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EFFICIENT LOCALIZED DEPLOYMENT ALGORITHM WITH BALANCED ENERGY CONSUMPTION IN WIRELESS SENSOR NETWORKS

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Abstract— **A Wireless Sensor Network (WSN) consists of spatially distributed autonomous sensors to cooperatively monitor physical or environmental conditions , such as temperature, sound, pressure, motion or pollutants. WSN consists of large number of small size sensors which they can sense the environment and communicate with each other and processing the sensing data. Because of the deployment nature of the Wireless Sensor Network once it deployed we can't recharge the battery. So energy conservation is one of the important factors. Under this constraint maintaining good coverage and connectivity is also important factor of designing WSN .In this paper, we propose a new sleep scheduling algorithm, named EC-CKN algorithm will reduce the energy consumption and to prolong the network lifetime.**

Keywords: **Autonomous systems, connectivity, coverage, deployment, Mobile WSN.**

I. INTRODUCTION

Sensor networks are envisioned as tiny power constrained devices, which can be scattered over a region of interest, to enable monitoring of that region for an extended period of time. The sensor devices are envisioned to be capable of forming an autonomous wireless network, over which sensed data can be delivered to a specified set of destinations. The nodes sense environmental changes and report them to other nodes over flexible network architecture.

Sensor nodes can be imagined as small computers, extremely basic in terms of their interfaces and their components. They usually consist of a processing unit with limited computational power and limited memory, a communication device, and a power source usually in the form of a battery. The cost of collecting environmental data using current methods is laboured intensive and expensive. The requirement for infrastructure, in particular, limits the area that can be monitored and the frequency at which measurements can be taken and transmitted.

Focus on monitoring related technologies for WSNs in mission-critical environment: The connectivity issues in mission-critical monitoring and the solutions. The data collection in mission-critical monitoring are addressed. The data collection requires technologies that can guarantee performance such as timeliness, reliability, scalability and energy efficiency. It can be provided by designed routing, link scheduling and even cross- layer mechanisms.

In mission-critical environment, dynamic network topology leads more difficulties in event detection. The related recent detection models and frameworks are addressed. A new promising way for mission-critical monitoring is to utilize wireless sensors.

The main challenge is to maintain connectivity from any sensors to the sink. Our first assumption is: all sensors are within communication range of each other at the beginning of the deployment. From the initial configuration, a sensor node may choose any direction to expand the network. This direction is linked to a deployment requirement. To avoid disconnection, the node has to maintain its connections to its neighbors that are parts of the Relative Neighborhood Graph (RNG) reduction.

After the first expanding process, some connections between th sensor and its previous neighbors are lost and deployment process continues in the same way. Every decision taken by sensors is based on local neighborhood information only, asynchronous and simple enough to take into account obstacles, or specific fields constraints.

Since the directions and the movements of a given node are only constrained by the connections to its RNG neighbors, the node's direction can be governed by any requirement which allows our algorithm to adapt to different coverage schemes. We provide a localized deployment algorithm for mobile sensor networks.

This paper is organized as follows. Section II includes a discussion on key concepts in this paper; section III gives the related works, section IV gives the details of proposed system, section V gives the result analysis and section VI gives the conclusion on this paper.

II. KEY CONCEPTS

A. Autonomous systems

An Autonomous System is a connected group of one or more Internet Protocol prefixes run by one or more network operators which has a single and clearly defined routing policy.

A multi homed Autonomous System provide connections between one or more AS. This allows the AS to make connection to the Internet in the event of a complete failure of one of their connections. But this type of AS would not allow pass traffic from one AS to another AS.

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A stub Autonomous System maintains connection to only one other AS. This may be waste of an AS number if the network's routing policy is the same as its upstream AS's. But the stub AS may have peering with other Autonomous Systems that is not reflected in public route view servers.

A transit Autonomous System provides connections to other networks. A transit AS can route transit traffic by running BGP internally so that multiple border routers in the same AS can share BGP information. When BGP is running inside an AS, it is referred to as Internal BGP (IBGP). When BGP runs between autonomous systems, it is called External BGP (EBGP).

A. Mobile WSN

Mobile WSN consists of collection of sensor nodes that interact with the physical environment. Mobile nodes have sensing ability, computing and communicating like static nodes. The main advantages of mobile sensor nodes have ability to repositioning and organizing the network. A mobile WSN start off with the initial deployment and the nodes can spread out to gather information.

Information gathered by a mobile node can be communicated to another node when they are within the communication range. A key difference between the mobile node and static node is data distribution. In static WSN data distributed using fixed routing. In mobile WSN data distributed using dynamic routing. Mobile sensor nodes can achieve higher degree of coverage and connectivity than static WSN.

