Improved Coverage In Wireless Sensors Using Geometric Programming Techniquese

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Abstract— Energy consumption is major issue in Wireless Sensor Network (WSN). As the battery-powered sensor nodes are greatly constrained in energy supply, it is of tremendous significance to investigate energy optimization methods to prolong WSN lifetime. For Energy optimization various approaches have been worked out by researchers. The one of approaches introduces reliable routing and networking protocol. The networking protocol provides reliable data delivery and minimizes energy overhead. In this paper, we address a practically important problem of minimizing sensors' movement to achieve both target coverage and network connectivity with some popular algorithms i.e. Voronoi diagram and Delaunay triangulation covering this issue has been discussed.

Keywords- *Wireless Sensor Network, power optimization, Target coverage, efficiency*.

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I. INTRODUCTION

A WSN is different from other popular wireless networks like cellular network, wireless local area network (WLAN) and Bluetooth in many ways. Compared to other wireless networks, a WSN has much more nodes in a network, distance between the neighboring nodes is much shorter and application data rate is much lower also. Due to these characteristics, power consumption in a sensor network should be minimized. A primary principle of wireless sensor network is energy efficiency. To avoid this issue of energy consumption different techniques are invented. The sensor nodes are generally inaccessible after deployment and normally they have a finite source of energy that must be optimally used for processing and communication to extend their lifetime. It is a well-known fact that communication requires significant energy. In order to make optimal use of energy, therefore communication should be minimized as much as possible [1]. A Wireless Sensor Network (WSN) is a collection of tiny sensor nodes which are interconnected by wireless communication channels. Each sensor node is a small device that can collect data from its surrounding area, carry out simple computations and communicate with other sensors or with the base station (BS).The nodes are deployed in a monitoring field as shown in the following Figure 1.1 and each of them capture data and sends data back to the base station or sink [3].

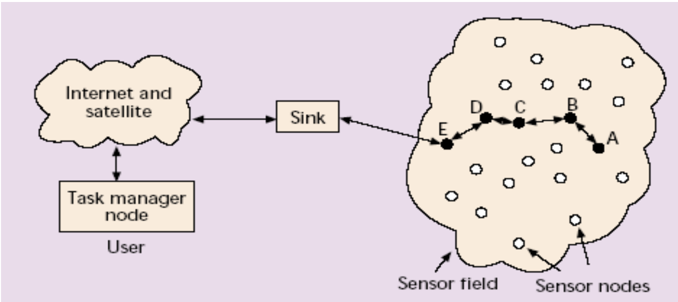


Fig. 1.1: Information flow in wireless sensor network [3]

Data are routed back to the sink by following direct or multi-hop dedicated path. The base station may communicate with the task manager via Internet or satellite. The information flow in typical WSN is explained in Figure 1.1 [3]. Wireless Sensor Networks (WSN) consists of a huge number of sensors with energy resource limitation, dispersed in a region. The network nodes sense data from the region and send them to base station. Each node just knows about sensing region of its own. The overlap areas will have negative impact on the energy factor. It is because of the possibility of repeating messages [4].

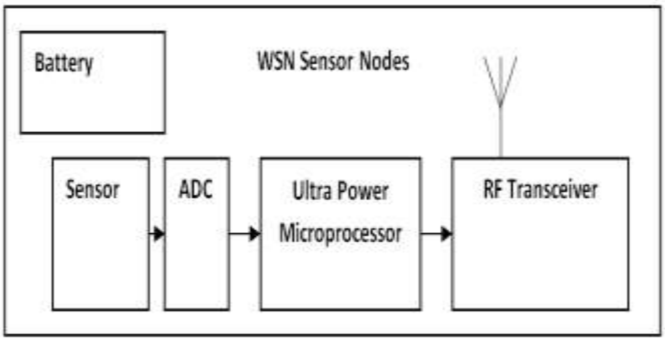


Fig. 1.2: Wireless Sensor Network Component [2]

As sensors are usually powered by energy limited batteries and thus severely power-constrained, energy consumption should be the top consideration in mobile sensor networks. Specially, movement of sensors should be minimized to prolong the network lifetime because sensor movement consumes much more energy than sensing and communication. However, most of the existing studies aimed at improving the quality of target coverage, e.g., detecting targets with high detection probability, lowering false alarm rate and detection delay. Little attention has been paid to minimizing sensor movement. To fill in this gap, this study focuses on moving sensors to cover discrete targets and form a connected network with minimum movement and energy consumption [1].

II. RELATED WORK

In these studies, mobile sensors move actively to improve the surveillance quality, but the optimization of sensor movement is not explicitly considered. Reactive mobility is exploited to improve the quality of target detection, but the movement of sensors is not considered as the primary optimization objective. In [7] mobile sensors are scheduled to replace failed static sensors in order to guarantee coverage ratio with minimum movement distance. But each sensor concerned in [7] can cover only one target and the maximum moving distance for each mobile sensor is limited. An optimal velocity schedule is proposed to minimize energy consumption in movement when the road condition is uniform.

