tasks.

This paper proposes an error node regaining algorithm for improving the lifespan of the wireless sensor networks. Lifespan of WSN decreases, either because the sensor nodes no longer have sufficient energy or they have reached their threshold. Implementation of an error node regaining algorithm results in lesser substitutions of sensor nodes. The compact sensing method has been implemented with the error node regaining algorithm to increase the energy efficiency, network lifetime and also reduces the cost of substituting the sensor nodes.

The WSN may fail due to a variety of causes, including the following: the routing path might experience a break, the WSN sensing area might experience a leak, the batteries of some sensor nodes might be depleted, requiring more relay nodes or the nodes wear out after the WSN has been in use a long period of time. Sensor nodes are usually scattered in a sensor field, which is an area where the sensor nodes are deployed. Sensor nodes coordinate among themselves to produce high-quality information about the physical environment.

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Each sensor node bases its decisions on its mission, the information it currently has, and its knowledge of its computing, communication, and energy resources. The power consumption of the sensor nodes in WSNs is unavoidable. This paper, however, proposes an algorithm to search for and replace fewer sensor nodes and to reuse the most routing paths.

## II. RELATED WORKS

Wireless sensor networks have many characteristics for their routing protocols. Some algorithms of Wireless sensor networks are analysed here.

1. **Sensing range-** Every sensor node in the network has a particular sensor range and it can transmit its packet in that particular range. Sensing range of the node is restricted to certain radius which cause coverage problem. To enhance the coverage of the sensor node, sensor nodes having large sensing range get used but this sensor node cost high. The issue of coverage arise due to random deployment of nodes. Due to random deployment of nodes sometimes nodes get deployed very close to each other and sensing range or coverage of the nodes get overlapped. So to remove this issue deterministic deployment of sensor nodes should be done.
2. **Data aggregation-** Sensor nodes may generate redundant data; similar packets from multiple sensor nodes get aggregated (gathered) to reduce the number of transmissions. Data aggregation is the combination of data from different sources according to a certain aggregation function. Aggregation functions are duplicate suppression, minima, maxima, and average. This technique has been used to achieve energy efficiency and data transfer optimization in a number of routing protocols. Signal processing methods can also be used for data aggregation. In this case, it is referred to as data fusion where a node is capable of producing a more correct output signal by using some techniques such as beam forming to combine the incoming signals and reducing the noise in these signals.
3. **Scalability-** The number of sensor nodes deployed in the sensing area is in huge number. Any routing scheme must be able to work with this huge number of sensor nodes. In addition, sensor network routing protocols should be scalable to respond to events in the environment. Until an event occurs, most sensors can remain in the sleep state, with data from the few remaining sensors providing coarse quality.
4. **Node deployment-** Node deployment in WSNs is application-dependent and can be either deterministic or non-deterministic (randomized). In deterministic deployment, the sensor nodes are manually placed and data is routed through predetermined paths. However, in random node deployment, the sensor nodes are scattered randomly, creating an ad hoc routing infrastructure. If the resultant distribution of sensor nodes is not uniform, optimal clustering becomes necessary to allow connectivity and enable energy-efficient network operation. Inter sensor communication is normally within short transmission ranges due to energy and bandwidth limitations. Therefore, it is most likely that a route will consist of multiple wireless hops.
5. **Energy consumption without losing accuracy-** Wireless Sensor nodes can use up their limited supply of energy performing computations and transmitting information and data in a wireless environment. As such, energy-conserving forms of communication and computation are essential. Sensor node lifetime shows a strong dependence on battery lifetime. In a multihop WSN, each node plays a dual role as data sender and data router. The malfunctioning of some sensor nodes due to power failure can cause significant topological changes, and might require rerouting of packets and reorganization of the network.
6. **Quality of service-** In some applications of sensor environment, data should be delivered within a certain period of time from the moment it is sensed, or it will be useless. Therefore, bounded latency for data delivery is another condition for time-constrained applications. However, in many applications, conservation of energy, which is directly related to network lifetime, is considered relatively more important than the quality of data sent. As energy is depleted, the network may be required to reduce the quality of results in

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order to reduce energy dissipation in the nodes and hence lengthen the total network lifetime. Hence, energy-aware routing protocols are required to capture this requirement.

