

Wireless Sensors networks deployment techniques, constraints: A survey

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Abstract - Wireless sensor networks is a node technology consists of hundreds or thousands of node deploy as per the application. WSN node consists of sensors which sense the physical quantities, microcontroller for processing purpose and transceiver for communication purpose. A wireless sensor network is the technology having wide range of applications.WSN have the different deployment technique as per the application. Thus paper describes the deployment techniques, and constraints of WSN.

Index Terms - wireless sensor networks (WSN), deployment techniques, constraints, communication hole

I. Introduction:

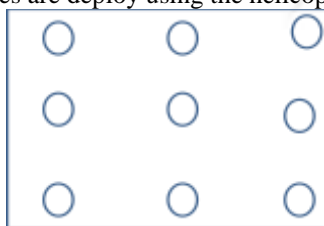
Wireless sensor networks have the different application areas such as environmental monitoring, agricultural, industrial, military, biomedical, mines etc. As per the application the area covered by the sensor network is also differ. Such as in case of the forest fire monitoring the area is large but in case of the biomedical monitoring the area is small. Also the weather or environmental conditions are differing for the working of the sensor nodes. Hence the deployment techniques of WSN are important. Deployment means placing the sensor node in the region of interest. It is more important to deploy the sensor node in the area of interest and deployment techniques decide the efficiency of the WSN. The good deployment techniques decide the coverage and connectivity of the network. An ideal deployment technique covers the area of interest with proper connectivity, but practically it is not possible all time. Sometimes proper coverage is not take place, at that time communication holes get created. To overcome from it different algorithms are used, which are review in the literature survey.

Wireless sensor networks have the different application areas such as environmental monitoring, industrial monitoring, underwater monitoring, habitat monitoring etc. As per the applications the requirements from the WSN are also changed, in case of the environmental monitoring the area monitor by the WSN is large hence it has with stand the climate changes. Harsh environment is having is case of the some industries. As per the application changes requirement are also changes. We know that WSN is very good technique rapidly developing. But it also has some limitations or constraints.

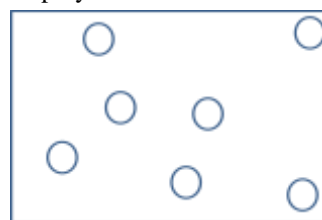
This paper shows the deployment techniques of WSN and also the constraints. It will try to give some ideas to overcome from these limitations.

A. Deployment Techniques:

The survey on deployment techniques shows there are two types' random deployment and deterministic deployment. In random deployment sensor nodes are randomly deploy in the area of interest where humans cannot go for e.g. deep forest areas or underwater. In case of the deterministic deployment the exact location of the sensor nodes is found out and deployment is done for e.g. in case of traffic monitoring system or agricultural. In case of the random deployment sensor nodes are deploy using the helicopter or airplane. In deterministic deployment the sensor nodes deploy by the humans.



Deterministic deployment



Random Deployment

Fig1 deployment techniques

The availability of number of sensor nodes is also one of the factors in coverage of the WSN. When we want the every event detection in coverage area then the dense deployment i.e. large numbers of sensor nodes are used. When number of nodes is less then sparse deployment is done. Due to the random deployment sometime total area of interest is not covered, most of the sensors gathered in the same area and remaining area have less sensor nodes. In such case mobile nodes are used. It is called as force based deployment. In Force based deployment mobility of sensors node taken place, using virtual repulsive and attractive forces. The sensors are forced to move away or towards each other so that full coverage is achieved. The sensors will keep moving until equilibrium state is achieved where repulsive and attractive forces are equal and thus they end up cancelling each other. Hence the proper deployment is done. But in this situation the large energy loss had done for the movement of the mechanical parts. Hence WSN constraints come in picture.

B. Wireless sensor networks nodes have variable size from small to large, with variation in capabilities. Hence the cost of them is also changes. These size and cost constraints such as battery i.e. energy, communication range, low bandwidth and limited

processing capability and storage of gathered information. Area coverage and connectivity are the prime requirements as shown in the deployment of WSN. Hence they come under the deployment constraints. If proper deployment is done then coverage and connectivity properties are also satisfy.

