Directional Sensor Network Lifetime Maximization and Optimal Coverage Using Mobile Sensor Nodes

Kalaivani.J, Mrs. Prabula,

III MCA, Lord Jegannath College of engineering and technology, Ramanathichanputhur,

Assistant Professor/Department of Computer Applications,

Lord Jegannath College of engineering and technology, Ramanathichanputhur

Abstract—Target surveillance applications of directional sensor networks are constantly emerging. The environmental energy harvesting technologies are promising solutions for alleviating the energy shortage in sensor networks. This work addresses the maximum lifetime target coverage problem in energy harvesting directional sensor networks.

Index Terms — Coverage quality, Directional sensor networks, energy harvesting, network connectivity, network lifetime, target coverage

1. INTRODUCTION

Directional sensor networks (DSNs) are widely applied in target observation. The maximum lifetime target coverage problems in DSNs have been reported by many researchers. Multiple directional cover sets (MDCS), and four algorithms are proposed to solve it. In a greedy algorithm and learning automata-based algorithm are developed to solve the MDCS. Some work investigates the maximum lifetime target coverage problems in energy harvesting wireless sensor networks. A linear programming based clarification and a scalable heuristic called maximum utility algorithm are proposed. In this job we address the maximum lifetime target coverage (MLTC) problem in EHDSNs. In this difficulty, the different coverage quality requirements of targets should be continuously satisfied, the network connectivity should be maintained, and the sensing power of a sensing node is independent of the number of the targets it covers. In recent years, with the development of micro-electromechanical systems (MEMS) directional sensor networks (DSNs) have received much attention due to their wide and important applications [1], which offer important economic benefits. A DSN is a wireless network which is equipped with directional sensors such as video sensors, ultrasound and infrared sensors. Differing from the sensor nodes of the usual wireless sensor networks (WSN) which have Omni directional sensing ranges, the sensing range of DSN sensor nodes are controlled by their directions and specific angular dimensions. Since directional sensing and directional communication have great impact on the performance of a DSN, several difficulties have emerged in DSN protocol design. One of the mainly fundamental problems is the coverage issue. Although there are extensive amounts of research about the coverage trouble in WSNs, however, these WSN research results cannot be directly applied to DSNs.

In this document a coverage control algorithm based on a multi-objective optimization method is expectations to reduce the control consumption of networks and widen the lifetime of the network. It should be noted that two assumptions which are generally considered in the published documents about Sensors 2015, 15, 30617–30635 the coverage problems of DSNs are relaxed in order to formulate a more sensible DSN deployment problem. The First statement, the types of sensor nodes in the DSN. Certainly, in most research mechanism, sensor nodes are identical in terms of energy and hardware difficulty. We consider in the paper a heterogeneous directional sensor network (HDSN), in which each node has different sensing radius, communication radius and field of angle. To the best of our information, research on the network coverage in HDSNs is less marked. The second statement is the sensing requirement within the monitored area. In most of the published documents, the whole supervised region is considered to be of the same importance. In other words, the sensing requirement is uniformly distributed within the area [2]. However, this statement is not always valid for some applications. For example, in water quality monitoring, the risky area near the chemical deposits or animal/human habitats needs high detection levels, while for other areas a low detection level is sufficient. To sum up, the key contributions of this documentation are as follows: Firstly, we suggest a sensible case study of a coverage algorithm for the assignment field considered by a geographical irregularity of the sensed events in a HDSN by ensuring the connectivity of the network, reducing the cost of deployment. Secondly, thisdocument suggest a learning automata-based coral reef algorithm for adaptive parameter selection. Learning capabilities are used in the coral reef algorithm to select its parameters. As a outcome, the convergence rate and the investigate abilities of the algorithm are enhanced. Experimental outcome show the superiority of the future algorithm. Thirdly, a narrative decay advance is introduced to decay the multi-objective problem into a single-objective problem. Theoretical proofs and numerical results indicate the efficiency of the proposed method.

2. RELATED WORKS

As an important investigates issue, the coverage trouble has been studied extensively, and many solutions have been pro- posed. Some solutions focus on pure coverage trouble to characterize the coverage of wireless ad hoc sensor networks. Other solutions integrate network connectivity into coverage trouble Network connectivity, which indicates whether any two nodes in a sensor network can communicate with each other, is necessary for successful data transmission. An algorithm to construct a sensor network with connected coverage is valuable to real world applications. Furthermore, minimizing the energy consumption to prolong the lifetime of a sensor network is considered. Some algorithms and protocols are designed to achieve energy efficiency while maintaining a fully covered connected wireless ad hoc sensor network. We surveyed existing methods and their contributions which address various research objectives in the coverage problem. In the following subsections, we will present in some detail the algorithms or solutions, their assumptions, and results.