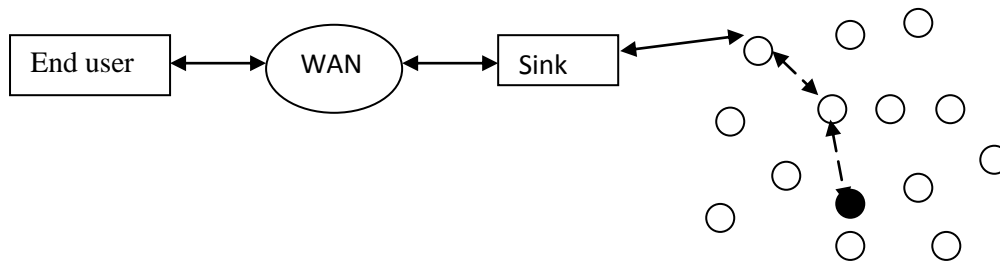


Fig. 1 Wireless sensor networks

The basic approaches to sensor network routing include the directed diffusion algorithm and the grade diffusion algorithm. This paper proposes an energy efficient routing algorithm which is based on the GD algorithm combined with Genetic algorithm with the main goal of replacing fewer sensor nodes that are inoperative or have depleted batteries and of reusing the maximum number of routing paths. This optimization will ultimately enhance the wireless sensor network life time and reduce sensor node replacement cost.

C. Intanagonwiwat et al. presented the Directed Diffusion(DD) algorithm in 2003. The goal of the DD algorithm is to reduce the data relay transmission counts for power management. The DD algorithm is a 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.

A ladder diffusion algorithm is proposed using ant colony optimization for wireless sensor networks to tackle the routing and energy consumption issues. Additionally, the LD-ACO algorithm enhances the sensor node's lifetime. The LD algorithm makes the ladder table in every sensor node dependent upon the whole wireless sensor network by issuing the ladder in create paper that is made from the sink node. After the ladder diffusion process, they proposed an ant colony optimization algorithm to balance the data transmission burden, increasing the life time of sensor nodes.

● Sink node

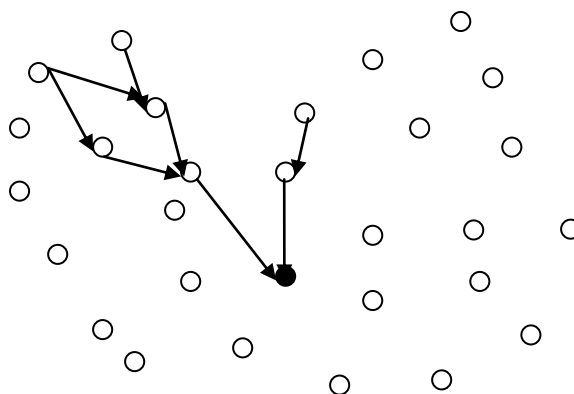


Fig. 2 Wireless sensor node routing

# International Journal of Innovative Research in Science, Engineering and Technology

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The grade diffusion algorithm is used to improve the LD algorithm using ant colony optimization for wireless sensor networks. The 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 nodes when its grade table lacks a node able to perform the relay. The GD algorithm can also record some information regarding the data relay. Then, a sensor node can select a node with a lighter loading or more available energy than the other nodes to perform the extra relay operation. That is, GD algorithm updates the routing path in real time and the occasion data is consequently sent to sink node rapidly and efficiently.

