Scheduling for Target Area Coverage Problem and Maximizing Network Lifetime of Wireless Sensor Network

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Abstract— Network lifetime plays an integral role in setting up an efficient wireless sensor network. The network will deploy sensor nodes at optimal locations and also it schedule the sensor nodes to increase the network lifetime. By using pre-specified sensing range it will identify the optimal deployment locations of the sensor nodes. It uses artificial bee colony algorithm and particle swarm optimization for sensor deployment problem followed by a heuristic for scheduling. In proposed system, using hybrid approach has ANT colony optimization technique is used to provide maximum network lifetime utilization. The comparative study shows that artificial ACO performs better than bee colony algorithm for sensor deployment problem. The proposed heuristic was able to achieve the theoretical upper bound in all the experimented cases.

Key words: Coverage, Scheduling, Sensor deployment, ANT colony algorithm, Wireless sensor network

I. INTRODUCTION

A wireless sensor network (WSN) consists of a collection of these nodes that have the facility to sense, process data and communicate with each other via a wireless connection. Wireless sensor networks (WSN's), the improvement in sensor technology has made it possible to have very Small, low powered sensing devices equipped with programmable compute, multiple parameter sensing and wireless message capability. Also, the low cost makes it possible to have a network of hundreds or thousands of these sensors, thereby enhancing the consistency and accuracy of data and the area coverage. Wireless sensor networks offer information about isolated structures, wide-spread environmental changes, etc. Wireless sensor network (WSN) is a network system comprised of spatially distributed devices using wireless sensor nodes to monitor physical or environmental situation, such as sound, temperature, and motion.

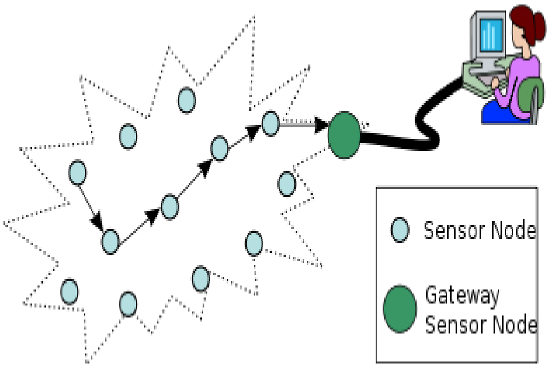

Fig. 1: An operating system of a WSN

A sensor network is designed to perform a set of high-level information processing tasks such as detection, track, or categorization. Measures of performance for these tasks are well defined, including discovery of false alarms or misses, classification errors, and track quality.

A heuristic to schedule the sensor nodes which maximizes the network lifetime. The heuristic could achieve the theoretical upper bound for all experimented cases. In the literature, deployment and scheduling for coverage problem are addressed mostly as independent problems and various methodologies have been proposed for deployment and scheduling separately. In this Paper, we attempt to address deployment and scheduling as one problem to maximize the network lifetime. We start with deploying sensor nodes such that the upper bound of network lifetime could be maximum for the specified coverage requirement, and then proceed using the heuristic to schedule the sensor nodes so that the network lifetime upper bound could be achieved.

II. RELATED WORKS

Chong Liu et al. [1] provides a thorough analysis on a randomized algorithm that makes scheduling decisions without the help of geographic information. The analytical results precisely describe the relationship among achievable network coverage, energy saving, and node density. We also analyze the performance of the randomized algorithm with time asynchrony and propose a heuristic randomized scheduling scheme to improve the performance. Finally, simulation study is performed to verify the correctness of the analytical results and to demonstrate the advantages of the proposed heuristic method.

Kui Wu et al. [6] the matter of estimating redundant sensing square measure as among neighboring wireless sensors is analyzed. We tend to gift straightforward ways to estimate the degree of redundancy while not the data of location or directional data. We tend to additionally give tight higher and lower bounds on the likelihood of complete redundancy and on the common partial redundancy. supported the analysis, we tend to propose a scalable light-weight Deployment-Aware planning rule, that turns off redundant sensors while not exploitation correct location data. Simulation study demonstrates that the LDAS rule will scale back network energy consumption and supply desired QoS demand effectively. Our analytical results can profit the analysis in wireless sensing element networks by providing straightforward formulae to estimate sensing element redundancy.

