Effective Deployment with Energy, Delay and Lifetime data collection protocol for Wireless Sensor Network

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Abstract- *The problem of multiple coverage has been intensively investigated for wireless sensor networks (WSNs), how to arrive at a multiple-coverage sensor deployment that optimizes certain objectives in relatively sparse WSNs. In this paper, we present a practical algorithm, i.e., the Effective Deployment with Energy, Delay and Life time data collection protocol for Load balancing in multiple-surface coverage , to move sensor nodes toward k-surface coverage, aiming at minimizing the maximum sensing range required by the nodes. It enables purely autonomous node deployment as it only entails localized computations to be closely integrated with compressive sensing, an emerging technique that promises considerable reduction in total traffic cost for collecting sensor readings under loose delay bounds. Finally, we use simulation results to evaluate its performance.*

Keywords- wireless sensor networks, deployment, k-area/surface coverage, load balancing, energy efficiency, Data collection, routing protocols.

I. INTRODUCTION

One of the major functions of wireless sensor networks (WSNs) is to monitor a certain area in terms of whatever physical quantities demanded by application. In achieving this goal, a basic requirement imposed onto WSNs is their area/ surface coverage:1 it indicates the monitoring quality of WSNs. Whereas many research proposals focus on either analysing the performance of static sensor deployments or scheduling sensor activity to retain the coverage of given deployments.

Due to the vulnerability of sensor nodes, multiple-coverage (k-coverage) is often applied to enhance the fault tolerance in face of node failures and prolonging the lifetime of WSN and guaranteeing packet delivery delays are critical for achieving acceptable quality of service. In addition, k-coverage may yield higher sensing accuracy through data fusion and Many sensing applications share in common that their source nodes deliver packets to sink nodes via multiple hops, leading to the problem on how to find routes that enable all packets to be delivered in required time frames, while simultaneously taking into account factors such as energy efficiency and load balancing. Existing approaches in achieving k-coverage rely on either randomized or regular deploy- ments. Whereas randomized deployments require a substantially denser network regular deployments serve only as theoretical guidelines as they often require centralized co ordinations and may not accommodate irregular network regions. Also, if the physical phenomena under surveillance change, To achieve trade offs in terms of delay, energy cost, load balancing , and re-deployment can be huge. Therefore, Effective deployments ,when movable nodes are available, are good complements to the randomized or regular deployments and on open vehicle routing (OVR) problems are usually based on similar assumptions and constraints compared to sensor networks, if we treat packet delays as delivery time of data packet, and energy cost as delivery cost of data packet, it may be possible to exploit research results in one domain to stimulate the other. However, existing techniques for Effective deployments may only handle 1-coverage, and extending them to k-coverage is highly nontrivial. Effective deployments through (node) motion control require each node to compute its coverage in a localized manner (i.e., relying as much as possible on close-by nodes). almost heuristics that offer no provable guarantee on the quality of the eventual deployment. Our goal is to cover a certain monitored area or surface to the extent that every point in this area/surface is at least monitored by k sensor nodes and that the maximum sensing range used by the nodes is minimized improves the energy efficiency with minimum delay and increases the life time of the WSN nodes.

II. RELATED WORK

Point coverage problem has been extensively studied in the past decade. Besides providing coverage service, their another concern is the limited energy supply of sensor nodes. Given a random deployment with static sensor nodes, they either divide the nodes into multiple sets and schedule the duties of these set,or minimize the number of the active sensor nodes to guarantee the network lifetime. The energy limitation is also taken into account in area coverage with random deployments, e.g. .Inspired by them, maximizing the network lifetime is also one of the main objectives of our proposal but in a quite different way. VRP finds routes between a depot and customers with given demands so that the transportation cost is minimized with the involvement of the minimal number of vehicles, while satisfying capacity constraints. With additional constraints, VRP can be further extended to solve different problems, where one of the most important is the vehicle routing problem with time windows (VRPTW) [9]. This problem occurs frequently in the distribution of packets and services, where an unlimited number of identical vehicles with predefined capacity serve a set of customers with demands of different time intervals .Our objective is to minimize the total transportation cost through the minimum number of vehicles, without violating any timing constraints in delivering packets. If vehicles are not required to return back to the depot, and if the time windows are replaced by deadlines, VRPTW can be further extended to the open vehicle routing problem with time deadlines.