Many research efforts have also been made to improve the area coverage with mobile sensors with the aim of maximizing the covered area. In [1] Voronoi diagrams are used to detect coverage holes. After that, sensors are dispatched to cover the detected holes. As a result, the area coverage ratio is improved. Further, a multiplicative weighted Voronoi diagram is used to discover the coverage holes corresponding to different sensors with different sensing ranges. However, Voronoi diagram to discover the coverage holes corresponding to different sensors with different sensing ranges. Voronoi diagrams in these studies are constructed according to the position of mobile sensors, and thus need to be recomputed after each round of sensor movement. Mobile sensors are used to improve energy efficiency of sensors in area coverage. In this work, when destinations have been determined, mobile sensors are designed to move along the shortest path to minimize the energy consumption. Given designated destinations, k-coverage is studied in [1]. In this work, a competition scheme is proposed to minimize energy consumption in movement. Recently, parameterized algorithms were exploited to find max- lifetime target coverage and min-power multicast paths in WSNs. In these studies, destinations of mobile sensors are given in advance, and the energy efficiency is considered in the path finding process.

Mobility of sensors could also be exploited to enhance network connectivity after the coverage stage is completed. In, a triangular deployment strategy is proposed to dispatch sensors to connect the network after deploying mobile routers to maximize the coverage area. In the proposed strategy, sensors move along the shortest path to the corresponding triangular vertices in order to save energy. The authors considered a hybrid network consisting of both static and mobile sensors. It first divides the static sensors into groups as large as possible, and then seeks the minimum number of mobile sensors to connect these static sensor groups. A sensor node relocation approach is proposed to maintain connectivity between a region of interest and a center of interest outside the deployment region where a particular event happens.

The originality of this study and differences from the existing work include. (1) In this work, sensors move reactively and each sensor can cover more than one target, which is more general in practice, but also makes the problem more complicated. (2) The Voronoi diagram of targets is adopted to find the nearest sensor, which avoids blind competition among mobile sensors. Besides, because our solution generates the Voronoi diagram according to the position of targets, it does not require re-computation of the Voronoi diagram as the targets are static. This contributes to the lower complexity of the proposed solution. (3) Destinations of mobile sensors are unknown, which should be computed by our algorithms. When mobile sensors move to these destinations, both target coverage and network connectivity are satisfied. (4) In order to investigate the impact of network parameters on the performance of our algorithms, analyses and evaluations are given according to the simulation experiment results, which provides a reference for practical engineering and theoretical basis for the design of mobile sensor networks.

III. METHODE OF APPROACHE

A. The Basic Algorithm

A simple heuristic to minimize the movement distance of sensors is to minimize the number of sensors that need to move. Actually, after the sensors are deployed, some targets may have already been covered. Denote the set of targets that have already been covered by Tinitcov, and denote the set of uncovered targets by Tneedcov. Then we have Tneedcov =T n /Tinticov. In order to minimize the number of mobile sensors that need to move, we first construct a graph of targets representing whether targets can be simultaneously covered, then find the destinations of mobile sensors by using clique partition. However, although the Basic algorithm minimizes the number of sensors to move, it may increase the total movement distance of sensors.

The graph is constructed as follows. For every target in Tneedcov, there is a vertex in the graph. There is an edge between two vertices if and only if the corresponding targets could be simultaneously covered by the same sensor. After the graph is constructed, we find a minimum clique partition of the constructed graph. Each partitioned clique represents a subset of targets that can be covered by the same sensor. Thus, for targets belonging the same clique, we need to dispatch only one mobile sensor to cover them. With this method, the number of mobile sensors that need to move is minimized. After the clique partition is obtained, the extended Hungarian algorithm is used to determine which sensor should be dispatched to cover the targets in each clique

B. The Target-Based Voronoi Greedy Algorithm

In [1] this section, we present a target based Voronoi greedy algorithm (TV-Greedy) to minimize the total movement distance of sensors to cover targets. The basic idea of TV-Greedy is to deploy the nearest sensor to cover the targets that are uncovered. Since sensors located in a target's Voronoi polygon are closer to this target than to others, we use Voronoi diagrams of targets to group sensors according to their proximity to the corresponding target. First, the Voronoi diagram of targets is generated by using the coordinate information of targets which is known to sensors. Based on the vertices information of Voronoi polygons, the neighbors of each target are determined.

Second, the own server group OSG of each target is determined. In each OSG, the own servers (sensors in the OSG) is sorted by their distances to the client (the target of the OSG) in ascending order, according to which the chief server is identified as the first in the sorted list. For the rest own servers, we identify the aid server for each neighbor of the client via distance comparison and sorting, as shown in Fig.

Third, for each target, if it is covered initially, sensors in its OSG stand by and wait for orders. If the target is not covered initially, then its CSG will be formed, which is a logical server group merged with the chief server of the target and all the aid servers from its neighbors.