XiaoleBai et al. [9] propose an optimal deployment pattern to achieve both full coverage and2-connectivity, and prove its optimality for all values of rc/rs, where rc is the communication radius, and rs is the sensing radius. We also prove the optimality of a previously proposed deployment pattern for achieving both full coverage and 1-connectivity, when $rc/rs<\sqrt{3}$. Finally, we compare the efficiency of some popular regular deployment patterns such as the square grid and triangular lattice, in terms of the number of sensors needed to provide coverage and connectivity. With the emergence of wireless sensor networks in the past decade, consideration of coverage alone is no longer enough when deploying sensors. The sensor network needs to be connected too. On the problem of achieving both coverage and connectivity at the same time, a few results are known in the literature.

Chi-Fu Huang et al. [4] tend to formulate this downside as a choice downside, whose goal is to work out whether or not each purpose within the topographic point of the sensing element network is roofed by a minimum of k sensors, wherever k may be a predefined price. The sensing ranges of sensors is unit disks or non-unit disks. We tend to gift polynomial-time algorithms, in terms of the amount of sensors which will be simply translated to distributed protocols. The result's a generalization of some earlier results wherever solely k = one is assumed. Applications of the result include: (i) positioning applications, (ii) things that need stronger environmental observance capability, and (iii) eventualities that impose additional rigorous fault-tolerant capability.

III. EXSISTING METHODOLOGY

Most of the existing works on sensor deployment problem focus on area coverage. Environments with obstacles are also considered for sensor deployment. From the perspective of coverage, address quality of the deployment and propose quality measures, which indicate if the deployment provides sufficient coverage, or whether redeployment is required or not. A Diamond pattern, which could be viewed as a series of evolving patterns, and another new deployment pattern called the Double-strip pattern is also proposed. The propose Connectivity-Preserved Virtual Force scheme, a modified virtual-force-based method which results in poor coverage in some cases and also describes a Floor based scheme which overcomes the drawbacks of CPVF.

It is possible sensor network deployment strategies that maximize sensor network lifetime by mitigating the problem of the hot spot around the data sink. Many sensor node scheduling algorithms are proposed to solve area coverage problem. To investigate sensor networks with directional sensing and communication capability and propose a method for deploying sensor nodes with directional sensing range, and subsequent connectivity checking and repairing. A deployment strategy, with sensors having adjustable sensing ranges to cover an area, is also proposed.

ABC algorithm for sensor deployment problem in irregular terrain. This is applicable for regions where the number of targets is more compared to the number of sensors to be deployed. The aim is to save energy by minimizing the sensing range requirement for the sensors. All these works aim at placing the sensor nodes in such a way that the required sensing range is minimum. Network lifetime defined as the time instant from which the network starts functioning to the time instant where the desired coverage criterion is not satisfied is a crucial factor that determines the efficiency of a wireless sensor network. Energy usage should be curbed to achieve enhanced lifetime. This is because sensor nodes are battery powered and cannot be easily recharged or replaced.

IV. DESCRIPTION OF THE PROPOSED SYSTEM

A. *Wireless Network Formation:*

- In Wireless network formation optimally locate the sensor nodes.
- Next choose the base station and produced the coverage area.
- In additionally we have used ANT colony optimization in order to increase the network lifetime.

B. *Optimal Location Determination:*

1) *Sensor Deployment to Achieve 1-Coverage:*

Given a set of n targets T = {T1, T2, . . . ,Tn} located in u×v region and m sensor nodes S = {S1, S2, . . . , Sm}, place the nodes such that each target is monitored by at least one sensor node and the network lifetime is maximum. The objective is to maximize U such that each target is monitored by at least one sensor node.

2) *Sensor Deployment to Achieve k-Coverage:*

Given a set of n targets T = {T1, T2, . . . ,Tn} located in u × v region and m sensor nodes S = {S1, S2, . . . , Sm}, place the nodes such that each target is monitored by at least k-sensor nodes and to maximize U.

3) *Sensor Deployment to Achieve Q-Coverage:*

Given a set of n targets T = {T1, T2, . . . , Tn} located in u×v region and m sensor nodes S = {S1, S2, . . . , Sm}, place the nodes such that each target Tj, $1 \leq j \leq n$, is covered by at least q j sensor nodes and to maximize U.