B. Deployment

The deployment scheme's depends on the type of sensors, application and the environment. Nodes can be placed in deterministically or randomly. Deployment of sensors nodes in physical unattended environment is an important issue since the performance of wireless sensor networks largely depends on deployment of sensors nodes. The deployment of sensor nodes is divided into two fractions according to the function of networks and these fractions are coverage and connectivity.

C. Connectivity

The ability to report the Sink node is called as connectivity. A network is said to be fully connected if every pair of node can be communicated with each other either. Due to larger number of sensors in networks, the total cost whole network is high and the cost of the individual sensor is low.

Therefore it is important to find the minimum number of sensors for a WSN to achieve the connectivity. The connectivity of a graph is minimum number of nodes that must be removed in order to portion the graph in to more than one connected component.

D. Coverage

A sensor network that has blind spots may fail to monitor events that happen at the location of such blind spots. The capability to monitor every coordinate on the sensor field has been termed the problem of coverage. A generalized version of the coverage-preserving problem requires a point to be covered by at least K sensors called the K-coverage problem. Each sensor node can detect the events with in **so**me very limited distance from itself. That distance is called as sensing range.

The coverage schemes are classified into different groups. They are, Area coverage, Point of Interest coverage, and Path coverage. In area coverage the sensors are try to monitor the whole area of interest. In POI coverage, only some specific points of the sensor field need to be monitored and for the Path coverage, the goal is to minimize or maximize the probability of undetected penetration through the region.

III. RELATED WORKS

Papers about deployment and self-deployment of wireless sensor networks are reviewed in this section. As our main focus is connectivity preservation for different deployment schemes, this paper consider connectivity during the deployment and briefly review some different coverage schemes.

A. Connectivity

The local deployment of multiple mobile sensors was first developed in achieve a better coverage of the whole sensing field. The Relative Neighborhood Graph was first proposed by Davis Simplot-Ryl [1].

The Relative Neighborhood Graph (RNG) [2][3] is a graph reduction method. Given an initial graph G, the RNG extracted from G is a graph with a reduced number of edges but the same number of vertices. Let the sensors be the vertices of the initial graph and that there exists an edge between two vertices if the two sensors can communicate directly. We assume here that the communication between two sensors is possible only if the distance between them is less than a given communication range. To build a RNG from an initial graph G, an edge that connects two sensors is removed if there existS another node that is at a lower distance from both sensors.

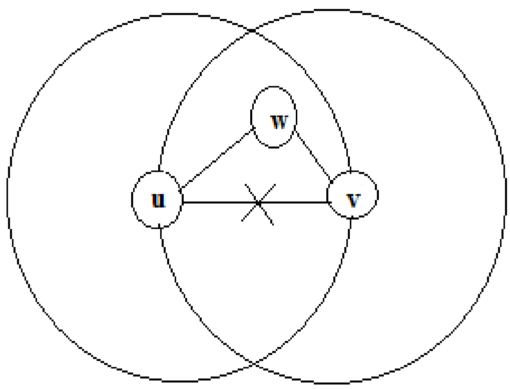

Fig. 1: RNG Edge Removal

Fig. 1 shows an example of edge removal, where edge between sensors *u* and *v* is removed since there exists a sensors *w* that is closer to both *u* and *v*. The RNG can be deduced locally by each node by using only the distance with its neighbors. With positing system, nodes need to send periodically an HELLO message with their coordinates. In this way, each node maintains a neighborhood list with neighbor locations that allows determining whether or not an edge is in RNG [10].

In this case, we need only 1-hop information. We can observe that if nodes do not have positioning system, they can decide RNG edges if they are able to determine mutual distances. Every node sends in its HELLO message the list of its neighbors with distances. The nodes can be ignored if the distance is greater than the transmission node.

Using the RNG reduction has two main advantages. First, the RNG reduction can be computed locally by each sensor since sensors only need the distances with its neighbors. Second, given that the initial graph is connected, the RNG reduction is also connected. These two properties are important for scalability issue and for connectivity preservation. Indeed, to preserve the connectivity of the whole network, each sensor has to only preserve the connectivity with its neighbors that are part of the RNG. We use these properties to preserve connectivity and avoid sensors from disconnecting the network.

B. Coverage Schemes

The coverage requirement is the primary aim that describes how the sensors have to be deployed over the field. Some ways of moving are strongly related to the coverage requirement, it is important to note that movement and coverage are independent. In this section the previous cited papers regarding coverage schemes can be recalled [6][7][8]. The coverage requirement can be divided into three categories.

- In the full coverage problem, sensors have to maximize the covered area. The work proposed in [4] uses virtual force based movement to increase the covered area.
- In barrier coverage problem, sensors must form a barrier that detects any events crossing the barrier. We consider the barrier coverage as a special case of POI coverage. In barrier coverage, POI are used to define a barrier between the starting points and the POI. Unlike in POI coverage, our aim is not to cover the POI, instead, the nodes has been regularly spread out between the starting point and the POI.
- In the POI coverage, only some specific points of the sensor fields need monitoring. Thus it provides both the coverage and connectivity.