### III. ERROR NODE REGAINING ALGORITHM

Error node regaining algorithm for WSNs based on the grade diffusion algorithm combined with the genetic algorithm. Error node regaining algorithm creates the grade value, routing table, neighbour nodes, and payload value for each sensor node using the grade diffusion algorithm. In the Error node regaining algorithm, the number of non-functioning sensor nodes is calculated during the wireless sensor network operation, and the parameter  $B_{th}$  is calculated. The ENR algorithm creates the grade value, routing table, a set of neighbour nodes, and payload value for each sensor node, using the grade diffusion algorithm. The sensor nodes transfer the event data to the sink node according to the GD algorithm when events appear. Then,  $B_{th}$  is calculated according to in the ENR algorithm. If  $B_{th}$  is larger than zero, the algorithm will be invoked and replace non-functioning sensor nodes by functional nodes selected by the genetic algorithm. Then the wireless sensor network can continue to work as long as the operators are willing to replace sensors grade is the sensor node's grade value. The variable  $N_{original}$  is the number of sensor nodes with the grade value  $i$ .

$$B_{th} = \sum_{i=1}^{\max\{grade\}} T_i \quad \text{Equation (1)}$$

$$T_i = \begin{cases} 1, & \frac{N_i^{NOW}}{N_i^{original}} < \beta \\ 0, & otherwise \end{cases} \quad \text{Equation (2)}$$

Then, the algorithm will calculate the sensor nodes to replace using the genetic algorithm. The parameters are encoded in binary string and serve as the chromosomes for the GA. The elements (or bits), i.e., the genes, in the binary strings are adjusted to minimize or maximize the fitness value. The fitness function generates its fitness value, which is composed of multiple variables to be optimized by the GA. At each iteration of the GA, a predetermined number of individuals will produce fitness values associated with the chromosomes. There are 5 steps in the genetic algorithm: Initialization, Evaluation, Selection, Crossover, and Mutation. Descriptions of the steps follow.

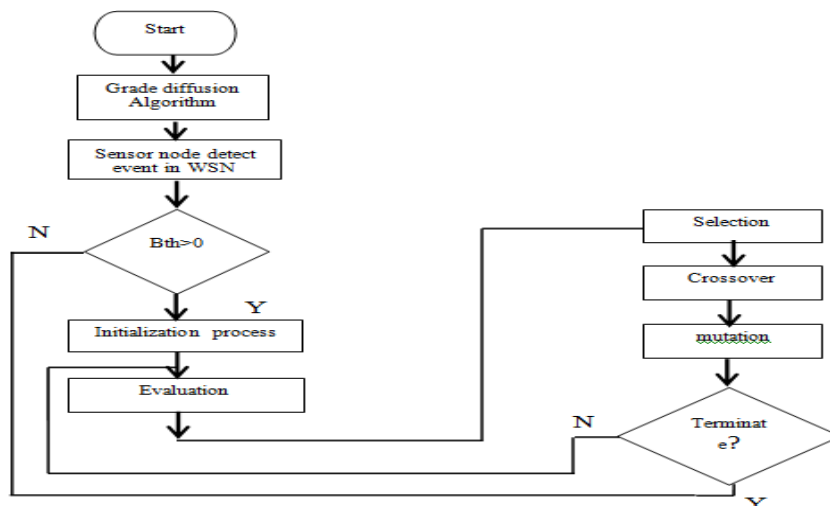


Fig. 3 Flowchart of Error node regaining algorithm

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

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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 non-functioning. 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. The chromosome length is 10 and the gene is 0 or 1, chosen randomly in the initialization step.

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

Fig.4 chromosomes and its gene

- 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 ENR algorithm, because the genes of the chromosome are simply whether the node should be replaced or not. In the ENR 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 non-functioning sensor nodes are replaced is calculated.
- 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.

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

Fig. 5 selection steps

4. Crossover- The crossover step is used in the genetic algorithm to change the 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.

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. The

# International Journal of Innovative Research in Science, Engineering and Technology

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chromosome with the best fitness value is the solution after the iteration. The ENR algorithm will replace the sensor nodes in the chromosome with genes of 1 to extend the WSN lifetime.

