Optimization Of Route With Sleep Scheduling Algorithm For Structural Health Monitoring

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ABSTRACT: Wireless Sensor Networks are most appropriate technology for Structural Health Monitoring (SHM) to monitor the structure by easy placement of the sensors. SHM is the technique for monitoring the engineering structures by implementing the sensors on the physical structure (bridges/dams). Some of the parameters, e.g., distant communication, energy of sensor these properties related to the sensor should be taken into account. The inaccuracies in sending data, unsteady connectivity can affect the throughput of sensor while observe structure. The existing system focused only on backup sensors placement that are resilient to WSN faults. The energy level gets depleted while sending the monitored data. In proposed system, the Genetic algorithm is introduced to optimize the path for the communication and sleep-wake up scheduling is used to awaken the nodes and placement of backup sensor nodes on the optimized route is used to communicate the collected data to the base station. This will increases the network lifetime and play down the energy utilization. The performance of the methods is mentioned detail using simulation.

Index items: Structural Health Monitoring, Genetic Algorithm, Optimization, Sleep-wake up scheduling, Fault sensor Structural Health Monitoring

1. PROBLEM STATEMENT

Usage of the Wireless Sensor leads to the faults (communication errors, unstable connectivity, sensor faults) while monitoring the health of the structure (bridges, buildings) and also leads to energy consumption while monitoring and sending the data to the receiver.

2. OBJECTIVES

- To make the Wireless Sensor resilient to the faults and to get better throughput of the wireless sensor, to fix the sensor nodes issues and assure a quantity of fault tolerance.
- To make the most of the network lifetime and reduce the energy consumption rate.

3. INTRODUCTION

3.1 Structural health monitoring

The improvements in sensor methodologies gave affordable answers for plenty of applications in wireless technology of sensor networks, such as monitoring the structure, studying about the scientific inventions and tracking the target. Civil physical structures like bridges and nuclear plants are complex engineering systems that are need to be monitored in timely basis. Structural health monitoring (SHM)[16] is the essential methods put into action to monitor the physical properties using sensors. Wireless sensors are more promising technology for SHM than contemporary wired systems. Examples include the Golden gate bridge in the US and Guangzhou new TV tower in China [4]. The objective of SHM is to find out the dent on the structure, to provide durable monitoring and to provide the rapid response to the strange vibrations, e.g., earthquakes, load, etc. The sensor deployment should ensure the instant monitoring, connectivity and reliable data delivery. Once the structural health properties are collected by all sensors which are placed in various places they are sent to the target place for more processing. There are several issues in Wireless sensors to achieve this monitoring process that will be faced in this paper. Each sensor is collecting the data actively for a long time it leads to severe usage of energy. The collection of data from all sensors is not so simple. As a result, the sensors placed on the structure struggling to collect data when there is an event occurs in the physical health structure. To lengthen the WSN lifetime, energy cost must be considered for each sensor.

4. RELATED WORKS

Wireless sensors are very relevant technology for monitoring process, efficient data communication to the target place. Placement of sensors plays a vital role in monitoring process and data communication to the target station. Some of the related work on placement of sensors and energy efficient nodes for the communication of sensors are done for the proposed technique. Jiannong [1] proposed the event-sensitive adaptive sampling to reduce the resource usage. By analyze this method the throughput of the present scheme for monitoring are not in accuracy manner. With the reference of this paper B. Li[5] proposed the deployment method of the sensors, the computer measurements used here are adjusted with the civil placement but it does missed the optimal locations on the structure. In this paper Md Zakirul Alam Bhuiyan[4] proposed the algorithm for placing the sensor, but fails to make over the energy depletion of all placed nodes while monitoring and sending the data to the target place. In this paper Joon-Woo Lee[2] focuses on energy efficient coverage method with the two techniques. But it fails to focuses on the drained out sensors and also not succeed to recover from the blunder sensor while monitoring process.