In our work, we use the property of *K*-connectivity to reduce the energy consumption. To the best of our knowledge, our work will provide reducing energy consumption with increasing the network lifetime.

IV. PROPOSED SYSTEM

Network lifetime is one of the most critical issues for wireless sensor networks since most sensors are equipped with non-rechargeable batteries with limited energy. To prolong the lifetime of a WSN, one common approach is to dynamically schedule sensors active/sleep cycles with sleep scheduling algorithm. A new sleep scheduling algorithm, named EC-CKN (Energy Consumed uniformly-Connected K-Neighborhood) algorithm, to prolong the network lifetime. The algorithm EC-CKN, which takes the nodes residual energy information as the parameter to decide whether a node to be active or sleep, not only can achieve the *k*-connected neighborhoods problem, but also can assure the *k* awake neighbor nodes have more residual energy than other neighbor nodes at the current epoch.

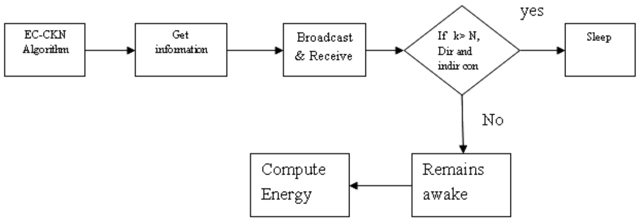

Fig.2: Flow chart for EC-CKN Algorithm

EC-CKN Algorithm

We develop a new sleep scheduling algorithm to prolong the network lifetime. A scalable distributed solution to EC-CKN problem based on node's current residual energy information is challenging for several reasons.

Algorithm: Energy Consumed Uniformly-CKN (EC-CKN)

1. Get the information of current remaining energy $Erank_{u;}$
2. Broadcast $Erank_u$ and receive the energy ranks of its currently awake neighbors N_u. Let R_u be the set of ranks.
3. Broadcast R_u and receive R_v from each $S_v \in N_u$;
4. If $|N_u| < k$ *or* $|N_v| < k$ for any $S_v \in N_u$, remain awake. Return
5. Compute $E_u = \{S_v \mid S_u \in Nu$ and $Erank_v > Erank_u\};$
6. Go to sleep if both the following conditions hold. Remain awake otherwise,
    - Any two nodes in E_u are connected either directly or indirectly trough nodes which is in the S_u 's 2-hop neighborhood that have $Erank_v$ larger than $Erank_u$;
    - Any node in N_u has at least k neighbors from E_u.
7. Return.

The pseudo-code of EC-CKN Algorithm is repeated at each scheduling epoch on each node. This algorithm takes an input parameter *k*, the required minimum number of awake neighbors per node. In EC-CKN, a node Su broadcast its current residual energy information $Erank_u$ (step1) and computes a subset *Eu* of neighbors having $Erank_v > Erank_u$ (step5). Before Su can go to sleep it makes sure that all nodes in *Eu* are connected by nodes with $Erank_u > Erank_u$ and each of its neighbors has at least *k* neighbors from E_u (step6) in Fig.2. These requirements ensure that if a node has less than *k* neighbors, none of its neighbors goes to sleep and if it has more than *k* neighbors, at least *k* neighbors of them decide to remain awake. The current residual energy is exchanged in Steps 2 and 3.

V. RESULT ANALYSIS

Simulation results are divided into two parts. In the first part, we present the simulation of different deployment schemes with increasing the reachability. In the second part, we consider the balanced in energy consumption with increasing the network lifetime. The simulation was performed using WSNet.[2].

A. Reachability

Fig. 4 plots an example of the evolution of reachability when the nodes have random position at the beginning of the deployment. Also shows that the rechability is strictly increasing which means that the two nodes *u* and *v* are connected.

