Wireless Sensor Network-Coverage Placement and Topology Management

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Abstract— **Wireless communication amongst sensors allows the creation of flexible sensor networks called as wireless sensor network, which can be deployed quickly over wide or unreachable areas. However, the necessity to collect data from all sensors in the network put some constraints amongst sensors. Here we will talk about and coverage, placement and topology management in wireless networks.**

Keywords— **Wireless Sensor Network, connectivity, Coverage, Placement, Topology Management**

I. INTRODUCTION

Wireless sensor network are class of network where nodes are sensor nodes i.e. nodes which have the ability to sense any physical phenomenon like temperature, light, sound, vibration, any object moving around them, etc. these sensor nodes collectively form a network known as wireless sensor network. The sensed information is transformed into digital signals and processed to reveal some properties of any phenomenon around them. Wireless networks are very popular because of diverse type of applications, they are used in mines, wildlife, health care, agriculture, target tracking, multimedia etc.

II. TYPES

Wireless sensor networks are broadly divided into two types:

- Stationary sensor networks
- Mobile sensor networks

In stationary sensor network nodes are stationary i.e. fixed while in mobile sensor networks its essential that some or in typical case all nodes are mobile i.e. they can move. Mobile sensor networks can be found in oceans as well as

Terrestorial zone like sensor nodes placed on bus, truck or any moving vehicle.

III. COVERAGE

Coverage stands for deploying or activating the sensor nodes so as to cover the entire area of interest. Deployment aims that the sub area of the area of interest is in the monitoring range of at least one node. Deployment can in terms of the following:

- Sensor Placement
- Density Control

Sensor placement aims at where to place the sensor nodes to cover the entire area of interest while density controls aims at controlling the density of sensors at a point in that area i.e. sensors should be homogeneously distributed. Two things that are to be kept in mind are that area should be covered satisfactorily and connectivity should be maintained amongst the sensor nodes so that the data reaches the sink node.

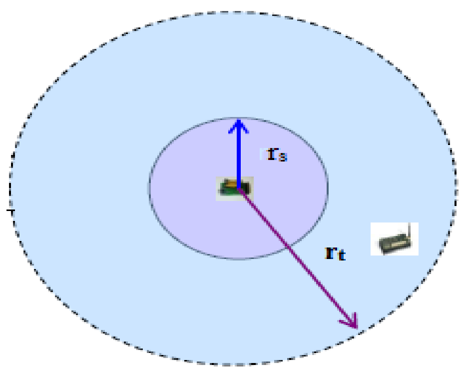


Fig.1 depicting Relationship Sensing Range and Transmission range

If Sensing range is rsand transmission range isrt and If transmission range >= 2*sensing range then coverage implies connectivity.

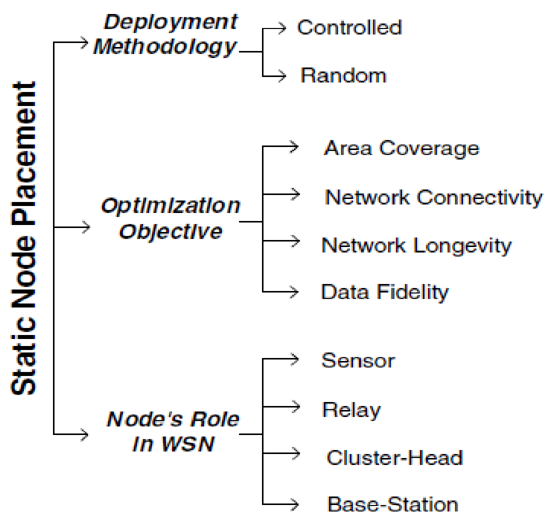
Criteria while covering is that if nodes are static nodes then how to deploy these sensor nodes or if nodes are pre deployed then how to activate these sensor nodes so that the application specific criteria is met and when nodes are mobile the problem is how to plan a trajectory to deploy these sensor nodes. The coverage algorithms proposed are either centralised or distributed or localized

- Distributed: here nodes compute their .position by communicating with their neighbours only.
- Centralized: here data is collected at any central point like base station and computed here only.
- Localized: it's a special type of distributed algorithm where only few sensor nodes participate in communication and computation of data.

IV. PLACEMENT

Placement refers to employing the sensor nodes in an area. In placement problem a perfect disk assumption is done in which each sensor monitors a circular area. Given the initial energy of each sensor node anddata density of the field, our objective is to answer the following questions:

What is the least number of sensor nodes we need to construct a sensor network and how these sensor nodes should be positioned such that the network can satisfy the scheduled lifetime and coverage requirement?



A. *Static positioning of nodes*

The position of nodes hasa intense impact on the effectiveness of the WSNand the efficiency of its operation. Node placementpatterns prior to network startup usually base theirchoice of the particular nodes' positions on metricsthat are free of the network state or assumea fixed network operation design that staysunaffected throughout the lifetime of the network.Examples of such static metrics are area coverage and inter-node distance, among others. Static network operation models often assume periodic data collection over set routes.

B. *Deployment Methodology:* Sensors can generally be positioned in an area of interest either deterministically or randomly. The choice of the deployment scheme depends extremely on the type of sensors, application and the environment that the sensors will operate in. Controlled node deployment is feasible and often necessary when sensors are costly or when their operation is significantly affected by their position. Such scenarios include populating an area with highly specific seismic nodes, underwater WSN applications, and placing imaging and video sensors. On the other hand, in some applications random distribution of nodes is the only possible option. This is particularly true for tough locations such as a battle field or a disaster region. Depending on the node distribution and the level of redundancy, random node deployment can achieve the needed performance objectives.