5. PROPOSED SYSTEM

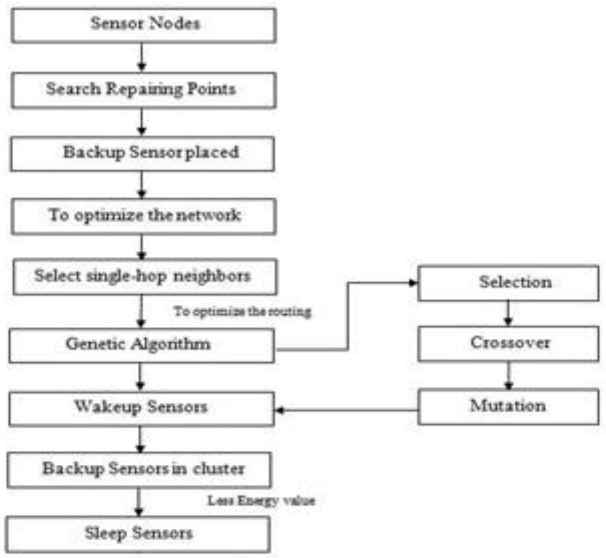

***Fig.,1**. Overall workflow of proposed system*

5.1 Fault-tolerance structural health monitoring

Fault-Tolerance Structural Health Monitoring (FTSHM)[3] is the process of placing the sensors so that the vibration in the structure can be monitored in SHM. FTSHM searches the repairing points of sensors placed on the structure and places some set of alternate sensors at repairing points so that the monitoring process of the sensors cannot be interrupted. FTSHM places the sensor so that the energy consumption is low, with the aim of assuring the connection of the sensors in the event of the fault. In FTSHM, the possible repairing points can be detected and restore them by placing the alternate sensors. It obtains dynamic communication problem properties of each sensor in the region.

5.2 Backup Sensor Placement at Repairing Points

Each node on the structure performs the deployment of alternate sensors using BSP[3] algorithm. BSP algorithm is relatively simple: detecting the locations to place the alternate sensors, and humanizing weak-connected clusters into strongly-connected clusters. First, BSP algorithm detects all of the repairing (or failure) points (RPs) step by step. The possible RPs is separable points, critical middle points, and isolated points in the WSN. Then, the algorithm places backup sensors until all RPs are found. The position of the alternate sensors inside the region where the sensors are weakly connected. The separable point or sensor is a Repairing Point, which is critical to communicate. In fact, sensor can be fail in sensing due to the more energy consumption. Failure of further sensors increases the hopping count. The Repairing Point[13] which is with the longest and irregular transmission distance and the link between sender and the receiver is so weak is called critical middle points. In order to achieve the link between the sink and target, place the alternate sensors to achieve the communication. For this work two cases are considered.

1) The communication between sender and receiver is not reliable.

2) There may be obstacles due to change in the modal shapes. e.g., due to ambient force vibration in the structure.

The Repairing Point when a sensor does not have the link for the communication or station receives the broken message, the sensors is an isolated sensor. This is because some sensors are ignored in its sensor cluster region which is isolated in the WSN it could not be communicated with any of the sensors. This repairing point is called isolated points. Fault-Tolerance Structural Health Monitoring (FTSHM)[13] is the method of inserting the sensors so that the performance of the SHM will not be affected the monitoring process. To make the energy efficient monitoring following methods are used. In this section, Multi-dimensional neighbor node calculation used to form clusters in a multi-dimensional way with the neighbor node distance calculation. The genetic algorithm is used for process of natural route selection among the sensors. Genetic algorithm is used for optimizing the way of data cluster head to the target station. It uses the selection, crossover and mutation techniques. The Sleep wakeup scheduling is used to maximize the network lifetime with low energy consumption.

5.3 Genetic Algorithm

Genetic Algorithm [6] is one of the most vital techniques for solving the combinatorial routing based optimization problem. It is quite simple and robust, and very easy to implement, so it has been applied to solve the routing issues and also durability of the network. The strength of a genetic algorithm is finding the route from the server and the destination routes in an optimization way. The route search is depends on energy level of each and every cluster nodes, this can be done by taking the distance between the nodes on the structure,
The Genetic Algorithm has 4 main phases for routing optimization. They are,

- Initial Population
- Fitness function
- Selection
- Crossover
- Mutation

5.3.1 Initial population:

The population size depends on number of sensors placed on the structure and the nature of the problem, but hundreds or thousands of sensors are possible solutions. Often, the initial population is generated randomly, this may be the range of possible solutions. The multi-dimensional way of calculated neighboring distance, that is taken from the previous phase is the initial population for this phase. The input for this phase is the distance calculation among the neighbor nodes, hop count and time of the each and every sensor nodes.

