EEFFECTIVE GLOBAL SENSOR DEPLOYMENT FOR COVERAGE PROBLEM IN WSN USING ANT COLONY OPTIMIZATION

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Abstract

To discover the finest employment locations of the given sensor nodes with a pre-specified sensing range and to listing them such that the network lifetime of maximum with the essential coverage level is the definitive is aim of this study. The ultimate goal is to realize an automated observing network so that recognition applications of various crisis actions can be nearly put into action. Further, the nodes are planned to achieve this upper bound. This study uses Enhanced Artificial Bee Colony (EABC) algorithm and Particle Swarm Optimization for sensor deployment problem followed by a heuristic for scheduling.

Keywords

UWSN, Sensor Deployment, Energy Hole, Sensor Scheduling, E-ABC algorithm

Introduction

Wireless sensor networks have recently come into prominence because they hold the potential to revolutionize many segments of our economy and life, from environmental monitoring and conservation, to manufacturing and business asset management, to automation in the transportation and health care industries. The design, implementation, and operation of a sensor network requires the confluence of many disciplines, including signal processing, networking and protocols, embedded systems, information management and distributed algorithms. Since the sensor nodes can be deterministically deployed, the optimal deployment locations and the schedule are decided at the base station, prior to actual deployment. The existing method has two phases: **sensor deployment** and **sensor scheduling**. The nodes are initially deployed randomly.

A. Sensor Scheduling

In addition, to schedule the sensor nodes such that the theoretical upper bound of network lifetime can be achieved, the existing system proposes a weight-based method for determining the cover sets. It includes the following main steps:

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

Sensor coverage is important while evaluating the effectiveness of a wireless sensor network. A lower coverage level (simple coverage) is enough for environmental or habitat monitoring or applications like home security. Higher degree of coverage (k-coverage) will be required for some applications like target tracking to track the targets accurately .or if sensors work in a hostile environment such as battle fields or chemically polluted areas. More reliable results are produced for higher degree of coverage which requires multiple sensor nodes to monitor the region/targets.

B. Sensor Deployment

Since the upper bound of network lifetime can be computed, we have to find the deployment locations such that the network lifetime is maximum. First use a heuristic to compute the deployment locations and then we use ABC and PSO algorithms to compute the locations.

C. Heuristic for sensor deployment:

If any sensor node is idle (without monitoring any target), the node is moved to the least monitored targets' location. This is to ensure that all sensor nodes play their part in monitoring the targets. The sensor nodes are then sorted based on the number of targets it cover. The sensor node is placed at the middle of all the targets it covers. The next nearest target is identified and the sensor node is placed at the middle of all these targets. If it can cover this new target along with targets it was already monitoring, allow this move, and else discard the move. This is done till the sensor node cannot cover any new target. At the end, upper bound is computed. The drawback of this approach is that it depends on the initial position of the sensor nodes. Though it may perform well for dense deployments, consistency cannot always be guaranteed.

LITERATURE SURVAY

A.Underwater acoustic sensor networks: research challenges

Ian F. Akyildiz, Dario Pompili and Tommaso Melodia[1] , describe a Underwater sensor nodes will find applications in oceanographic data collection, pollution monitoring, offshore exploration, disaster prevention, assisted navigation and tactical surveillance applications. Moreover, unmanned or autonomous underwater vehicles (UUVs, AUVs), equipped with sensors, will enable the exploration of natural undersea resources and gathering of scientific data in collaborative monitoring missions. Underwater acoustic networking is the enabling technology for these applications. Underwater networks consist of a variable number of sensors and vehicles that are deployed to perform collaborative monitoring tasks over a given area. Multiple unmanned or autonomous underwater vehicles (UUVs, AUVs), equipped with underwater sensors, will also find application in exploration of natural undersea resources and gathering of scientific data in collaborative monitoring missions. To make these applications viable, there is a need to enable underwater communications among underwater devices.

Underwater sensor nodes and vehicles must possess self-configuration capabilities, i.e., they must be able to coordinate their operation by exchanging configuration, location and movement information and to relay monitored data to an onshore station.

Self-configuration - This includes control procedures to automatically detect connectivity holes due to node failures or channel impairment and request the intervention of an AUV. Furthermore, AUVs can either be used for installation and maintenance of the sensor network infrastructure or to deploy new sensors. They can also be used as temporary relay nodes to restore connectivity. A protocol stack for uw-sensors should combine power awareness and management, and promote cooperation among the sensor nodes.

