Performance of Node Deployment Techniques in WSN: A Review

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Abstract—Wireless sensor network is growing area for research, commercial development and armed forces of country. Performance of Wireless Sensor Network depends on coverage and connectivity of network whereas coverage of network depends on deployment of sensors. Deployment can be done either Random deployment or Deterministic deployment. Deterministic deployment of sensor nodes is impractical in some situations such as dynamic battle regions and hazardous situations. In such situations there is an alternative way to deploy the sensors randomly. Random deployment causes area of intersection in nodes. The techniques are reviewed in this paper that can be implemented to resolve deployment issues. The main objective of this paper is to review the techniques that can maximize the coverage and removes the overlapping area between nodes.

Key words: Deployment, Fuzzy Logic System, Maximum Coverage, Wireless Sensor Network

I. INTRODUCTION

A wireless sensor network is also called as Actuator network. Wireless sensor network is connection of “nodes” that communicates between a couple to hundred or even thousand nodes, which monitor specified area and communicate the monitored information to sink node. Each such sensor node has typically several parts: a radio transceiver, an electric circuit and energy source or an embedded form of energy harvesting.

Fig. 1: block diagram of wireless sensor

Applications of WSN are area monitoring, medical fields, earth sensing, pollution monitoring and calamity alleviation etc. sensing, pollution monitoring and calamity alleviation etc. Sensor deployment is major issue of WSN. Performance of wireless sensor network depends upon techniques used for deployment of sensors. Sensor node is considered as cheap computer or device that performs three basic functions sensing, computation and communication. Sink node features as gateways and they store and ahead the information gathered.

A. Characteristics of WSN

1) Power utilization constraints for hubs utilizing batteries or vitality gathering.

2) Ability to cope with node failures.

3) Scalability to vast size of sending.

4) Ability to withstand with harsh environment conditions.

5) Ease of use.

6) Cross layer design

B. Challenges of Wireless Sensor Network

1) Localization

2) MAC and Scheduling

3) WSN Security

4) Data Aggregation and dissemination

5) Routing and Clustering

6) Quality of Service

7) Design and Deployment

Deployment: In this paper our main concern is with deployment of wireless sensor. Basically deployment means to deploy or spread out or arrange strategically. Deployment can be categorized into two ways, sparse deployment and dense deployment. In case of sparse deployment few numbers of nodes are deployed in field of interest. In case of dense deployment large numbers of nodes are deployed in field of interest. [9]

Fig. 2: Random and Deterministic deployment

Types of Deployment: There are two types of sensor deployment described as following.

a) Random deployment: The sensors are dropped in a plane randomly. Basically random deployment of sensors can be example of dense deployment as large numbers of sensors are deployed to ensure maximum coverage.

b) Deterministic deployment: In this type of deployment location of nodes is planned and then placed to obtain desired performance. So that deterministic deployment can also know as planned and controlled deployment.

Coverage: Another performance metrics in wireless sensor network is coverage and connectivity. Maximum coverage and low cost deployment have now become a challenge for developers. Coverage is basically considered as how well a sensor network will monitor a field of interest [4]. The type of coverage depends on area to be monitored, types of coverage are written as follows [1].

1) Point coverage

2) Barrier coverage

3) Area coverage
Point coverage is also referred as sweep coverage, in point coverage particular points of region of interest are observed. It is used for event detection and patrol inspection etc.

Barrier coverage is covering the boundary of the area. The sensors are placed near the boundary. Barrier coverage is utilized to accomplish static arrangements of sensor nodes which amplifies the location rate of targets appeared in sensor system.

![Fig. 3: Barrier Coverage](image)

Area coverage is also known as grid coverage, field coverage, and blanket coverage [4]. Area coverage is covering of the enthusiasm with at least one sensor at each point. The minimum number of sensor nodes is deployed within a field to achieve area coverage. This type of coverage is represented problem of minimization and also problem of maximization [2].

![Fig. 4: Area Coverage](image)

II. TECHNIQUES

Various techniques of deployment are written as follows:

A. Genetic Algorithm

Genetic algorithm is considered as evolutionary algorithm. The normal genetic algorithm is based on simulation of genetic mechanism and theory of biological evaluation [9]. A GA is utilized to look for close ideal arrangements when no deterministic strategy exists or if the deterministic technique is computationally difficult. A lot of work has been done from last few years in optimized deployment of wireless sensor network. Shuhpreet and Uppal et al. [1] have implemented the Genetic algorithm to remove overlapping of sensor nodes and to ensure maximum coverage. Their proposed algorithm was successful to achieve maximum coverage and intersection free deployment but still there exists an issue of energy consumption.

Yoon and Kim et al.[6] additionally characterized Maximum Coverage Sensor Deployment Problem (MCSDP) in their paper and attempted to evacuate issue utilizing proposed efficient genetic algorithm using normalization function, likewise embraced Monte Carle technique to outline efficient evaluation function. To overcome the problem of overlapping and coverage Brar and Virk et al.[3] have proposed a new method using GA, the algorithm then ensures the maximum coverage with interference free nodes.