Some work in [3]–[5] investigates the maximum lifetime target coverage problems in energy harvesting wireless sensor networks. A linear programming based solution and a scalable heuristic called maximum utility algorithm are proposed in [3]. In addition to the centralized algorithm, a distributed algorithm named maximum energy protection is presented in [4]. Different from the work in [3], [4], the work in [5] considers the network connectivity requirement. Herein, a linear programming based solution and energy conservation heuristic are devised. The work in [3]–[5] aims at energy harvesting Omni directional sensor networks, and is not applicable to EHDSNs. In this work, we address the maximum lifetime target coverage (MLTC) problem in EHDSNs. In this problem, the different coverage quality requirements of targets should be

Continuously satisfied, the network connectivity should be maintained, and the sensing power of a sensing node is independent of the number of the targets it covers. The remainder is organized as follows. The next section elaborates the problem, and formulates it as a mixed integer nonlinear programming (MINLP) model. Two algorithms are proposed to solve it in section III. Section IV compares the performance of the proposed algorithms by simulations. Finally, section V concludes this work.

3. PROBLEM STATEMENT

We consider the scene where a number of rechargeable directional sensors and a base station are utilized to monitor some targets with different priorities. The direction (or orientation) of a sensor is defined by the counter clockwise angle from the positive horizontal axis to the unit vector which divides the sensing range of the sensor in half. We denote the number of the sensors by M, the number of the targets by N, the i-th sensor by si, where 1 ≤ i ≤ M, and the j-th target by tj, where 1 ≤ j ≤ N. The base station is labelled by sM+1. All sensors have the same sensing radius rs, sensing angle θ, and direction set Ψ={ψ1,ψ2,...,ψL}, where L is the number of the directions per sensor. Each sensor can rotate to any direction in Ψ and perform Omni directional communication. The transmission radius of each sensor is continuously adjustable, and all sensors have the same maximum transmission radius rtmax. Let di,j, di,j and μi,j represent the distance between sensor si and target tj, the distance between node si and node sj, and the counter clockwise angle from the positive horizontal axis to the ray sitj, respectively. Similar to [6], the coverage quality requirement of a target tj is given by λj = c1ωj +c2, where ωj is the priority of tj, c1 and c2 are configuration parameters, and the coverage quality provided by a direction ψj of sensor si for target tk is defined as i,j,k =1−(di,k/rs)2 di,k ≤ rs and |μi,k −ψj|≤θ 2 0 otherwise (1)

Let σ (bps) is the sensed data generation rate of each sensing node. Denote es (J/b) and er (J/b) as the energy consumed for sending and receiving a bit data, respectively. The energy consumed by a sensor si to transmit a bit data to a node sj is given by eti,j = α + δ(di,j)β (J/b) [6], where α and δ are constants, β is the power attenuation exponent. The energy harvesting rate of a sensor si is marked by hi (W). In this work, we do not consider the energy consumption and delay caused by sensor rotation, and assumes that a sensor in the sleep state expends no energy. Denote B and E0 i as the battery capacity of each sensor and the initial residual energy of a sensor si, respectively.