B. VBF: Vector-Based Forwarding Protocol for Underwater Sensor Networks

Peng Xie, Jun-Hong Cui and Li Lao [2] describe a small fraction of the nodes are involved in routing. VBF also adopts a localized and distributed self-adaptation algorithm which allows nodes to weigh the benefit of forwarding packets and thus reduce energy consumption by discarding the low benefit packets. The sensor networks have emerged as a very powerful technique for many applications, including monitoring, measurement, surveillance and control. Vector-Based Forwarding (VBF) protocol addresses the node mobility issue in a scalable and energy-efficient way. In VBF, each packet carries the positions of the sender, the target and the forwarder (i.e., the node which forwards this packet). The forwarding path is specified by the routing vector from the sender to the target. Upon receiving a packet, a node computes its relative position to the forwarder by measuring its distance to the forwarder and the angle of arrival (AOA) of the signal. Recursively, all the nodes receiving the packet compute their positions. If a node determines that it is close to the routing vector enough (e.g., less than a predefined distance threshold), it puts its own computed position in the packet and continues forwarding the packet; otherwise, it simply discards the packet. Therefore, the forwarding path is virtually a routing "pipe" from the source to the target: the sensor nodes inside this pipe are eligible for packet forwarding, and those outside the pipe do not forward.

C. Analytical Modeling and Mitigation Techniques for the Energy Hole Problem in Sensor Networks

Jian Li and Prasant Mohapatra [3] investigate the problem of uneven energy consumptions in a large class of many-to-one sensor networks. In a many-to-one sensor network, all sensor nodes generate constant bit rate (CBR) data and send them to a single sink via multihop transmissions. This type of sensor networks has many potential applications such as environmental monitoring and data gathering. Based on the observation that sensor nodes sitting around the sink need to relay more traffic compared to other nodes in outer sub-regions, their analysis verifies that nodes in inner rings suffer much faster energy consumption rates (ECR) and thus have much shorter expected lifetime. System lifetime of a sensor network is concerned with the time period in which the network can maintain its desired functionality , such as maintaining enough connectivity, covering entire area, or keeping miss rate below a certain level. Note that system lifetime is related to, but different from nodal lifetime. Nodal lifetime is the lifetime of individual sensor nodes. It depends on both given battery capacity and energy consumption rate. System lifetime of a sensor network has different definitions based on the desired functionality. It may be defined as the time till the first node dies. It may also be defined as the time till a proportion of nodes die.

D. Three-dimensional and two-dimensional deployment analysis for underwater acoustic sensor networks

Dario Pompili, Tommaso Melodia and Ian F. Akyildiz [4] describe a Underwater sensor networks envisioned to enable applications for oceanographic data collection, ocean sampling, environmental and pollution monitoring, offshore exploration, disaster prevention, tsunami and seaquake warning, assisted navigation, distributed tactical surveillance, and mine reconnaissance. There is, in fact, significant interest in monitoring aquatic environments for scientific, environmental, commercial, safety, and military reasons. While there is a need for highly precise, real-time, fine grained spatio-temporal sampling of the ocean environment, current methods such as remote telemetry and sequential local sensing cannot satisfy many application needs, which call for wireless underwater acoustic networking. UW-ASN communication links are based on acoustic wireless technology, which poses unique challenges because of the harsh underwater environment such as limited bandwidth capacity, high and variable propagation delays [5], high bit error rates, and temporary losses of connectivity caused by multipath and fading phenomena. In this paper, the authors consider two communication architectures for UW-ASNs, the two-dimensional architecture, where sensors are anchored to the bottom of the ocean, and the three-dimensional architecture, where sensors float at different ocean depths covering the entire monitored volume region. Deployment strategies for two-dimensional and three-dimensional architectures for underwater sensor networks were a deployment analysis was carried out, with the objective of determining the minimum number of sensors to achieve application-dependent target sensing and communication coverage; providing guidelines on how to choose the deployment surface area, given a target region; studying the robustness of the sensor network to node failures while providing an estimate of the number of required redundant sensors.