Resource constraints:

1. Energy constraints: We know that the wireless sensor network nodes are battery powered. When these nodes are deploy in the required area then they stay there for lifetime. Hence battery power is also want to stand for lifetime. But it is not possible as it has many functions to do such as sensing, computing, communication etc. Hence energy lost taken place. Hence life of the nodes depend upon the battery life. [9] If we process the sensed data before transmission then we can save some battery power. Sometimes due to harsh environment nodes are unavailable, in that situation if they go to sleep mode then also battery power is saved. Use of the solar system for battery charging is also possible for some situations.
2. Storage/memory constraints: Wireless sensor networks uses microcontroller as processing unit. Controllers have the limited memory available, which is used for execution of program and storage of data sensed by the sensors. If we want that all data get saved then it is not possible due to limited memory. Hence after a particular time it has to erase the memory for new data. This constraint can be removed by regularly saving the sensed data at the operator's centralized workstation. Also by adding the extra memory at nodes we can remove it in some extents.
3. Bandwidth constraints: Wireless sensor networks deploy for surveillance and monitoring task have the bandwidth and energy constraints [8].

Deployment constraints:

Sensor deployment is a fundamental constraint in WSN. Deployment issue is directly related with the mobility of sensor nodes, which is limited. Deployment types, number of sensors and target locations determine the intrinsic property of WSN is connectivity, coverage, cost and life [9]. If the proper deployment is done then it covers the area of interest and gives proper connectivity.

II. Literature Survey:

P.V. Naveenkumar et. All [1] gives the survey of different papers on deployment of sensor node. The deployment area shape of the WSN is studied to find out the better area structure for the deployment. The Hexagonal shaped cell is effective in achieving a good coverage of a given region of interest and reduces the number of sensor nodes in the area. Random deployment errors affect the coverage quality of WSN. The connectivity problems are discussed and show that star deployment improves from it. This paper explain the different shapes such as triangle, square, circle, hexagonal, equilateral, bus, star etc. deployment techniques. As per the requirement i.e. coverage, target detection, quality of service, the shape of deployment is give results. This paper also explains communication holes, redeployment problems, estimating network lifetime.

Pallavi Sahu et. All [2] study the coverage and connectivity in large scale wireless sensor networks. Coverage is used to determine the quality of service of the network. Paper explains the solving the coverage problems based on strategies. These are divided into three categories force based, grid based and computational geometry based. Force based deployment strategies rely on the sensors mobility, using virtual repulsive and attractive forces the sensors are force to move away or towards each other so that full coverage is achieved. Grid points are used in two ways in WSN deployment; either to measure coverage as used in VFA or to determine sensors positions. Computational geometry is frequently used in WSN coverage optimization, the most commonly used computational geometry approach are Voronoi diagram.

Avneet Kaur et. All [3] reviews the techniques that can maximize the coverage and removes the overlapping problem. The deployment means to deploy or spread out or arrange strategically the sensor nodes. The performance metrics of WSN are coverage and connectivity. The types of coverage are written as point coverage, barrier coverage and area coverage. Point coverage means particular points of region of interest are observed. Barrier coverage means covering the boundary of the area. Area coverage means covering the each area with at least one sensor at each point. This paper explains the different deployment techniques such as genetic algorithm, neural networks, fuzzy logic, particle swarm optimization and Reinforcement Learning. Genetic algorithm is utilized to look for close ideal arrangements when no deterministic strategy exists. Advantages of Genetic Algorithm: Medium computation, optimal solutions are provided by GA in deployment and disadvantages are High memory requirements and Lack of flexibility. Neural networks require medium memory and provide optimal solutions. NN have the complex architecture. In reinforcement learning it gains its information by effectively investigating the surrounding. Fuzzy logic system is multi valued function i.e. derived from fuzzy set values to deal with approximate reasoning. Fuzzy can reduce development time as compared to other techniques. PSO is easy for implementation but it require large memory and costly method for real time application.

Jaspreet Kaur et. All [4] describes that localization is one of the forecast issue in the area of WSN. Localization means to compute the locations of wireless devices. This paper describes the different deployment techniques to improve the localization. There are three types of node deployment, static, dynamic and energy aware. In case of static sensor nodes are fixed hence reduces performance where as in dynamic the sensor nodes are movable. In energy aware deployment the sensor node is equipped with power. There are two types of algorithm for static deployment and also used for dynamic are artificial bee colony (ABC) and bio-geographical based optimization (BBO). In ABC algorithm implemented by taking into consideration the foraging actions of honeybee swans. It gives good result (99.34% for 10,000 iterations). Due to the randomness of sensor deployment the effective coverage is not possible. Hence in BBO both static and dynamic nodes are used. Dynamic node deployment algorithm is virtual forced based algorithm. Energy aware node placement the algorithm is bio-geography based optimization algorithm. It uses the SEAD protocol called distributed self-organizing protocol, which saves the power.

