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# A Survey on Multi-Objective Node Deployment Technique in Wireless Sensor Networks

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***Abstract*—A wireless sensor network consist of sensor nodes which are capable to perform sensing, computation and transmission. These sensor nodes have limited power which is difficult to replace due to hostile environment. Therefore to increase the lifetime of wireless sensor network, it is required to develop such techniques to consume lesser energy. Wireless sensor network is nowadays being applied in many different civilian applications like vehicle tracking, building and forest and earthquake contemplation, bio-medical or health care applications. Wireless sensor network is built with many sensor nodes. Node deployment is very important task in wireless sensor network. Different approaches are used for the deployment of sensor nodes are: random deployment and deterministic deployment.**

***Index Terms*— Wireless Sensors Network, Parameters, Node deployment.**

## I. Introduction

Wireless sensor networks (WSN) can be used in wireless communication technology, sensing technology, micro-electronics technology and embedded system, for a wide variety of applications and systems with excessively varying requirements and characteristics. A wireless sensor network design is affected by many factors such as transmission errors, network topology and power consumption. One of the most fundamental issues in WSN designing is the deployment problem. There are different specific problems in the literature, e.g. deployment, layout, coverage or positioning problem in WSNs. The term positioning seems to be more general, so we propose a classification illustrated in Figure 1. On the left is localization – its aim is to location of nodes where the nodes are placed. On the right is deployment – its aim is to determine where the nodes should be placed.

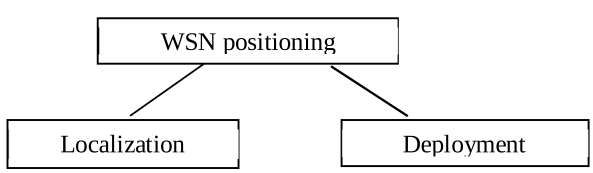


Fig. 1 A classification for positioning in WSN

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The most important step of design to selectively decide the locations of the sensors to optimize the desirable objectives, e.g., maximize the area coverage or minimize the use of energy. Fundamental questions in this case include [1]:

- How many sensor nodes needed to meet the overall system objectives?
- For a given network with a certain number of sensor nodes, how do we deploy these nodes in order to optimize network performance?
- When data sources change or some part of the network malfunctions, how do we adjust the network topology and sensor deployment?

## II. WSN PARAMETERS

There are various significant parameters which are included in WSN which are the following [2]:

### *A. Coverage*

In WSN, when the nodes are deployed randomly  the position of the nodes is out of control and as a result some nodes which are  places in the target region are known as coverage holes remaining are uncovered.

### *B. Connectivity*

In WSN, network connectivity is measured by network connectivity graph. If the network connectivity graph is connected as the whole graph, the network is assumed connected, otherwise partitioned. If there is more than one distinct path between every two nodes of the network, the connectivity degree is defined as the minimum number of these paths.

### *C. Scalability*

Some WSN applications need the order of deployment of sensor nodes for monitoring and detecting events in the target environment to be as high as hundreds or thousands. In some specific applications this number may even reach to the extreme value of millions. The new scheme in the wireless sensor networking must be applicable to such large values. These new scheme should grow network or develop without major changes to the design.

### *D. Lifetime*

Network lifetime is directly related to the battery lifetime of the sensor nodes. The increase in node's activities leads to a network node's power consumption that results in lower battery and less network lifetime.

### *E. Latency*

The delay in transmitting data, data aggregation and routing is defined as latency. These parameters can be measured as the time between arrival of data packets at the destination and its departure from the source node.

### *F. Cost*

In WSNs, the cost of a wireless sensor network starts from the construction phase of sensor nodes. Depending on the application and sensor devices used in the node, the cost of the node can be variable. Some applications do not consider node cost because of the low price of node used.

## III. CLASSIFICATION OF NODE PLACEMENT

The node deployment of wireless sensor is mainly classified into the two parts: static and the dynamic deployment.

### *A. Static deployment*

The static deployment chooses the best location according to the optimization strategy, and the location of the nodes has no change in the lifetime of the WSN.

### *B. Dynamic deployment*

Random deployment, firstly randomly throw nodes, and then using a variety of optimization algorithm for the optimization of placement. The optimization algorithms are Virtual force algorithm, virtual force oriented particles algorithm, simulated annealing algorithm (SAA), particle swarm optimization (PSO) algorithm and simulated annealing genetic algorithm.

## IV. PERFORMANCE INDEX OF NODE DEPLOYMENT

Generally, the optimization of the sensor nodes deployment mainly includes the following performance indexes [3]:

### *A. Coverage area*

Coverage is main issue in WSN and it is related to energy saving, connectivity, and network reconfiguration. It solves how to place the sensor nodes to achieve emphatic coverage of the service area so that atleast every point in the service area is monitored by one sensor node.

### *B. Network connectivity*

Network connectivity is the communication between the wireless sensor nodes, the node and base station, base station and client, the client and server. Presently, the network connectivity is not difficult problem. We build routing between the node and sink to send the data.