E. DBR: Depth-Based Routing for Underwater Sensor Networks

Hai Yan, Zhijie Jerry Shi, and Jun-Hong Cui [5] describe a novel protocol, called depth-based routing (DBR), for underwater sensor networks. DBR well utilizes the general underwater sensor network architecture: data sinks are usually situated at the water surface. Thus based on the depth information of each sensor, DBR forwards data packets greedily towards the water surface (i.e., the plane of data sinks). In DBR, a data packet has a field that records the depth information of its recent forwarder and is updated at every hop. The basic idea of DBR is as follows. When a node receives a packet, it forwards the packet if its depth is smaller than that embedded in the packet. In this paper, the authors presented Depth Based Routing (DBR), a routing protocol based on the depth information of nodes, for underwater sensor networks. DBR uses a greedy approach to deliver packets to the sinks at the water surface. Different from other geographical-based routing protocols that require full-dimensional location information of nodes, DBR only needs the depth information, which can be easily obtained locally at each sensor node. Further, DBR can naturally takes advantages of the multiple-sink underwater sensor network architecture without introducing extra cost. Their simulation results have shown that DBR can achieve high packet delivery ratios for dense networks, with reasonable energy consumption.

III SENSOR DEPLOYMENTALGORITHM

ABC algorithm

Artificial Bee Colony (EABC) 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.

ABC Algorithm

1: Initialize the solution population BS
2: Evaluate fitness value
3: cycle_loop = 1
4: repeat
5: Search for new solutions in the neighborhood location
6: if new solution is better than old solution then
7: Memorize new solution and discard old solution
8: end if
9: Replace the discarded solution with a new randomly generated solution
10: Memorize the best solution
11: cycle_loop = cycle_loop + 1
12: until cycle = maximumcycles

Heuristic For Sensor Deployment:

If any sensor node is idle (without monitoring any target), the node is moved to the least monitored targets' location. This is to ensure that all sensor nodes play their part in monitoring the targets. The sensor nodes are then sorted based on the number of targets it cover. The sensor node is placed at the middle of all the targets it covers. The next nearest target is identified and the sensor node is placed at the middle of all these targets. If it can cover this new target along with targets it was already monitoring, allow this move, and else discard the move.

This is done till the sensor node cannot cover any new target. At the end, upper bound is computed. The drawback of this approach is that it depends on the initial position of the sensor nodes. Though it may perform well for dense deployments, consistency cannot always be guaranteed.

A heuristic for Sensor Deployment

1: Place sensor nodes randomly
2: for i = 1 to m do
3: if Si does not monitor any target then
4: Move Si to the least monitored target
5: Recompute sensor-target coverage matrix
6: end if
7: end for
8: S = Sensor nodes sorted in ascending order of number of targets it covers
9: for i = 1 to m do
10: repeat
11: Place Si at the center of all targets it covers
12: Move Si to the center of all targets it covers and its next nearest target
13: if Si can cover a new target then
14: Recompute sensor-target matrix
15: else
16: Discard move
17: end if
18: until Si can cover another target
19: end for
20: Compute upper bound of network lifetime using

PSO Based Sensor Deployment:

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.

Algorithm PSO Algorithm

1: Initialize particles
2: repeat
3: for each particle do
4: Calculate the fitness value
5: if fitness value is better than the best fitness value (pbest) in history then
6: Set current value as the new pbest
7: end if
8: end for

9: Choose the particle with the best fitness value of all the particles as the gbest

10: for each particle do

11: Calculate particle velocity according to velocity update

12: Update particle position according to position update

13: end for

14: until maximum iterations or minimum error criteria is attained.

ACO For Sensor Scheduling

As mentioned earlier, another objective of this paper is to schedule the sensor nodes such that the theoretical upper bound of network lifetime can be achieved.