III. PROBLEM DEFINITION AND MATHEMATICAL BACKGROUND

In this section, we first present the system model and define our optimization problem, and then introduce the relevant mathematical basics. To simplify the exposition, the above discussions are all for 2-D plane with Euclidean metric.

A. System Model

We assume a WSN consisting of a set N = {n1,⋯,nN} of sensor nodes, and |N| = N. Let U = {u1,⋯,uN} denote the locations of sensor nodes. The nodes are initially deployed arbitrarily on a 2-D targeted areaA. Each node ni is equipped with certain mechanisms (e.g., motors plus wheels) that allow it to gradually change its location ui [10]. We also suppose that nodes are equipped with bumper sensors to detect and avoid obstacles in the targeted area [30]. All nodes have an identical transmission range γ, and we denote by N(ni)= {nj $\| u_i - u_j \|_2 \leq \gamma, i \neq j$} the one-hop neighbours of ni. We define the omnidirectional sensing model as a disk centred at ui with sensing range ri. We assume the sensing ranges are adjustable according to different application requirements A point v ∈A is said to be covered by node ni if f the Euclidean distance between v and node location ui is no longer than ri, i.e., $\| v - u_j \|_2 \leq$ ri. We use f (v,ui,r i) to indicate if v is covered by node ni: f (v,ui,r i)=1if v is covered by ni; otherwise, f (v,ui,r i)=0.

B. PROBLEM MODEL

The objective function of the delivery tasks is that all packets need to be delivered with the minimum total cost. The lifetime of a node is defined as the time for it to deplete its energy. A list of these definitions is shown in the Table I. Based on these notations, for each link and each route , we define as if route contains link otherwise Next, we initialize for links with appropriate values. If the link quality is poor, then the link cost should be proportion- ally higher. On the other hand, to meet our goal of lifetime balancing, it is appropriate to assign a higher weight to those links connecting nodes with less remaining energy, so that they will be less frequently selected by the algorithm during execution. Finally, those nodes that consume more energy for transmitting packets are less likely to be selected. For each link and each route , we define as if route contains link otherwise $l_{ij} \in E$ and each route k , we define as x_{ijk} as

$$x_{ijk} = 1, \text{ if route } k \text{ contains link } l_{ij}$$
$$x_{ijk} \quad 0 \text{, other wise} \quad \rightarrow (1)$$

Based on this intuition, we develop the following formula to assign with proper values:

$$C_{ij} = [(L - \min l_i, l_j) \div (q_{ij} \times q_{ji})] \times T_{tpi} \times t_{ij} \quad \rightarrow (2)$$

Where

$$l_i = L \times [e_i \div Emax, t_{pi}] \quad \rightarrow (3)$$

where (defines a step equation for computing the remaining energy level of node .

C. HIGH ORDER VORONOI DIAGRAM

We hereby briefly introduce the ideas and theories on high order Voronoi diagram [31]. They are key to our autonomous deployment strategy. In a k-order Voronoi diagram, the targeted area A is seg- mented into Nk disjoint areas{Vk j }j=1,..., ˆ Nk ,2 each of which is associated with k closest generators (sensor nodes in our case), i.e.,a subset.

D. COMPLEXITY ANALYSIS

Theorem :The problem of finding the minimum cost routes to deliver packets within their deadlines,

Proof: To prove this fact, we need to select a open vehicle routing problem with time deadlines which is a variant of vehicle routing problem with time windows (VRPTW) .This problem aims to find the least-cost routes from one point to a set of scattered points and has been proven as NP-hard. Formally, this problem is defined as follows: Given a graph G= (V,E)with n+1 vertices V and a set of edges .Let E contain one depot node and n customer nodes that need to be served within specified time windows. Each edge in E has a nonnegative weight d_{ij} and a travel time tr_{ij}. Specifically, includes the service time on node , which we denote as , and the transportation time from node i to node j , which we denote as tl_{ij}. The objective is to minimize the total travel cost with the smallest number of routes.

