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Improving the Sensing Quality in Wireless Sensor Networks Using Information Tables

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Abstract: In wireless sensor networks, physical damage, battery drainage leads to decrease in number of sensors deployed with respect to time, resulting in performance degradation. Further to improve the sensing quality, actors are used to allocate the spare sensors to Deficient Regions (DR) and relocate the sensors from Bountiful Regions (BR) to DR. In this paper, we propose the concept of Information Tables (IT) and threshold limits for both the allocation and relocation process to improve the performance of the wireless sensor networks. Allocation and relocation of sensor nodes can be made with the help of Greedy Algorithm (GA). In GA the IT is considered as a key factor. This new proposed approach, GA-IT avoids the dead node problem. Thus the results show that the performance is increased significantly. Simulation results are provided to demonstrate the performance increase in wireless sensor networks.

Keywords: Sensing Quality, Allocation, Relocation, Information Tables (IT)

I. INTRODUCTION

Wireless Sensor Network provides a simple, cost-effective approach for the deployment of distributed monitor and control devices, avoiding the expensive retrofit necessary in wired systems. Wireless Sensor Network consists of spatially distributed sensor nodes. In a WSN, each sensor node is able to autonomously perform some processing and sensing tasks. Furthermore, sensor nodes communicate with each other in order to forward their sensed data to a central processing unit or conduct some local management such as data fusion. WSN consists of sensor nodes used to monitor and track the environmental conditions [1],[2],[3],[4],[5]. One of the most active research areas in the wireless sensor network is that of sensor coverage. Addition to that of coverage, connectivity is more important. Sensor nodes have limited battery life and hence it can be used for a smaller period of operational time. A sensor node that collects the data consumes more energy [2].

This operation leads to the decrease in the total availability of sensors in the network. Decrease in the number of sensor nodes results in the downgrade of sensing quality and performance degradation [1]. Actors are the mobile sensor nodes capable of replacing the deficient sensor nodes in the network. Grid head is responsible for maintaining the information about the particular grid members. Sensor allocation and sensor relocation are two problems that arise when the deficient sensor nodes are detected. Sensor allocation aims at optimally placing the new sensor nodes using actors to increase the sensing quality within the network.

Greedy algorithm is used to solve the sensor allocation problem which requires the global information for decision making [1]. Sensor relocation problem involves the actors need to search for redundant sensor nodes from bountiful regions to deficient locations. Further to improve the sensing quality, dead nodes in the network are completely avoided with the help of information tables, which dynamically maintains the information about the sensor nodes in the network.

Available spare sensor information is maintained by the actor. The coverage problem is a elementary problem in sensor network design. The dilemma is about the placement and/or scheduling of sensors to maximize the ability to detect or capture interesting events appearing in a deployment area. It is practicable to deploy a large number of these sensors for area monitor. Carefully controlled placements of the sensors may be difficult, due to their huge numbers or challenge of the topography [5].

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The rest of the paper is organized as follows: In section 2, discussed about the related works on censing quality and coverage verification. Section 3 describes the system model. Section 4 describes the proposed work for sensor allocation and relocation problems. Simulation results and performance comparisons are presented in section 5 and conclude the paper in section 6.

II. RELATED WORK

Each sensor uses the distance between its neighbouring sensors to calculate the intersection points. If the intersection points with neighbours are all k-covered by its neighbouring sensors, then coverage of a fixed sensor can be preserved in the coordinate system [9][11].To maintain coverage performance the detection of coverage hole and dispatch the actor accordingly to repair the hole is important. The most existing work assumes the perfect disc sensing model for coverage verification. Zhang et al. pointed out that we only need to consider the intersection points of the sensing border of all sensors, which greatly simplifies the computational complexity of coverage verification algorithms [9]. The network life span is the time interval from the activation of the network until the first time at which a coverage hole appears. An activation schedule is a order of sensor covers that are activated in successive slots, such that in every slot, each sensor in the activated sensor cover has non-zero energy. The maximum network lifetime problem seeks to find an activation schedule that maximizes the network life span [10].