5.3.2 Fitness function:

This fitness function detects the ability to struggle with the individuals. The selection of the individual is based on the fitness score. This gives the distance between the nodes in the cluster.

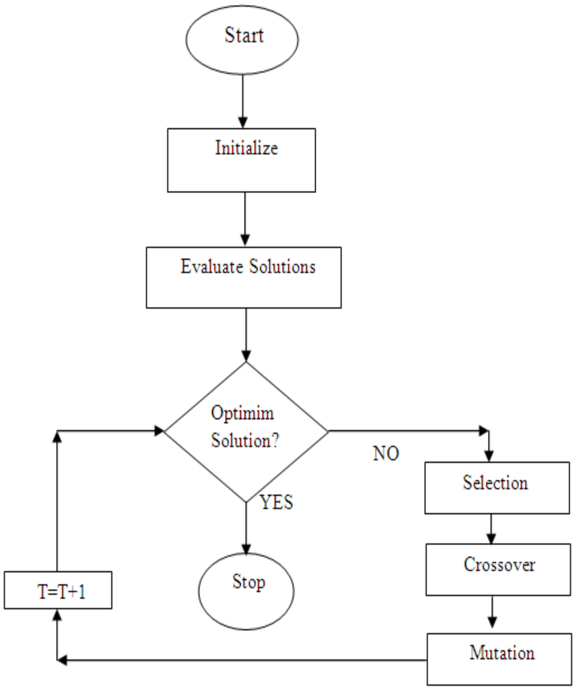

Fig.,2. *Steps for Genetic Algorithm*

The multi-dimensional way of calculated neighboring distance, that is taken from the previous phase is the initial population for this phase. The input for this phase is the distance calculation among the neighbor nodes, hop count and time of the each and every sensor nodes.

5.3.3 Selection:
The selection phase is used to select the higher energy node among placed nodes. If node is selected, that node should have the capable of sending the monitored packets with the higher energy to the base station. That higher energy level node is fit as the cluster head node so that it can take the responsibility collect the monitored data and can send the data collected to the base station. This is selection phase.

5.3.4. Crossover:
The Crossover is the process of producing the child solution from the parent solution. In this step, it takes number of routes as the parent solutions and gives the optimized routing as the child solution. The optimized routing path should have the higher energy level nodes, so then it able to send the monitored and collected data to the target station from the cluster node. If energy level gets decreased on that path, immediately the path gets shifted to another higher energy level path. This point in this phase is called cross over point. This is crossover phase.

5.3.5. Mutation:
Mutation is the process of introducing the new feature on the occasional time into the solution of the population pool to maintain diversity in the selected route mutation allows avoiding early convergence toward local optima. The routing is found in the path of high energy level. The energy level path is maintained in this phase. Through the iterative process of this algorithm the path can be shifted and this can be maintained in this mutation phase. The sharing of the packet gets travelled in this path and this path should be maintained. These are the process of the Genetic Algorithm. Each and every time the energy level gets updated through the iterative process of this algorithm. The routing path may change because of the energy level on that path, immediately path gets shifted to another higher energy level path automatically using Genetic algorithm routing optimization.

5.3.5. Sleep-wake up Scheduling
Sleep wake scheduling[7] is used to improve the network lifetime. Energy consumption is the major part in the sensor, more energy consumption minimizes the network lifetime. To save the energy, sleep scheduling algorithms can be used to turn the nodes to the awaken state to pass the packets to the base station. When backup sensors are not in use while sending, make sensor to sleep state and let that node to continue the monitoring process.