E. CENTRALIZED HEURISTICS

We assume that nodes have been selected as sources at the beginning of each data collection period. The heuristic algorithm consists of two phases: route construction, which finds an initial feasible route solution, and route optimization, which improves the initial results using optimization technique. we present a heuristic algorithm based on the revised push forward insertion (RPFIH) method, as shown in Algorithm 1. The original push forward insertion algorithm was proposed, and we modify it to fit the needs of wireless sensor network .At the be-ginning of RPFIH, for each node, the minimum cost path to the delay requirement is met. If no candidate node can guarantee the delay, RPFIH initializes a new route with the node that has the largest path cost to the sink in there mining sources and repeats this process until all sources are connected with the sink. Finally, RPFIH generates set of found routes as the final output. Sink is found. RPFIH then finds the node that has the largest path cost to the sink and incrementally selects can did at e nodes with the lowest additional insertion cost. For each candidate node, RPFIH also checks its feasibility by making sure that the overall delay requirement is met. On the other hand, if the delay bound is very loose, VRPTW is equivalent to VRP. Furthermore, if the vehicle capacity is not restricted, the lower bound on the cost of an optimal route is the weight of the minimum spanning tree T [32] of source nodes, where . On the other hand, in the worst case, we can observe that becomes a pre-order tree walking of T, while the insertion cost of nodes are ordered in the pre-order tree walking sequence, as shown in Fig.2

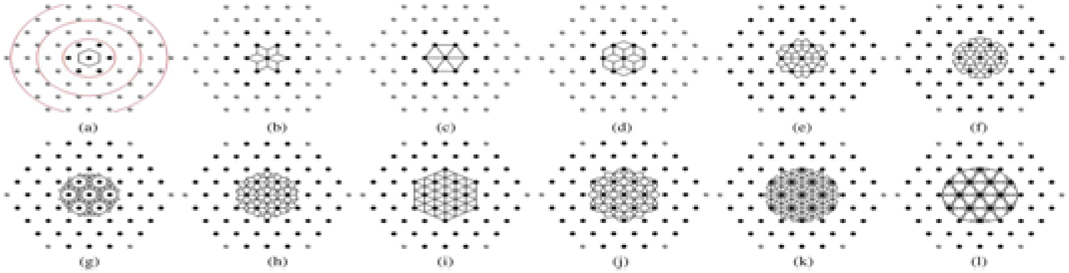

Fig. 4. The dominating region of the central node in k-order Voronoi diagram k =1,...,12. The central node needs to collect location (or range) information from its neighboring nodes (the dark nodes) via multi-hop communication according to Algorithm 2. Additionally, we illustrate multi-hop transmission range using red circles in (a). While the cases for k =1can be handled by involving only the 6 closest nodes (1-hop neighbors) to the central node, computing the 2-, 3-, and 4-order dominating regions requires 2-hop neighbors. When k>4, all sensor nodes within 3 hops are involved. (a) 1-order; (b) 2-order; (c) 3-order; (d) 4-order; (e) 5-order; (f) 6-order; (g) 7-order; (h) 8-order; (i) 9-order; (j) 10-order; (k) 11-order; (l) 12-order.

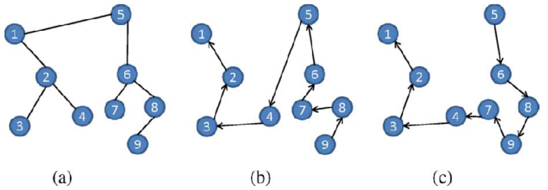

fig.2 optimal solution of RPFIH.

IV. SIMULATION BASED EVALUATION

In this section, we present the performance evaluation results on a large network topology with a simulation platform .Studying the energy consumptions during and after the autonomous deployments, we also evaluate the performance of in Min-Node k-Coverage and Maximum k-Coverage, followed by the adapt- ability to network irregularities. We implement the centralized heuristic and compare their performance in terms of network lifetime, selected nodes, and packet delay, with and without the integration of compressive sensing, to two selected baselines. The network life time is defined as the time for critical nodes to deplete their energy in the network. The details are shown in the following parts of this section.

a) Experiment Results for Network with Heterogeneous Nodes

As described proposed system designed for heterogeneous networks with heterogeneous nodes and different types of packets. We assume that heterogeneous nodes consume different amount of energy for packet transmissions, and different types of packets have heterogeneous delay bounds. To measure the performance of such networks, we present simulation results .