Coordinate -free distributed coverage algorithm is exploited for the coverage performance [10]. On detection of the coverage hole, the deficiency in the coverage is communicated to other sensors, so that replacement of failed sensor is made on timely basis [7][8]. Grid quorum-based solution is used to the find the redundant sensor and coverage holes in the network [7].

The coverage problem is an elementary problem in sensor network design. The dilemma is about the placement and/or scheduling of sensors to maximize the ability to detect or capture interesting events appearing in a deployment area. It is practicable to deploy a large number of these sensors for area monitor. Carefully controlled placements of the sensors may be difficult, due to their huge numbers or challenge of the topography [5]. Density controls ensure a subset of sensor nodes operates in the active to mode with the requirements of coverage and connectivity [2]. Coverage hole can be healed with spare sensors in a repair process with the help of hierarchical structure with Hamilton cycles. Movement of actors is guided by the Markovian Chain and Monte Carlo method to guarantee the optimal sensor allocation in an middling manner [1]. Asynchronous network exceed the synchronous network in the coverage intensity [5].

III. SYSTEM MODEL

Actor, the sensor node has the mobility within the network, responsible for carrying the deficient sensor node to the recharging unit and spare sensor modes to the deficient regions in sensor allocation. In sensor relocation actor picks the redundant, unutilized sensor nodes to the spare nodes. Collections of static sensor nodes are deployed in the rectangular region of interest (ROI). The sensing location is divided into N = P X Q grids, each with the side length L. The sensing location is divided into an N number of square grids; each grid is covered at least with one sensor.
Each gird contains one gird head for the local maintenance, which holds the information about the gird members. Only the grid head can communicate with the actor. Actor maintains the availability information about the spare sensor nodes. Each sensor knows its location information with the help of GPS [15]. For assumption, grid head has the high configuration than the other sensor nodes. It is assumed that grid head never fails during the operations.

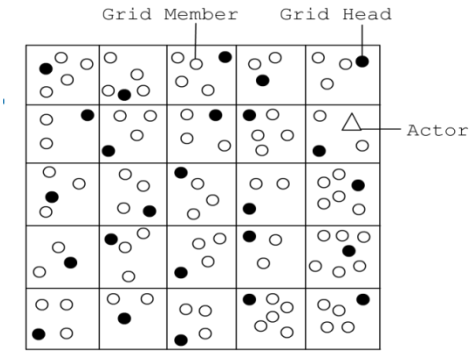

Fig 1. Network model

When the sensor in the grid detects one of its neighbors is out of functions, inform to the gird heads. Each grid has the unique grid id G_i and sensors with the id Si. Communication range for the sensor nodes in the network is C_s and for the grid head is C_g. The range C_s is based on the grid size and C_g is based on the network. Sensor node drops energy when the sensor detects faulty node or an object within the C_s and during the communication with grid head. For each grid a corresponding weight is provided respectively.

IV. SENSOR ALLOCATION AND RELOCATION

To maintain the global optimality in the wireless sensor network greedy algorithm is used. Grid head in each grid is responsible for maintaining the information about the grid members of the respective grid, which is maintained in the Information Table. The table consists of information about time of deployment, battery level and sensor id. It is updated periodically and it is preserved in ascending order based on the battery level.

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A Threshold value for the battery level is considered. In case of tie arises in battery levels between two or more sensors it is broken by grid head using the sensor id, if there is tie again in the time of deployment of corresponding entries.
Each grid head monitors the available information and when the battery level of any sensor falls below the threshold value then the corresponding grid head communicates the information to the actor along with the sensor id, time of deployment and grid id. During the communication process the top of the information table entry is chosen without any considerations.
Actor performs the sensor allocation by replacing the deficient node with the spare sensor nodes that are available. The deficient node is placed in the recharging unit, after it reaches the maximum level it is moved to the spare sensor location.
Sensor allocation can be done only till the availability of spare sensor nodes. To maintain the spare sensor node availability, sensor relocation is performed at the earlier stage. When the threshold value of number of spare sensor node is reached sensor relocation is made. Actor maintains the spare sensor nodes information. Sensor relocation involves picking up the long idle sensor node from the grids to the spare sensor node location. Actor communicates with the grid heads and sensors with high residual energy or high battery value is chosen. Ties are broken using similar technique. Each grid head chooses one member from corresponding grids, Actor need to pick the one sensor among the N sensors with high residual energy.