### *C. Network lifetime*

The important requirements of WSN are to reduce the energy consumption. Hence, there is a need for energy efficient and routing techniques that will increase the lifetime of a network. When a node receives more than one packet at the same time, these packets are termed as collided. All packets that cause the collision have to be discarded and retransmission of these packets is required, which increase energy consumption. The second reason for energy worthless is overhearing, which means that a node receive packets that are destined to other nodes. The third energy waste occurs as a result of control-packet overhead.

## V. LITERATURE SURVEY

*Swagatam Das et al., 2012 [4]* proposed the objectives of sensor nodes deployment that needed to be satisfied were monitored coverage of the area, energy consumed by the WSN, lifetime of the network, and connectivity and number of deployed sensors. Sensor node deployment task had been formulated as a constrained multi-objective optimization problem where the aim was to find a deployed sensor node arrangement to maximize the coverage area, to minimize the energy consumption, to maximize the network lifetime, and minimize the number of node deployment while maintaining connectivity between each sensor nodes and the sink nodes for data transmission.

*Mayur C. Akewar, 2012 [5]* presented the different mobile sensor network deployment approaches with their features and drawbacks different approaches had been proposed for the deployment of mobile sensor by considering different issues. Coverage and Connectivity was the main issue of deployment. Mobility of sensor nodes adds additional functionality to the wireless sensor network of node deployment and relocation of sensors. Sensors find their own position and placed themselves over the objective area after initial sensor distribution.

*Seyed Mahdi Jameii et al., 2013 [6]* proposed a NSGA-II based multi-objective algorithm for optimizing area coverage, number of active sensor nodes and energy consumed by nodes all of these objectives simultaneously. The efficiency of algorithm was demonstrated in the simulation results. This efficiency could be shown as finding the optimal balance point among the maximum rate of coverage, the least energy consumption, and the minimum number of active nodes while maintaining the connectivity of the network.

*B G Premasudha et al., 2013 [7]* focused on performance comparison of different spatial wireless sensor node deployment algorithms. The primary challenge will face in designing wireless sensor networks was to find tradeoff between the desired and inimical requirements for the lifetime, coverage or cost while coping with the computation, energy and communication constraints. The properties of WSNs applications determine the placement problem.

*Shikha Swaroop et al., 2013 [8]* presented the features of the environment in which the sensor networks may deploy. Wireless Multimedia Sensor Networks was networks of wirelessly interconnected devices comprising multimedia sensor nodes that were able to process real time multimedia content such as video and audio streams, still images, and scalar sensor data from the environment. Node deployment in wireless multimedia sensor network was application dependent. It can be in deterministic or random. In both the condition coverage area was concerned.

*Baldeep Kaur Brar, 2014 [9]* proposed a wireless sensor network consists of sensor nodes which were capable to perform sensing and transmission. These sensor nodes had limited battery power which is difficult to replace due to resistant environment. To increase the lifetime of wireless sensor network, it was required to develop such techniques to consume less energy. Less consumption of overall energy of the network results in increase in the system capacity. The relay node deployment problem for wireless sensor networks was concerned with placing the minimum number of relay nodes into the wireless network to meet certain connectivity requirements.

*Mohammed Alnuem, 2014 [10]* described the state-of-the-art node placement schemes and analyzed their performance for linear wireless sensor networks (LWSN).The performance of random and uniform placement schemes in linear sequential configuration analyzed while placing the gateway (GW) at the edge of the deployment region. A non-uniform scheme called linearly decreasing distance (LDD) and analyzed its performance. He analyzed to make uniform energy consumption, LDD gradually decreases the distance between nodes and deploy them closer to each other towards the GW. He analyzed the impact of GW location on the network performance.

*Shobha et al., 2015 [11]* described wireless sensor network was built with many sensor nodes. Node placement was very important task in wireless network. Different approaches were used for the deployment of sensor nodes were, random deployment and the deterministic deployment. The performance metrics of WSNs were: network coverage, network connectivity, and lifetime of sensor node. A sensor deployment can reduce the complex problems in WSN. Efficient coverage was very important for wireless sensor networks. The Coverage techniques used in wireless sensor network were static coverage strategy and dynamic coverage strategy.

*KiranKumar Y. Bendigeri et al., 2015 [12]* proposed the optimized network developed by effective placement of nodes in circular and grid pattern, which called as uniformity of nodes to be compared with random placement of nodes. Each of the nodes was in optimized positions at uniform distance with neighbors, followed by running energy efficient routing algorithm that saves an additional energy to provide connectivity management by connecting all the nodes.

*Sasmita Manjari Nayak, 2015 [13]* investigate random and deterministic sensor node deployments in WSN. The Sensor Node deployment was a fundamental issue to be solved in Wireless Sensor Networks (WSNs).A proper node deployment could reduce the complexity of problems in WSN. It could extend the lifetime of WSNs by minimizing energy consumption.