C. *Process:*

- The nodes are initially deployed randomly.
- Based on the theoretical upper bound of network life time
- we compute the optimal deployment locations using ABC algorithm
- A heuristic is then used to schedule the sensor nodes such that the network lifetime is maximum.

V. SCHEDULING ALGORITHM

A. *ABC Based Sensor Deployment:*

Artificial Bee Colony (ABC) Algorithm is an optimization algorithm based on the intelligent behavior of honey bee swarm. The colony of bees contains three groups: employed bees, onlookers and scouts. The employed bee takes a load of nectar from the source and returns to the hive and unloads the nectar to a food store. After unloading the food, the bee performs a special form of dance called waggle dance which contains information about the direction in which the food will be found, its distance from the hive and its quality rating. Since information about all the current rich sources is available to an onlooker on the dance floor, an onlooker bee probably could watch numerous dances and choose to employ itself at the most qualitative source. There is a greater probability of onlookers choosing more qualitative sources since more information is circulating about the more qualitative sources.

B. *Particle Swarm Optimization:*

Particle Swarm Optimization (PSO) consists of a swarm of particles moving in a search space of possible solutions for a problem. Every particle has a position vector representing a candidate solution to the problem and a velocity vector.

Moreover, each particle contains a small memory that stores its own best position seen so far and a global best position obtained through communication with its neighbor particles.

C. Heuristic for Sensor Scheduling:

To achieve this, we propose a weight-based method for determining the cover sets

- Weight assignment
- Cover formation
- Cover optimization
- Cover activation and Energy reduction.

D. Upper Bound of Network Lifetime:

The upper bound is the maximum achievable network lifetime for a particular configuration and as stated the upper bound is calculated as,

$$U = min_j \left[\frac{\sum i\, M_{ij} * b_i'}{q_j} \right]$$

VI. SENSOR SCHEDULING

A. 1- Coverage Scheduling:

Given m sensor nodes S ={S1, S2, . . . , Sm} with battery power B = {b1, b2, . . . , bm},energy consumption rate ei for Si and n targets T ={T1, T2, . . . , Tn}, find a schedule {C1, . . . ,Cy } for time tick{t1, . . . , ty} such that for all ticks,

- Each target is covered by at least one sensor node
- Network lifetime is maximized.

B. K-Coverage Scheduling:

Given a set of sensor nodes S ={S1, S2, . . . , Sm} with battery power B = {b1, b2, . . . , bm},energy consumption rate ei for Si and a target setT = {T1, T2, . . . , Tn}, generate a schedule {C1, . . . ,Cy }, for {t1, . . . , ty}, such that for all ticks,

- Each target is covered by at least k sensor nodes, 1≤k≤m
- Network lifetime is maximized

C. Q-Coverage Scheduling:

Given a set of sensor nodes S ={S1, S2, . . . , Sm} with battery power B = {b1, b2, . . . , bm},energy consumption rate ei for Si and a target setT = {T1, T2, . . . , Tn}, generate a schedule {C1, . . . ,Cy }, for{t1, . . . , ty}, such that for all ticks,

- T = {T1, T2, . . . ,Tn} is covered by at least **Q** ={q1, q2, . . . , qn} sensor nodes, where each target Tj, 1 ≤ j ≤n, is covered by at least q j sensor nodes
- Network lifetime is maximized

VII. CONCLUSION

The flexibility, fault tolerance, high sensing fidelity, low-cost and rapid deployment characteristics of sensor networks create many new and exciting application areas for remote sensing. Several deployment quality measures are proposed and the effect of the sensor model parameters, width of the field, and the number of sensors are analyzed. Artificial bee colony algorithm performs better than PSO algorithm for this problem. In order to avoid the battery drain of all nodes at a time, sensor node scheduling can be done so that only minimum number of sensor nodes required for satisfying coverage requirement needs to be turned on. The other nodes can be reserved for later use. This method helps to prolong the network lifetime. We use a heuristic which is powerful enough to schedule the sensor nodes in such a way that the network lifetime matches the theoretical upper bound of network lifetime. Network lifetime is extended by using this method of deploying at optimal locations such that it achieves maximum theoretical upper bound and then scheduling them so as to achieve the theoretical upper bound.

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