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Energy Hole And Coverage Holes Avoidance In Uwsn Using Dynamic Scheduling Algorithm

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Abstract : *This paper aims to identify optimal deployment locations of the given sensor nodes with a pre-specified sensing range, and to schedule them such that the network lifetime is maximum with the required coverage level. Since the upper bound of the network lifetime for a given network can be computed mathematically, this knowledge is used to compute locations of deployment such that the network lifetime is maximum paper. In this paper ultimate goal is to realize an automated monitoring network so that detection applications of various emergency events can be practically implemented. Further, the nodes are scheduled to achieve this upper bound. This proposed system uses artificial bee colony algorithm and particle swarm optimization for sensor deployment problem followed by a heuristic for scheduling. In addition, 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.*

Keywords : *UWSN, Sensor Deployment, Energy Hole, Sensor Scheduling, ABC algorithm, ANT Colony Algorithm, PSO algorithm.*

I. 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.

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:

1. Weight assignment
2. Cover formation
3. Cover optimization
4. 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.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.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.

II. Literature Survey

Balanced Load Distribution with Energy Hole Avoidance in Underwater WSNS[1] describes a hybrid routing mechanism is adopted and a two dimensional network model is proposed. BTM balances the data load among all sensor nodes by dividing the energy of each sensor node into energy levels. EEBET presents an Efficient and Balanced Energy consumption Technique (EBET) to avoid direct transmission at long distances for saving energy and calculates an optimum number of energy levels to enhance the network lifetime. Spherical Hole Repair Technique (SHORT) to repair coverage holes which are created due to energy holes. The technique has three phases: Knowledge Sharing Phase (KSP), Network Operation Phase (NOP) and Hole Repair Phase (HRP).

Autonomous Deployment of Sensors for Maximized Coverage and Guaranteed Connectivity in Underwater Acoustic Sensor Networks[2] describe a novel remote deployment of acoustic sensors which can maximize the coverage in 3-D while guaranteeing the connectivity among the sensors and a surface sink node to collect data. The approach assumes a randomly deployed UWASN on the surface of the water in 2-D. This can be achieved with random dropping of a certain number of sensors in a targeted area. The approach then determines the connected dominating set (CDS) of the whole UWASN at 2-D plane using a distributed approach [9]. The main goal here is to determine a backbone of the network consisting of dominators and then maintain the very same backbone connected underwater by exploring the third axis.

DSH-MAC: Medium Access Control Based on Decoupled and Suppressed Handshaking for Long-delay Underwater Acoustic Sensor Networks[3] describe a propose MAC protocol, DSH-MAC, designed for UW-ASNs to address their long propagation delay issue, based on active selection of sender by the receiver in an intelligent way. In DSH-MAC, The two control packets, namely NOTE and GRANT, are analogous to RTS and CTS packets, respectively. The NOTE packets are used to notify others of the sender's transmission intention, including the number of packets buffered for each receiver and the data generation rate. The two control packets are decoupled so that parallelism is allowed between handshaking/handshaking and handshaking/data transmissions, leading to higher network throughput.

Scheduling Multiple Mobile Sinks in Underwater Sensor Networks[4] describes Acoustic communications are used as a medium but they are only good for transmitting e.g. signalling information. Autonomous Underwater Vehicles (AUVs) can serve as mobile sinks that gather and deliver larger amounts of data from the underwater sensor network nodes. Value of Information (VoI) is a data tag that encodes the importance and time-based-relevance of a data chunk residing at a sensor node. VoI, therefore, can serve as a heuristic for path planning and prioritizing data retrieval from nodes.The use of multiple mini-sized AUVs has certain advantages as compared to the use of a single large AUV. Using multiple AUVs helps in the scalability of the area coverage and also provides the advantage for the fault-tolerance ability of the acoustic sensor network - an AUV can reschedule and complete the tasks for another AUV that has malfunctioned. Further, with the use of appropriate scheduling algorithms, one can use the heterogeneous abilities of different AUVs as an advantage.

Efficient Camera Selection for Maximized Target Coverage in Underwater Acoustic Sensor Networks[5] describe an approach that can coordinate the movement of appropriate cameras through the on-surface gateway. Each camera provides its location and orientation information to the gateway in advance so that the gateway can process this information in real-time when a request comes from the sensors to actuate cameras. When a target is detected, an approximate bounding box which contains the target is computed .The gateway then runs an algorithm to determine the cameras that are qualified to be covering the bounding box by vertical movement. Specifically, for each camera the gateway determines the set of discrete points it can cover with the least vertical movement. This problem is similar to minimum set cover where the discrete points for the bounding box constitute the set to be covered by the subsets owned by each camera. They model the problem as a weighted minimum set cover to also accommodate the distances of cameras to the target. Since weighted minimum set cover is also an NP-hard problem, they used a greedy heuristic for faster processing.

III. Sensor Deploymen Algorithm

3.1 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
16. lifetime
17. else
18. break
19. end if
20. 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.

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

Table 4.1 Sensor Deployments Scheduling (Node Energy Detection)

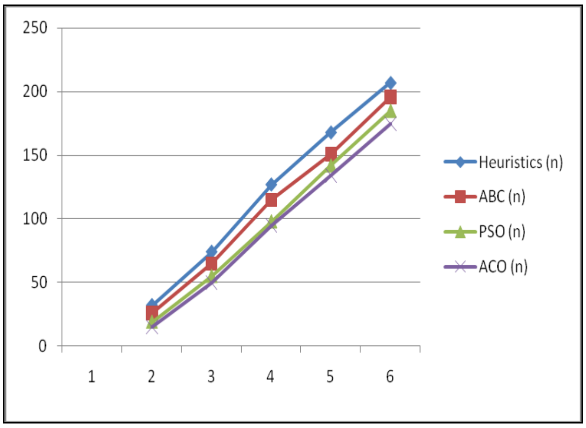

Fig 4.1 Sensor Deployments Scheduling
(Node Energy Detection)

The following **Fig 4.1** describes experimental result for Heuristics, ABC, PSO algorithm and ACO algorithm in sensor deployment energy detection analysis. The figure 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.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.

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**

Table 4.2 Sensor Deployments Scheduling
(Time Interval Analysis)

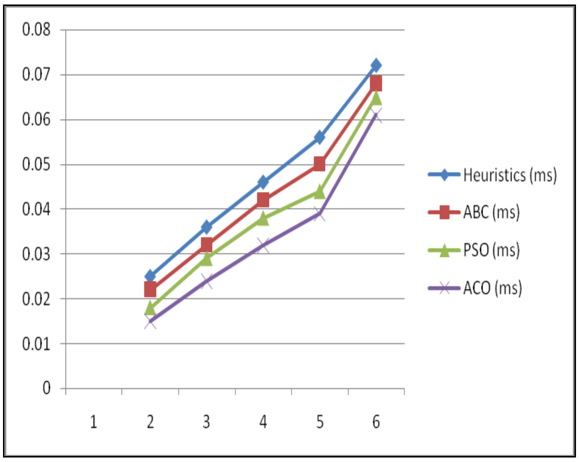

Fig 4.2 Sensor Deployments Scheduling
(Time Interval Analysis)

The following **Fig 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.

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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