*Dr. P. Ponmuthuramalingam et al., 2015 [14]* proposed wireless sensor networks (WSN) was one of the upgrading technologies to afford a service to the network users. WSN was used to sensing the node to transfer the data among the network sensor node. While transferring the data in the sensor node they were faced many issues occurred due to the reasons of power failure, noise volatility, which harmfully incit the coverage of the WSN. These problems were occurred due to the coverage problem among the nodes and also node placement is also a major issue in WSN. To solve this problem many approaches where proposed like Dense sensor node placement, Battery-powered sensor nodes, Self configurable, Severe energy, computation, and storage constraints.

*Xuemei Sun,2015 [15]* proposed node deployment algorithm in wireless sensor networks based on Steiner tree algorithm. This algorithm considered the two aspects algorithm complexity and practical topology to design improvement strategies. The algorithm could ensure high arithmetic speed and better results to solve node deployment based on network connectivity.

*Smita S. Kharade,2015 [16]* proposed the model Support Vector Machine (SVM) which predicted faulty nodes in wireless sensor network and add minimum number of relay nodes. Faults affected on quality of services (QoS), in WSN networks faults produced incorrect data provided by sensor nodes or the network made a misjudgement on nodes or the network and placing relay nodes to endure these faults, to improve Quos and reliability of the network.

## VI. CONCLUSION

In this paper, we focused on the wireless sensor network about the node deployment strategies. The node deployment is a better option for Wireless Sensor Network (WSN) in the sense of coverage performance evaluation. In the future work, we will do further research and implementation of sensor nodes deployment using NSGA-II based on multi-objective algorithm for optimizing the coverage of area, number of active sensor nodes and energy consumed by nodes in wireless Sensor networks.

## REFERENCES


[1] Michał Marks. "A Survey on Multi-Objective Deployment in Wireless Sensor Networks."*Journal of Tele communication and Information Technology*, 2010.

[2] Kamal Jadidy Aval and Shukor Abd Razak."A Review on Implementation of Multiobjective Algorithms in Wireless Sensor Networks." World Appl. Sci. J., 19 (6): 772-779, 2012.

[3] Haitao Zhang and Cuiping Liu."A Review on Node Deployment of Wireless Sensor Network."*International Journal of Computer Science Issues (IJCSI), Vol. 9, Issue 6, No 3*, 2012.

[4] Soumyadip Sengupta , Swagatam Das, M.D. Nasir, B.K. Panigrahi. "Multi-Objective Node Deployment in WSN: In Search of An Optimal Trade-off among Coverage, Lifetime, Energy Consumption, Connectivity." 2012.

[5] Mayur C. Akewar. " A Study of Wireless Mobile Sensor Network Deployment." *International Journal of Computer Networks and Wireless Communications (IJCNWC), Vol-2*, 2012.

[6] Seyed Mahdi Jameii and Seyed Mohsen Jameii. " Multi- Objective Energy Efficient Optimization Algorithm for Coverage Control in Wireless Sensor Networks." *International Journal of Computer Science, Engineering and Information Technology (IJCSEIT), Vol.3*, 2013.

[7] Mamatha G,B G Premasudha." Deployment Techniques of Nodes in WSN for Multidomain Applications." *International Journal of Advanced Computer Research, Volume-3*, 2013.

[8] Shikha Swaroop,Prashant Krishan, Ayashasiddiqua." A Survey of Architecture and Node Deployment in Wireless Multimedia Sensor Network." *Intenational Journal of Scientific and Research Publications ,Volume 3*, 2013.

[9] Baldeep Kaur Brar. "Review on Relay Node Placement Techniques to Increase System Capacity in WSN." *International Journal of Engineering Research And General Science ,Volume 2*, 2014.

[10] Mohammed Alnuem."Performance Analysis of Node Placement in Linear Wireless Sensor Networks."*Journal of Emerging Trends in Computing and Information Science, vol-5*, 2014.

[11] Shobha and Kiran Kumari Patil. "Survey Paper on Node Deployment and Coverage Strategies in Wireless Sensor Networks." *In Proceedings of 35th IRF International Conference*, 2015.

[12] Kirankumar Y. Bendigeri, Jayashree D. Mallapur." Multiple Node Placement Strategy for Efficient Routing in Wireless Sensor Networks." 2015.

[13] Sasmita Manjari Nayak."Node Deployment and Coverage in Wireless Sensor Networks." *International Journal of Innovative Research in Advanced Engineering (IJIRAE)*, Volume 2 , 2015.

[14] Dr. P.Ponmuthuramalingam, M.Preethi. "A Survey on Node Deployment for Sensing Mobile- Node in WSN ." *International Journal of Advanced Research in Computer and Communication Engineering* ,Vol. 4, Issue 6, 2015.

[15] Xuemei Sun."Node Deployment Algorithm Based on Improved Steiner Tree."*International Journal of Multimedia and Ubiquitous Engineering* ,Vol.10, 2015.

[16] Smita S. Kharade, Simran R. Khiani."Fault Prediction and Relay Node Placement in Wireless Sensor Network." *International Journal of Innovative Research in Computer and Communication Engineering,* Vol. 3, 2015.