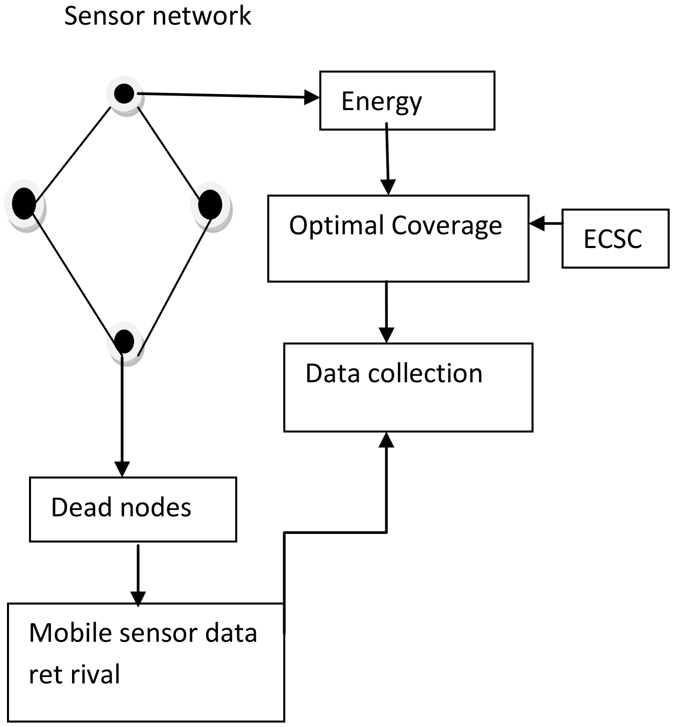
4. PROPOSED ALGORITHMS

4.1 PROPOSED SYSTEM

In this job, we address the maximum lifetime target coverage (MLTC) problem in EHDSNs. In this problem, the different coverage quality requirements of targets should be continuously satisfied, the network connectivity should be maintained, and the sensing power of a sensing node is autonomous of the number of the targets it covers A maximum lifetime heuristic (MLH) for MLTC is presented. It iteratively use the cover set construction (CSC) algorithm to construct a number of the cover sets and determine their working time until a cover set cannot be formed. CSC first selects the sensing nodes and their working directions, and then builds the communication paths from the sensing nodes to the base station. We propose an enhanced maximum lifetime heuristic (EMLH) for MLTC. It iteratively adopts the enhanced cover set construction (ECSC) algorithm to build a series of cover sets with assigned functioning time.

- The efficiency of coverage has been increased.
- Network partitions situations handled by mobile sensor nodes.

4.2 ARCHITECTURE DIAGRAM



4.3 MODULES

a. NETWORK FORMATION

A single sensor can be characterized by traditional specification such as sensing range, resolution, and accuracy. To characterize the coverage quality in a sensor network, the approach presented in [8] proposed a new sensor network specification called Sensing Field (SF). The sensing field measures how well a position in the area of sensor network is monitored. Computing the sensing field helps to deploy a sensor network with better sensing performance.

d. ENHANCED COVER SET CONSTRUCTION

A Coverage Configuration Protocol (CCP) is proposed in [10]. CCP can configure a sensor network to any coverage degree and maintain network connectivity at the same time. A scheduling mechanism is used in CCP to activate sensor nodes; but this mechanism does not ensure the number of activated sensor nodes to be minimum. Assuming a disk sensing range, the work in [10] shows that coverage implies connectivity if the communication range Rc is greater or equal to twice the sensing range Rs. CCP is base on the K-coverage Eligibility algorithm which is executed by each sensor node (e.g. node A in Fig. 2) to decide whether it should become active. The coverage degrees of the intersection points (e.g. p1, p2, p3 in Fig. 2) are computed. If any one of these intersection points is covered by less than K sensors, sensor A is eligible to activate itself. In Fig. 2, node A is ineligible for K =1, but eligible for K ≥ 2. The complexity of the K-coverage Eligibility algorithm is O(d3), where d is the number of nodes in the largest sensing neighbour set. CCP is a distributed and localized protocol, which has three modes, sleep, listen, and active. If Rc ≥ 2Rs, CCP is sufficient to configure a sensor network with both coverage and connectivity; if Rc < 2Rs, CCP integrates SPAN [4] to maintain the network connectivity**.**

b. OPTIMIZED COVERAGE

In this section, a maximum lifetime heuristic (MLH) for MLTC is presented it iteratively utilize the cover set construction (CSC) algorithm to construct a number of the cover sets and determine their working time until a cover set cannot be formed. CSC first selects the sensing nodes and their working directions, and then builds the communication paths from the sensing nodes to the base station.

c. DATA COLLECTION

After determining the sensing nodes and their working directions, we find the paths to connect the sensing nodes to the base station. To effectively balance the energy consumption of sensors, we should adapt the maximum lifetime paths. In [18], the algorithm termed greedy single-topology multicast (GSM) can be used to find a maximum lifetime path from a source node to a destination node. However, when MLTC is solved, GSM cannot be directly applied to construct a maximum lifetime path from a sensing node to the base station because it considers only the transmission power. In order to construct a directed acyclic graph instead of a tree to connect all the sensing nodes to the base station, we iteratively construct a path from a sensing node to the base station. Thus, when we apply GSM to build a maximum lifetime path from a sensing node to the base station, we should take into account the existing total power of a sensor.

d. MOBILE SENSOR

The working time of a cover set is the smaller between the minimum operation time of the sensors in the cover set and the minimum operation time of the sensors in the cover set and the minimum recharging time of the sensors outside the cover set. This can reduce the waste of the recharging opportunities of sensors. We propose an enhanced maximum lifetime heuristic (EMLH) for MLTC. It iteratively adopts the enhanced cover set construction (ECSC) algorithm to build a series of cover sets with assigned working time. CSC splits the cover set construction into the sensing node set construction and the communication path set construction. As a result of the splitting, the sensing node selection ignores the energy consumption rates and the recharging rates of sensor. This can deteriorate the energy balance of sensors. To overcome these disadvantage. ECSC constructs a cover set by integrating the sensing node set construction with the communication path set construction.