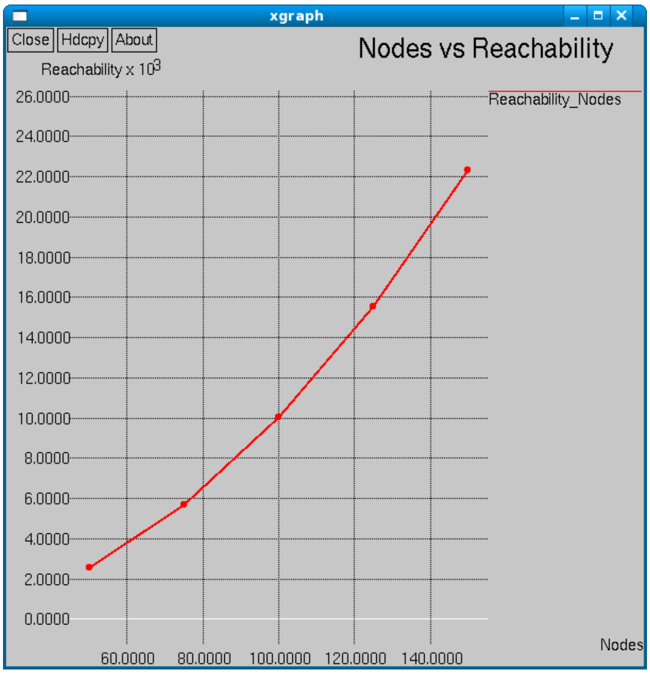

Fig. 4: Reachability of the network

B. Network Lifetime

Large amount of sensor nodes are deployed in wireless sensor network area. Sensor nodes are used to sense some events which will be occurred in the wireless sensor network area. So no need to stay awakes all sensor nodes in all time. These will leads to increase the energy consumption even there is no message transmission.

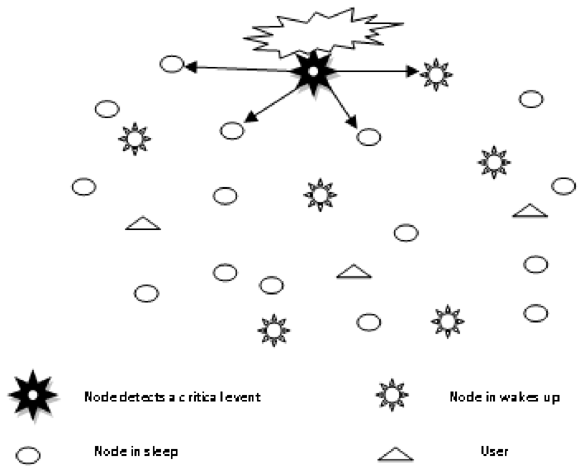

Fig. 3: Events detected by sensor nodes

To overcome this limitation we introduce the sleep scheduling concept in wireless sensor network. Here some of the sensor nodes in sleep mode that are in deactivation mode. The rest of the nodes in the wireless sensor network remain in the wake-up mode that is activation mode. Whenever the event occurs that is sensed by the nearby sensor node which is in the activation mode. This node sends the notification to its neighbor sensor node. This sender node remains in activation mode until the receiver sensor node receiver that notification. After sending that notification the sender node immediately goes to the deactivation mode. Sleep scheduling will decrease the energy consumption and the same time the network lifetime also increases as shown in Fig.5.

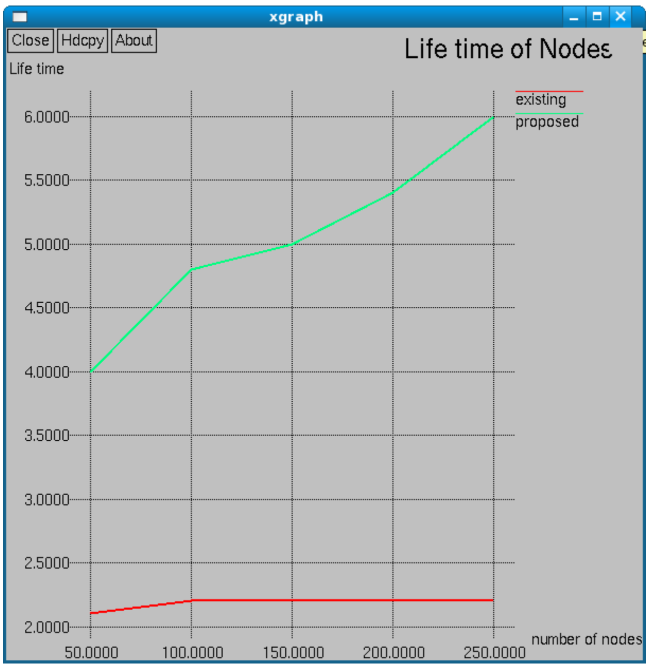

Fig. 5: Life Time of Nodes

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VI. CONCLUSION

Connectivity is an important property in wireless networks and especially in wireless sensor networks, which provided some localized algorithms for mobile sensor deployment with connectivity guarantee. To preserve connectivity, nodes only maintain the connections with a sub-part of its neighbors during the deployment. Choose the Relative Neighborhood Graph it can be computed locally and it maintains global connectivity. Through analysis that with a perfect physical channel the connectivity is guaranteed. Moreover the connectivity preservation scheme provide an high degree of reachability when message losses are considered .Moreover, when deploying WSN for practical application a good sleep scheduling algorithm will balance sensor nodes energy consumption by using EC-CKN algorithm and the network lifetime also increased.

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