TV-Greedy starts from the generation of targets' Voronoi diagrams, which divides sensors into independent groups for each target. With assistance of targets' Voronoi diagrams, we can construct a sensor group for each target, which includes sensors in proximity to this target.

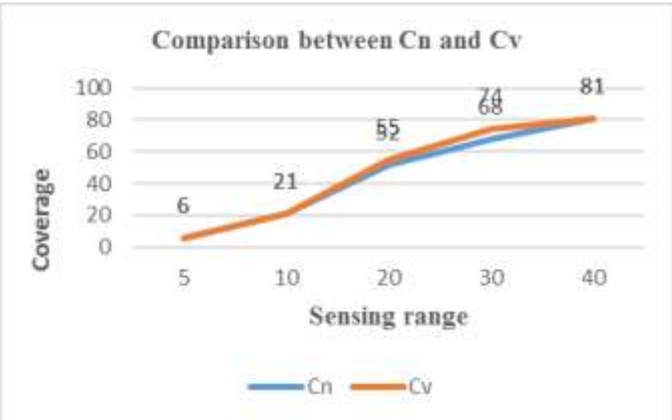
C. Delaunay triangulation

In this section, we present the Delaunay algorithm which is used to place the nodes in proper locations.

Comparison Table and Graph for Coverage Cn and Cv

Sr (m)	Cn	Cv
5	6	6
10	21	21
20	52	55
30	68	74
40	81	81

Where, Sr-sensing range
Cn-Coverage obtain normally
Cv-Coverage obtained using voronoi algorithm



The graph shows the comparison between coverage obtained normally and coverage obtained using voronoi algorithm. The graph shows that there is a little improvement in coverage after using the voronoi algorithm. After using voronoi algorithm the area is divided into number of parts but the sensors are also sensing or detecting the targets which are not in their area means the targets situated in the neighboring area is also sensed or detected. The energy is wasted in detecting the neighboring targets so now we have to again minimize the movement of the nodes so that the sensor nodes sense the targets which are only in their area. For this purpose we are going to use the Delaunay triangulation method which place the nodes into proper places so that the movement of the nodes range is up to the boundaries of the region.

The basic idea of TV-Greedy is to deploy the nearest sensor to cover the targets that are uncovered. Since sensors located in a target's Voronoi polygon are closer to this target than to others, we use Voronoi diagrams of targets to group sensors according to their proximity to the corresponding target.

For the sake of clarity, the definitions and notations that will be used in the algorithm description is presented below:

1) If a sensor is located in a target's Voronoi polygon, the sensor is defined as a server to this target, and the target is regarded as a client of its servers. The set of a target's servers is called that target's own server group (OSG). The sensor in a target's OSG that is nearest to the target is called the chief server of that target, and other sensors are called non-chief servers of the target.
2) Two targets are neighbors if their Voronoi polygons share an edge. For two neighboring targets A and B, the sensor in A's OSG that is closest to B is called an aid server to B.
3) A target's candidate server group (CSG) is the union of its own chief server and aid servers from neighbors. For a target, only sensors in its CSG will be dispatched to cover it.

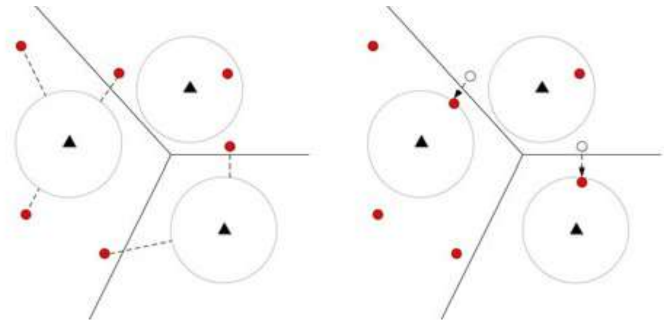


Fig. 1.2 Voronoi diagram

For instance, as shown in Fig. 4, the own server group of target t_B is OSG_B = {S4, S5, S6}, in which s4 is the chief server. For other sensors in OSG_B, S6 is the aid server for t_A, and s5 is the aid server for t_C. Meanwhile, t_B has an aid server from t_C, which is s2. Thus the candidate server group of t_B is CSG_B = {S4, S2}. Note that there is no sensor in target t_C's Voronoi polygon, and thus there is no aid server for t_B from t_C even though t_B and t_C are neighbors.

IV. CONCLUSION

Proposed work will result in minimizing the energy needed for movement of nodes, improve coverage area and throughput is also improved. The concept of Voronoi diagrams to divide the entire network into regions of varying nodes. So a node will only have the responsibility to improve the coverage of the area in which Voronoi diagram has placed it. Thus the node movement is restricted. So the energy needed for movement will be reduced and the coverage area will be improved. This will allow the network to retain energy for a longer time duration.

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