C. *Optimization objective:* Application developers surely like the sensors to be positioned in a way that aligns with the overall design goals. Therefore, most of the suggested node placement schemes in the works have focused on increasing the coverage, accomplishing strong network connectivity, prolonging the network lifetime and improving the data fidelity. A number of secondary objectives such as tolerance of node letdown and load balancing have also been considered. Most of the work attempts to maximize the design goals using the least amount of assets, e.g., number of nodes. Obviously, meeting the design objectives through random node distribution is an supreme challenge. Meanwhile, although intuitively deterministic placement can theoretically meet all major and minor objectives, the hunt for minimizing the required network resources keeps the problem very tough.

D. *Nodes role in WSN:*The positions of nodes not only affect coverage but also considerably influence the properties of the network topology. Some of the published work has concentrated on architecting the network in order to improve some performance metrics, for example, to extend the network lifetime or reduce packet delay. These architectures often describe roles for the working nodes and pursue a node-specific positioning strategy that is dependent on the part that the node plays. In this section, we opt to categorize role-based node employment strategies. Generally, a node can be a regular sensor, relay, cluster-head or base-station. Since cluster-heads and base-stations often act as data collection agents for sensors within their scope, we jointly refer to them as data collectors.

E. Dynamic reposition of nodes

Dynamically relocating the nodes while the network is active is essential to furtherexpand the performance of the network. Forinstance, when severalsensors in the areaof the base-station stop functioning due to theexhaustion of their batteries, some redundant sensorsfrom other parts of the examined region canbe recognized and repositioned to replace the lifeless sensorsin order to increase the network lifetime. Suchdynamic replacement can also be very useful in atarget tracking application where the target ismovable. For instance, some of the sensors can berepositioned close to the target to uplift the fidelityof the sensor’s data. Moreover, in some applicationsit may be wise to preserve the base-station a safe distancefrom dangerous targets, e.g., an enemy tank,by repositioning it to safer areas in order to guarantee itsavailability.

V. Topology Management

The primary objective of the topology managementtechniques in WSNs is to achieve sustainable coveragewhile retaining network connectivity and preserving energy. For example, these methods are employed totrack the status of communication links among the nodes,to preserve energy by switching off some of the nodeswithout degrading network coverage and connectivity, tosupport hierarchical task assignment for data aggregation,to balance the load on existing nodes and links, or to providescalability by minimizing medium access collision andlimiting overhead. Topology management in WSNs can bedone through deterministic node placement or performedautonomously after random deployment given the limitedhuman intervention. Present topology managementtechniques/algorithms for WSNs can be categorized into thefollowing five categories:-

A. Node Discovery

Detecting the nodes and their locationsis an essential task in a WSN not only afterthe initial placement but also for integrating newlyadded nodes. The range of node discovery is subject tocertain trade-offs based on the application goals. Forexample, for big networks, resource savings in termsof energy and bandwidth can be attained by not sharingsome of the topology details that are consideredneedless for certain parts of the network.

B. Sleep Cycle Management

To preserve energy and increase the network lifetime, some of the redundantnodes in a WSN can be turned off. In addition to theenergy savings, this technique reasons the number oftransferred messages to drop, which lowers signalinterference and the failed transmission attempts.Determining the sleep plan while sustaining fullarea coverage and strong network connectivity is a populartopology management optimization that hasreceived quite an attention from the research community.

C. Clustering

To attain scalability and energy efficiency,nodes of a WSN may be assembled to form a hierarchicaltopology. In this way, nodes can direct their readings to a clustered which in turn aggregates and forward thedata to the sink node after removing redundant dataAlthough the failure of the cluster-head oftenrequires re-clustering, some approaches have provisionedthe topology adjustment by associating primaryand backup cluster-heads for each sensor node.

D. Power Control

The transmission range reflects theextreme distance at which a receiver can be from asender. The longer the range is, the higher the powerconsumption would be. Many of the advanced radiosallow programmable transmission power so that a nodecan avoid consuming excessive energy in reachingnearby receivers. Low power transmission can alsoreduce interference and boost the network throughput.
However, the use of low transmission power limits thenetwork connectivity since nodes would have fewerdirectly reachable neighbors.

E. Movement Control

Node mobility has been exploitedas a means for improving the network performance.The objectives achieved by the movement differ. For example, the focus is on extending the networklifetime by decreasing energy consumed by stationarysensors, whereas in other metrics such asasset safety and data delivery latency have been targeted.In addition, mobile relays with more abilitiesthan sensors are used as data forwarders in order toextend the lifetime of a network of stationary sensorsor to link disjoint batches of nodes. Due to the severe environment, limited energy and hardwareResources inWSNs, topology management can also beconsidered together withfault management. For instance,Sensor failures can create holes in the coverage area andeven disconnect the network into multiple partitions leavingmultiple functional nodes unreachable. In such a case,topology management must function as self-diagnosticand self-healing and serve as a fault handling service.

VI. CONCLUSIONS

Wireless sensor networks (WSNs) have attractedlots of attention in recent years due to their potentialin many applications such as border protection andcombat field surveillance. Given the criticality ofsuch applications, maintaining efficient networkoperation is a fundamental objective. However, theresource-constrained nature of sensor nodes and the ad-hoc formation of the network, often coupled with unattended deployment, pose non-conventional challenges and motivate the need for specialtechniques for designing and managing WSNs. In this paper, we have discussed the sensor coverage, nodeplacement and topology management in WSNs.

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