1) Advantages of Genetic Algorithm:
   1) Medium computation.
   2) Optimal solutions are provided by GA in deployment.

2) Disadvantages of Genetic Algorithm:
   1) High memory requirements.
   2) Lack of flexibility.

B. Particle Swarm Optimization

is a branch of Artificial knowledge that spotlights on the aggregate conduct and properties of perplexing, self-composed, decentralized framework with a social structure for example flying creature runs, insect states and fish schools [5]. Particle Swarm Optimization is optimization approaches which have been previously implemented in wireless sensor network. Kulkarni et al. [7] have been studied PSO technique for maximum coverage deployment, localization, clustering of nodes and data aggregation. PSO provides high quality results, fast merging and inconsequential calculation. Then again PSO requires vast measure of memory which restricts its utilization in rapid constant applications. Soliman and tan et al. [10] have been applied adaptive hybrid optimization, PSO and GA to eliminate sensor location problem for maximum coverage. The method ensures true results for desired coverage.

1) Features Of Particle Swarm Optimization:
   1) Easy implementation.
   2) Availability of guidelines for choosing its parameters.
   3) High quality solutions.
   4) Accessibility of variations without a doubt, number and twofold areas.

2) Disadvantages Of Particle Swarm Optimization:
   1) Large memory is required
   2) It is costly method for real time problems.

C. Neural Networks

Neural system is comprised of interconnecting artificial neurons that copy the properties of biological neurons. The human brain which possesses an extraordinary ability to keep, store, and execute is a complex network of over billions of neurons, each connected on average to about 10,000 other neurons. Every neuron gets signals through neurotransmitters, which control the effects of the signals on the neuron. NN learns comprises of a system of neurons sorted out in information, covered up and yield layers. In feed forward NN, the outputs of a layer are connected as the inputs to next layer while in recurrent networks, feedback connections are allowed as fig. 5. In an Elman type recurrent network, a copy of hidden layer output is referred as context layer, is presented as the input to hidden layer. [7]
Fig. 5: Architecture of Neural Network[7]

1) Advantages Of NN:
   1) NN’s requires medium memory requirements.
   2) NN’s provides optimal solutions.

Drawback of NN’s is its complex architecture.

D. Reinforcement Learning

Reinforcement learning depends on machine learning. RL is naturally enlivened and gains its information by effectively investigating its surroundings. At every step, it chooses some conceivable activity and gets a reward from nature for this particular activity. The best possible action at any state is never known as A-priori. As drawback, the operators needs to attempt a wide range of activities, arrangement activities and gains from its encounters. Reinforcement learning is appropriate for steering (e.g. for distributed issues).

Fig. 6: Model of Reinforcement Learning

Q-learning, Dual Reinforcement learning, Team-partitioned opaque-transition Reinforcement learning, Collaborative Reinforcement learning are Algorithms of Reinforcement learning.

E. Fuzzy Logic

Fuzzy logic system is multivalued function i.e derived from fuzzy set values to deal with approximate reasoning. The use of fuzzy logic is suitable for decision making. Fuzzy logic is applied to deal with imprecise information rather than precise. The use of fuzzy logic is appropriate method for decision process as it describes system intuitively using linguistic variables. Fuzzy can reduce development time as compared to other techniques.

1) Advantages of FLS:
   1) FLS is simple as less computation is required.
   2) FLS can endure imprecise and unreliable data.[12]

Fuzzy logic system can be applied in deployment of wireless sensor network. FLS in deployment is previously used by Mathur et al.[11] their system was successful to achieve fast and stable deployment with maximum coverage. It also optimizes energy consumption of sensor nodes during deployment. But this system does not remove overlapping of nodes. This drawback of system should be removed in future. Amjad Osmani [8] have presented the sensor deployment to achieve enhanced coverage after redeployment of sensor nodes using fuzzy sensor placement based on neighbor state. But still there is need to work on energy consumption and intersection of nodes in this technique.

Fig. 7: Deployment using FLS

There are four components of fuzzy logic system.

1) Fuzzification module: It changes the system inputs, which are crisp numbers, into fuzzy sets. All fuzziness for fuzzy sets is calculated by member functions.
2) Knowledge Base: It stores IF-THEN rules provided by experts.
3) Inference engine: It recreates the human making so as to think procedure fuzzy surmising on the inputs and IF-THEN guidelines.
4) Defuzzification: It changes the fuzzy set obtained by the inference engine into a crisp value.

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Table 1: Properties of Deployment Techniques

III. Conclusion

The deployment is rising issue in wireless sensor network as performance of sensor network depends upon deployment technique. We have concluded that random deployment is better than deterministic deployment. But there exists a problem of overlapping of nodes with random deployment that should be removed to ensure maximum coverage and connectivity. Different algorithms are formally reviewed.
that are used to resolve this problem like PSO, FLS, GA, NN, RL. But we have concluded that fuzzy logic system is better than other algorithms as fuzzy logic system shows best properties among others. In our future work we will implement FLS to remove overlapping of nodes and to ensure maximum coverage.

REFERENCES