## IV. COMPRESSIVE SENSING AND MODEL EVALUTION

There are many studies on application of compressive sensing theory on wireless sensor networks. In several random routing methods for wireless sensor networks exploiting compact sense base measurement techniques are proposed. The proposed methods technology compressibility of the signal to reduce the amount of acquired data. In CS based data collection algorithm for wireless sensor networks is proposed. This analysis of the Compressive sense accurately recovers data from a small amount of compressed data. This is very useful in recover a random packet loss caused by collisions.

A sensor acquires the signal at least at its Nyquist rate for proper reconstruction. It is done by solving optimization problems, using linear programming and global optimal solution is achieved. The base station consumer more energy than the ordinary sensor nodes. The base station must know the measurements matrix of the wireless sensor networks to solve the optimization problem. The measurement matrix does not change through the lifetime of the wireless sensors, hence the sensor nodes can be preloaded with this data before deployment. Instead of that this matrix can be transmitted to the sensor nodes by the base station. However, the data dissemination is not frequent, and thus, does not lead to any significant energy consumption.

In the area of WSNs, energy efficient routing protocols has been always a hot research area but the mobility factor is not addressed in an appropriate level as it is evident that majority of the routing protocols assumes the nodes to be static. But we can find that in most of the applications where wireless sensor networks are involved like disaster applications or medical care etc., the nodes can be mobile. So mobility of the nodes i.e. either the source or the sink has to be considered. Literature has shown that mobile sink assisted routing helps to reduce energy consumption to a great extent. Hence we thought of developing an energy efficient routing algorithm which is supported by the mobility of multiple sinks. Movement of the mobile sinks can be decided by the static sink. As the nodes are assumed to be deployed randomly every time, in order to have a uniform style of movement the mobile sinks are made to move from the centre to the four corners of the deployed rectangular region. The numbers of nodes, area of deployment, initial energy of the nodes, range of the sensors etc., can be varied to have an extensive simulation results. We assume sensors are distributed randomly across the network. Mobile sinks can navigate the network to collect the packets and report the data to the static sink. The path for mobile sink is assumed to be obstacle free. The mobile sinks are assumed to have higher communication range, so it can reach the static sensor node. It has three processes of mobile sink routing

- a) Network Clustering: The network is partitioned to clusters using clustering algorithms of LEACH with fewer number of cluster heads possible. Once cluster head nodes are chosen, they broadcast beacon to advertise their presence within their communication range. Based on the received signal strength each non cluster nodes choose their cluster heads to which they belong to. The cluster heads nodes send their information to the static base station also. Because of this arrangement sensor nodes need only low power to transmit their data to the cluster head nodes. The cluster head nodes will aggregate the data and keep it in their memory and wait for mobile sink nodes to reach near them to collect the data.
- b) Mobile sink navigation: Once the static sink receives the cluster head information; it does a path planning to find the optimal number of sensors to navigate the network.
- c) Data collection: The mobile sinks collect all the sensed data from the cluster heads aggregates it again and finally pass on to the static sink from where the user can get the information.

By incorporate some nodes which are less residual energy to sleep state also increase the efficiency of wireless sensor networks. There are many sleep scheduling in wireless sensor network. The energy efficient TDMA sleep scheduling is one of the methods to increase the life time of WSNs. The advantage of the sleep state in sensor nodes will help in using the energy efficiently in network. It is used to maximise the life of sensor and to reduce the packet loss in wireless sensor networks.