To achieve this, we propose a weight-based method for determining the cover sets. It includes the following main steps:

1: Input M, B

2: Initialize k/Q, max_run, priority calculated using battery power

3: for r = 1 to max_run do

4: for iteration = 1 to mi=1 bi do

5: if cover possibility exists then

6: Determine cover based on priority

7: Optimize cover

8: Activate optimized cover and reduce battery power

9: else

10: break

11: end if

12: end for

13: Calculate network lifetime (nlife)

14: if nlife < U then

15: Consider weight due to covered targets to compute priority to check for better lifetime

16: else

17: break

18: end if

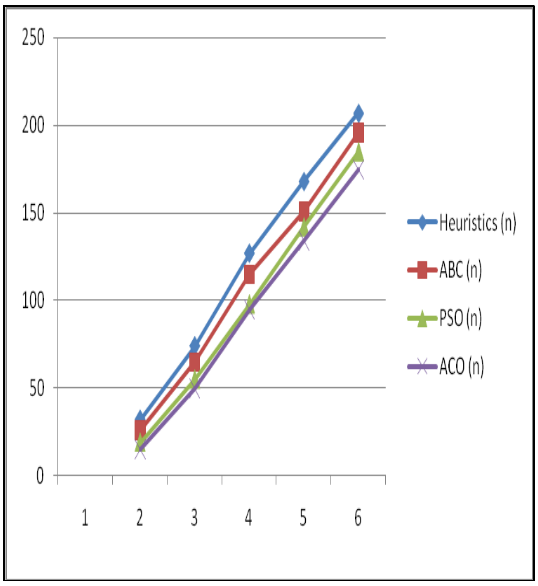
19: end for

IV EXPERIMENTAL RESULTS

The following **Table 4.1** describes experimental result for Heuristics, ABC, PSO algorithm and ACO algorithm in sensor deployment energy detection analysis. The table contains total number of wireless sensor node deployment and number of node count energy detection for Heuristics algorithm, number of node count energy detection for ABC algorithm, number of node count energy detection for PSO algorithm, number of node count energy detection for ACO algorithm details are shown.

Table 4.1 Sensor Deployments Scheduling (Node Energy Detection)

S.NO	NUMBER OF WSN NODE (n)	Heuristics (n)	ABC (n)	PSO (n)	ACO (n)
1	50	32	26	19	15
2	100	74	65	55	50
3	150	127	115	98	95
4	200	168	151	142	134
5	250	207	196	185	175



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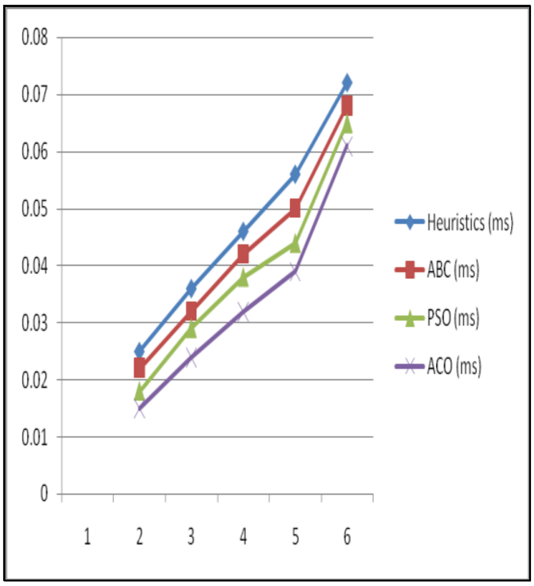
The following **Table 4.2** describes experimental result for Heuristics, ABC, PSO algorithm and ACO algorithm in sensor deployment time interval analysis. The table contains total number of wireless sensor node deployment and number of node time taken for Heuristics algorithm, number of node time taken for ABC algorithm, number of node time taken for PSO algorithm, number of node time taken for ACO algorithm details are shown.

Table 4.2 Sensor Deployments Scheduling (Time Interval Analysis)

S.NO	NUMBER OF WSN NODE DEPLOYMENTS(n)	Heuristics (ms)	ABC (ms)	PSO (ms)	ACO (ms)
1	50	0.025	0.022	0.018	0.015
2	100	0.036	0.032	0.029	0.024
3	150	0.046	0.042	0.038	0.032
4	200	0.056	0.050	0.044	0.039
5	250	0.072	0.068	0.065	0.061



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V CONCLUSION

In this paper, compute deployment locations for sensor nodes using artificial bee colony algorithm such that the network lifetime is maximum. 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. A heuristic algorithm 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.

The future work is to improve the contrast and produce more clear the resultant secret image. Further extend this work to use this technique with other format of sensor deployment. In future, study related to establish a sophisticated mixing model for the extended sensor deployment with better color quality will be considered. For future work, plan to extend this method of deployment and scheduling for probabilistic coverage in wireless sensor networks.

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