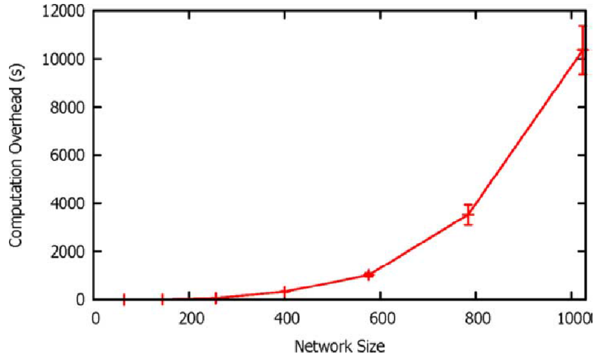

Fig 3. Computational time overhead of the centralized heuristic under different network sizes.

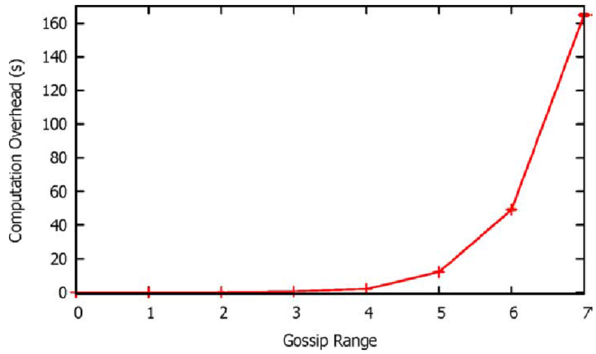

Fig.4 Computational time overhead of the distributed heuristic with different gossip ranges in a network with 256 nodes.

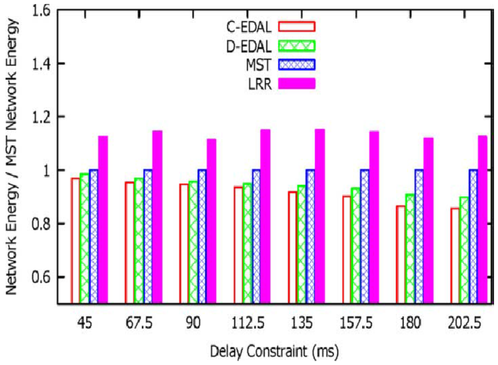

Fig 5 Average energy consumption of the network running different routing algorithms.

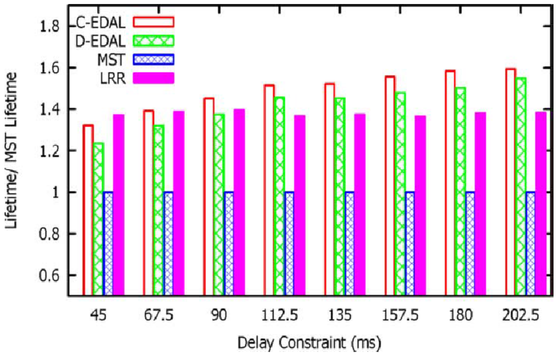

Fig.6 Network lifetime while running different routing algorithms with different delay requirements.

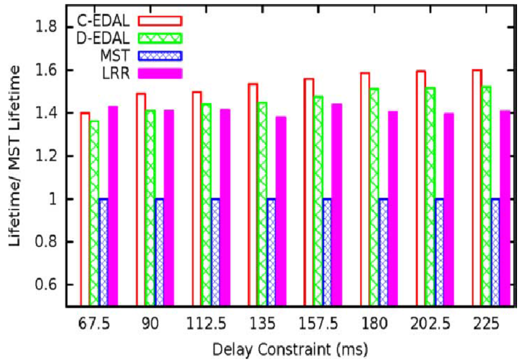

Fig 7 .Network lifetime while running different routing algorithms in the heterogeneous network.

V. CONCLUSION

Now the challenge endorse off reducing most detecting variety toward gain load matching k-coverage over self-sustaining positioning and it create paths to join altogether supply nodules by nominal overall route charge, below limitations of pack postponement requirements then cargo pair desires. The period of the positioned device community stays too sensible through transmission loads to hyperlinks constructed at the enduring strength stage nodules. Based on simulation assessment effects, we take a look at that powerful Deployment energy, put off and lifestyles time based statistics series procedure completes a significant growth on community period short of impious envelope postponement controls.

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