# International Journal of Innovative Research in Science, Engineering and Technology

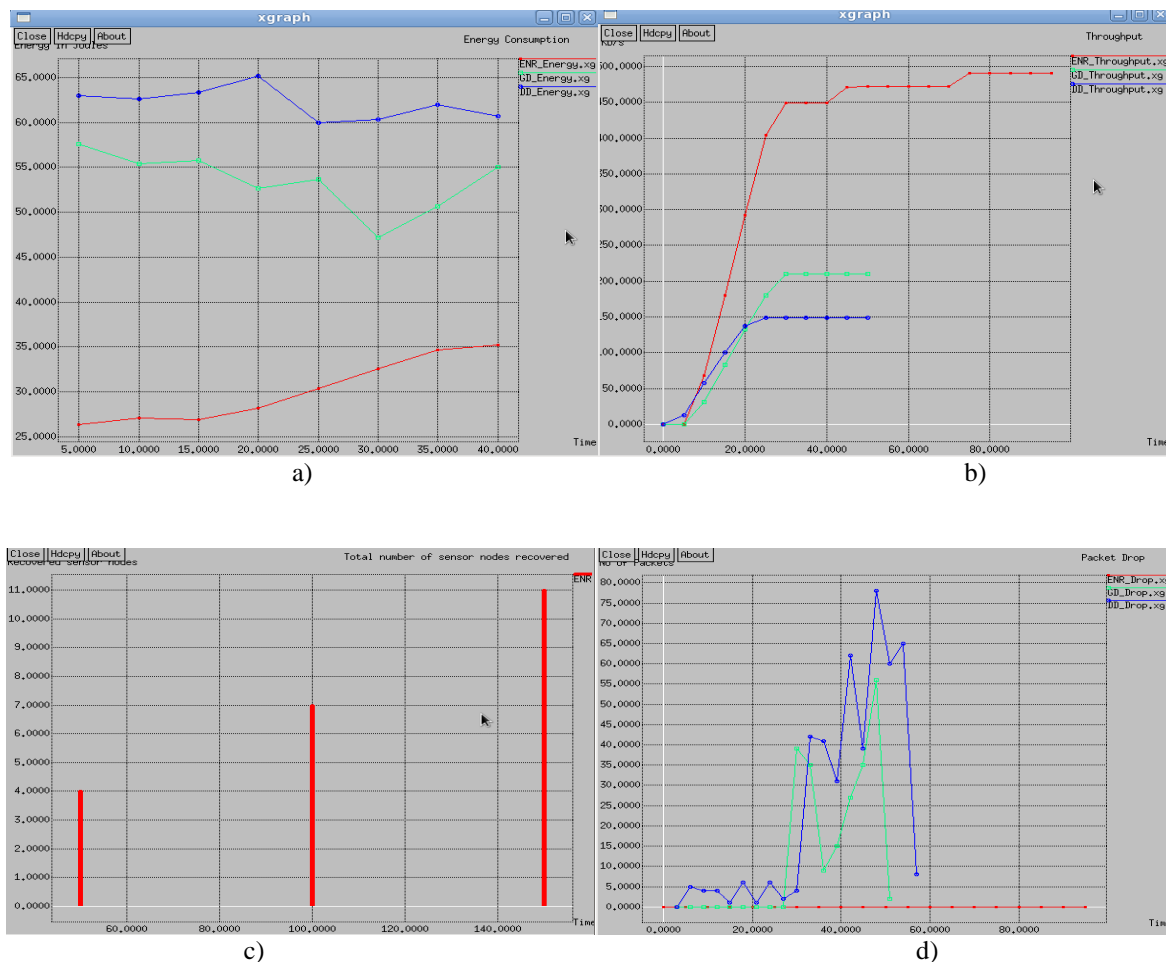
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## V. SIMULATION

In each of these simulations, the sensor nodes were distributed uniformly over the space. It uses the Linux operating system. We going to use NS-2 simulator with protocol developed in C++ language. The scripting language is developed in TCL (Tool command Language).Initially we are going to use 45 sensor node and analysis the sensor parameter using ENR algorithm.

Fig. 6 Analysis of DD, GD and ENR algorithm a)energy consumption b) throughput c) total number of sensor nodes recovered d) packet drop



## VI. CONCLUSION

This paper proposes an error node regaining algorithm for wireless sensor network which is based on the Grade diffusion algorithm combined with genetic algorithm and using energy efficient sensing method. The sink mobility will reduce the packet loss and use the energy efficiently in wireless sensor networks. Then, putting some nodes in sleep states increase the life time of sensor nodes. Therefore power consumption of the sensor nodes are decreased by using compact sensing method and at the same time substitution of faulty nodes also reduced, thus enhancing the life time of sensor node as well as the reduction in replacement cost of the sensor node.

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