The steps as follows:

- Creating the cluster for the target coverage. The clusters are created using first phase. These are taken to the next step.
- Using GA best path is finding from source to destination. This step gives the path detection from the sensor node to the base station.
- If backup sensors are on that path wake up the sensors to pass the packets to the destination node. It includes primary sensors. While passing the collected data, the path should awaken so, and then it can send the monitored data.
- Wake that path for some period. Due to a higher energy level the path might wake until next energy level gets updated and find another path at a higher energy level.
- The path stays awake when sending the monitored data from the cluster node to the base station

6. PERFORMNCE

6.1 ENERGY EFFICIENT RATIO
Energy Efficient Ratio is the energy of each node to monitor the structure and to transmit the packets from the cluster head to the destination node. If that occurs, the energy of nodes can be preserved for the whole monitoring process.

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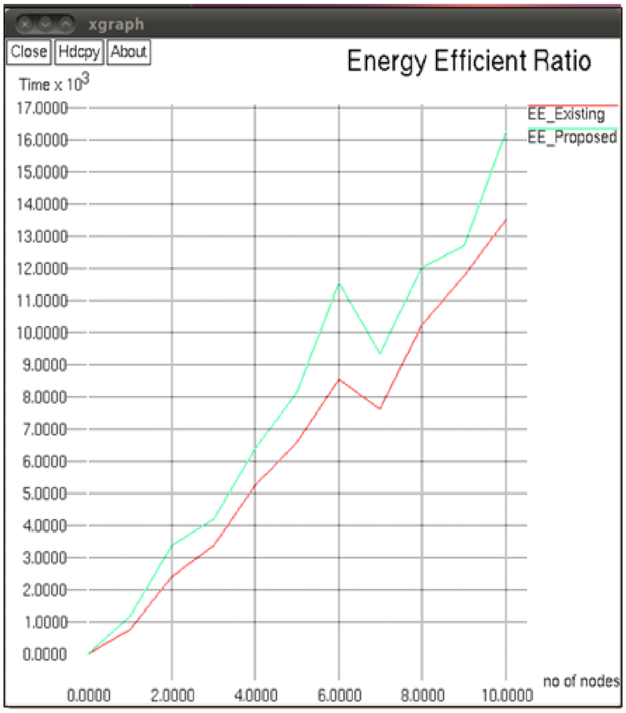

Fig 3. *Energy Efficient Ratio*

6.2 MAXIMUM THROUGHPUT RATIO

The average time taken by a data packet is to land in destination (receiver sensor). It contains the delay caused by the communication among the sensors. Only, data packets that fruitfully carried to the target station are considered as successful monitoring of the health status of the structure. In this graph, the delay rate is decreased using optimization method.

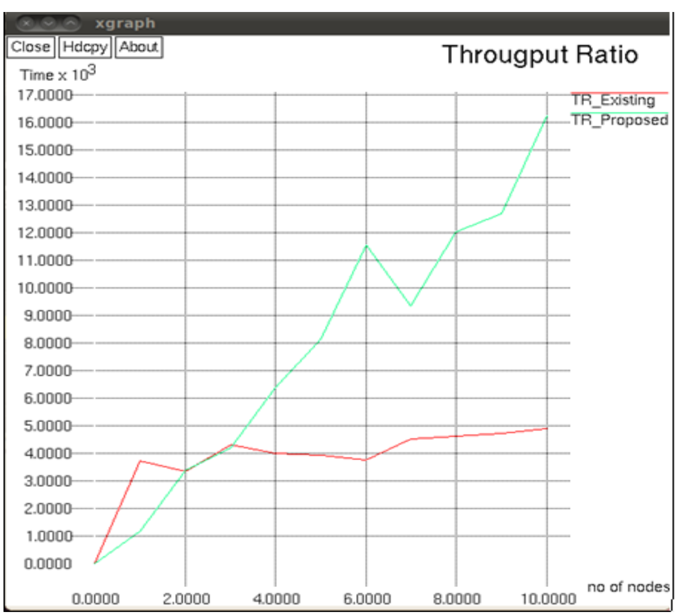

Fig 4. *Throughput ratio*

7. CONCLUSION

The objective of this methodology is to explain the new way to reduce the energy consumption rate by sending the monitored data in the optimized way after placing the backup sensors in faults specific place. Using scheduling method, the lifetime can be maximized. Security is added to improve the path more secured. The performance of the methods is illustrated through both simulations and real experiments.

8. FUTURE WORK

The future work is to develop SHM-specific techniques in the hardware experiments and can add security for the data carry over.

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