V. PERFORMANCE EVALUATION

In this section, results of simulation and performance of proposed methods are demonstrated.
We use Network Simulator to perform simulations. The sensing region is considered of 80m x 80m. The side length of each square grid is 10m, thus the total number of grids is 64. Initially, sensors are deployed randomly with Poisson point process. The number of request is request received for node allocation to the Actor.

A. Sensor Allocation

When the grid head communicates to the actor for allocation when threshold level is attained, Actor performs allocation using Spare sensor. Allocations are performed before the sensor node reaches the dead node until tie occurs. Dead nodes arise when more ties are found among the grids and also within the grid. Till the availability of spare sensor nodes number of dead nodes are maintained to some extent, when no more spare sensors are available number of dead nodes increases dramatically observed from Fig. 2 .

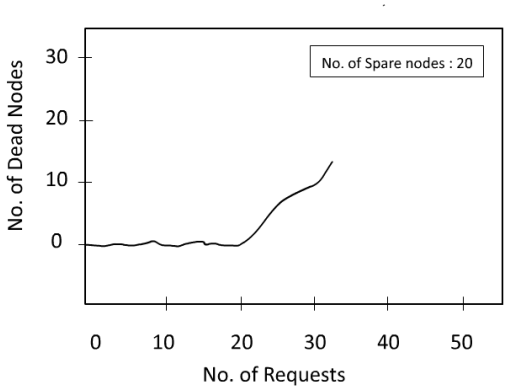

Fig. 2. Sensor allocation using single Actor

B. Sensor Relocation

When there are no spare sensors are available to add into the network, actor needs to first search for the long idle sensor nodes and then drop them to locations where from the request arises. Relocation operation needs some time to discover the long idle sensor nodes, during the operation sensing quality drops below the requirement and number of dead nodes also increased. Fig .3 gains little performance than the Fig .2 in the consideration of number of dead nodes in the network.

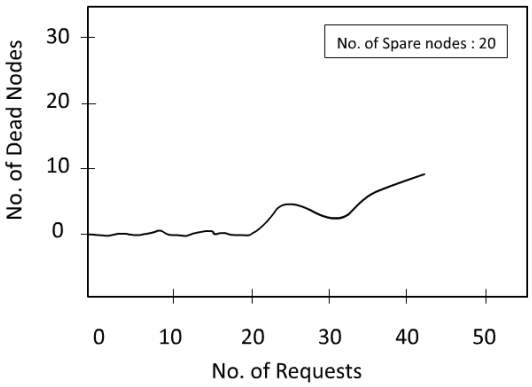

Fig. 3. Sensor relocation using single Actor

C. Sensor Allocation and Relocation using Information Tables

Sensor allocation and relocation are performed before the node leads to dead state; a threshold value is provided for the number of spare sensors and battery value in the information tables. Information tables are maintained at grid head and grid head communicates with the actor for allocation and relocation processes. Fig .4 depicts the decreased dead nodes using the Information Tables.

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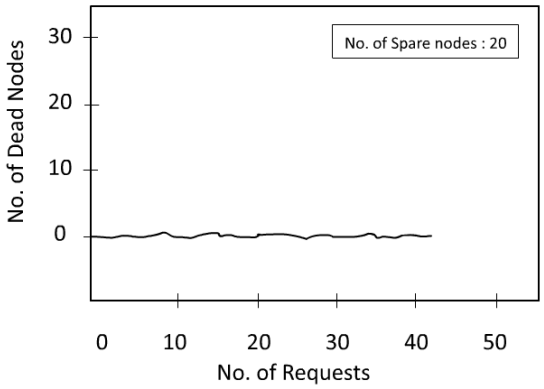

Fig. 4. Sensor allocation and relocation using single Actor with Information Tables

VI. CONCLUSION

In this paper, we have considered improving the sensing quality in wireless sensor networks. First sensor allocation and relocation is considered and information tables are used and performed the same operations and simulation results are provided showing decrease in number of dead nodes for only the minimal number of nodes in the wireless sensor network with single Actor.

When more ties are takes place single Actor cannot be effectively allocate or relocate, in such cases more number of Actors can be used.

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