Mamatha G et. All [5] focus on optimal node placement algorithm. The effective node position is very important for effectiveness of the WSN. The choice of the node deployment depends on types of sensors, application domain and the environment in which sensors has to operate. In static node deployment have the controlled node deployment and random node deployment. Controlled node deployment is good when nodes are expensive and if their operation is depends on their position. Controlled node deployment is used for indoor applications. In some harsh environmental cases where humans cannot reach the random node deployment is used. Primary objective of the node deployment are increasing area coverage, extending the network lifetime, boosting the data fidelity and achieving strong network connectivity. Secondary objectives such as fault tolerance and load balancing are also considered.

Application-level interest can vary over time, and the availability of network resources may change as new nodes come and join the network, or as older nodes exhausts their energy. Target Recognition & Tracking (ATR) application where the target is in moving condition. In such cases the dynamic node deployment is effective. Dynamic re-positioning is categorized in to types on demand relocation and post deployment sensor relocation. The post deployment is carried out when sensor deployment is done randomly; hence no proper coverage of area is done. Hence quality of coverage is improved by relocation of sensor nodes. On demand repositioning is decided when network operation is based on the changes in either application level or the network state.

You-Chiun Wang et. all [6] sensor deployment is critical issue, it reflects the cost and detection capability of WSN. Deployment systems consider both coverage and connectivity. Coverage requires that every location in the sensing field is monitored by at least one sensor. Connectivity requires that the network is not partitioned in terms of nodes communication capability. Coverage is affected by sensors sensitivity, while connectivity is influenced by sensors communication ranges. This paper considers sensing field as an arbitrary-shaped region possibly with obstacles. It describes the two naive deployment algorithms. To keep a minimum number of sensors, minimize the overlapping coverage.

Seema et. All [7] two types of nodes are explain, these are homogeneous and heterogeneous. In homogeneous all sensor nodes are identical and having the same capability. In heterogeneous all sensor nodes are not identical and do not have the same capability. It explains the types of holes. Coverage or communication holes are those holes in which area is not covered by any sensor node. It happens due to random deployment creating voids, presence of obstructions and node failures etc. A routing hole consists of a region in the sensor network where either node is not available or the available nodes cannot participate in the actual routing of the data. When the object to be tracked is equipped with jammers which are capable of jamming the radio frequency used for communication among the sensor nodes, then the jamming holes get created.

Alejandro Ribeiro et. All [8] wireless sensor networks used for surveillance and monitoring purpose under stringent energy and bandwidth constraints. In this paper developed algorithms and studied interesting tradeoffs that emerge even in the simplest distributed setup of estimating a scalar location parameter in the presence of zero-mean additive white Gaussian noise of known variance.

C. S. ahaya Kingsly et. All [9] this paper study the factors that influence a WSN in terms of constraints and give recommendations to overcome from it. There are some factors that influence the wireless sensor network design, such as fault tolerance, scalability, cost, operating environment, topology etc. fault tolerance is the ability of a WSN to sustain sensor functionalities without interruptions due to node failure. Cost of the single node is important because it determines the overall cost of the network. WSN have some resource constraints such as energy, computational speed, memory and bandwidth. These constraints along with deployment constraints are discuss here. The efficiency of the WSN is determined by the coverage and connectivity of the network, which is depending upon the deployment techniques.

Indu et. All [10] explains about the different challenges and issue in case of the WSN. Different types of wireless sensor networks such as terrestrial WSN, underground WSN, underwater WSN, multi-media WSN, and mobile WSN are revive in it. Fault, low latency, scalability, transmission media, coverage problems such design issue discusses here, along with the topology issue. Challenges in real time as WSN works in real environment hence sensed data must reach in proper time constraints. Many other functions also meet the real time constraints such as data fusion, data transmission, target and event detection and classification, query processing, and security. Limited processor bandwidth and small memory are two arguable constraints in sensor networks, which will disappear with the development of fabrication techniques. However, the energy constraint is unlikely to be solved soon due to slow progress in developing battery capacity.

III. Conclusion:

Wireless sensor networks are the technology which is rapidly increasing its use in different types of applications. As per the application the area covered by is also vary. Hence the deployment techniques of WSN are very important to properly cover the area called coverage and give proper communication between nodes and the operator called connectivity. To satisfy coverage and connectivity proper deployment must done. Wireless sensor networks also have some limitations or constraints such as battery power, communication range, low bandwidth etc. To overcome from such constraints proper work has to done.

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