5. PERFORMANCE EVALUATION

In this section, we compare the performance of the proposed algorithms by simulations with regard to the average network lifetime and the average running time. The simulation program is developed using java programming language on MyEclipse8.5 platform and runs on Lenovo Think Pad Computer T450s installed Windows 7 with CPU Intel Core i5-5200U at 2.20 GHz and RAM 4 GB. For each setting of them, we randomly generate 100 problem instances each of which can by successfully solved by both the proposed algorithms. In each instance, the positions of all sensors, all targets, and the base station are randomly generated, the initial residual energy and energy harvesting rate of each sensor are randomly drawn from intervals [0.01.0.2] W respectively.

We observed from them, EMLH can always obtain longer average network lifetime than MLH. Thus, the simulation results verify our theoretical analysis. We can find that the network lifetime decreases as the number of targets grows, because more energy has to be consumed. With the rise of the number of sensors, more energy is available, so the network lifetime increases, as observed. This due to the fact that less sensors are needed to satisfy the coverage quality requirements of all targets. One can see that the running time of an algorithm does not always increases as the number of targets grows. The reason is that the number of cover sets in a solution decreases despite the rise of the computing time of constructing a cover set. The main reason why EMLH has longer average computing time than MLH is that EMLH invokes MLPB more times than MLH.

6. CONCLUSION

DSNs are widely used to survey targets. A powerful approach to supplementing the battery energy of the directional sensors is enabling them to harvest energy from their surrounding environments. However, EHDSNs may not ensure the perpetual continuous target monitoring. To this end, examine the MLTC problem in this work. It show that MLTC is NP-hard, give an MINLP formulation for it, and develop two heuristic algorithms for it .Both the algorithms are effective as they deal with the indispensable sensor directions and the critical targets, find better communication paths, and improve the coverage efficiency. Different from MLH, EMLH integrates the sensing direction set construction and the communication path set construction to further balance the energy of sensors. Simulation results show that the algorithms are effective and EMLH outperforms MLH in terms of solution quality. The algorithm that integrates optimization into scheduling has achieved significant energy conservation. We plan to compare the performance of these algorithms based on a common platform using simulations. More research could be conducted for the practical deployment of a sensor network.

REFERENCES

1. M. A. Guvensan and A. G. Yavuz, “On coverage issues in directional sensor networks: A survey,” Ad Hoc Networks, vol. 9, no. 7, pp. 1238– 1255, 2011.
2. F. K. Shaikh and S. Zeadally, “Energy harvesting in wireless sensor networks: A comprehensive review,” Renewable and Sustainable Energy Reviews, vol. 55, pp. 1041–1054, 2016.
3. C. Yang and K.-W. Chin, “Novel algorithms for complete targets coverage in energy harvesting wireless sensor networks,” IEEE Communications Letters, vol. 18, no. 1, pp. 118–121, 2014.
4. “A novel distributed algorithm for complete targets coverage in energy harvesting wireless sensor networks,” in Proceeding of IEEE ICC 2014, 2014, pp. 361–366.
5. “On complete targets coverage and connectivity in energy harvesting wireless sensor networks,” in Proceedings of the 22nd International Conference on Telecommunications (ICT 2015), 2015, pp. 391–397.
6. “Lifetime Maximization of Connected Differentiated Target Coverage in Energy Harvesting Directional Sensor Networks” Xiaojian Zhu School of Computer Science and Engineering Changshu Institute of Technology, Changshu 215500, China.
7. A. Orda and B.-A. Yassour, “Maximum-lifetime routing algorithms for networks with Omni directional and directional antennas,” in Proceedings of MobiHoc’05, 2005, pp. 426–437.
8. H. Mohamadi, S. Salleh, and A. S. Ismail, “A learning automata-based solution to the priority-based target coverage problem in directional sensor networks,” Wireless Personal Communications, vol. 79, no. 3, pp. 2323–2338, 2014.
9. Y.-H. Kim, Y.-H. Han, Y.-S. Jeong, and D.S.Park, “Lifetime maximization considering target coverage and connectivity in directional image/video sensor networks,” The Journal of Super computing, vol. 65, no. 1, pp. 365–382, 2013.
10. H. Mohamadi, A. S. Ismail, and S. Salleh, “Utilizing distributed learning automata to solve the connected target coverage problem in directional sensor networks,” Sensors and Actuators A: Physical, vol. 198, pp. 21– 30, 2013.