www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 4 Issue 1 January 2015, Page No. 10150-10254

A Study on Mobile Networks and 3d Self-Deployment Algorithm

Muskan Sharma
Research Scholar (M Tech)
Kurukshetra University Kurukshetra

ABSTRACT
The sensor deployment problem of wireless sensor networks (WSNs) is a key issue in the researches and the applications of WSNs. Fewer works focus on the 3D autonomous deployment. Aimed at the problem of sensor deployment in three-dimensional spaces, the 3D self-deployment (3DSD) algorithm in mobile sensor networks is proposed. A 3D virtual force model is utilized in the 3DSD method. A negotiation tactic is introduced to ensure network connectivity, and a density control strategy is used to balance the node distribution. The proposed algorithm can fulfill the nodes autonomous deployment in 3D space with obstacles. Simulation results indicate that the deployment process of 3DSD is relatively rapid and the nodes are well distributed. Furthermore, the coverage ratio of 3DSD approximates the theoretical maximum value

INTRODUCTION

The proliferation of wireless and mobile devices has fostered the applications of wireless sensor networks (WSNs) pervaded from military to industry, agriculture, and other scenarios. The node deployment is a key issue in WSNs, since it seriously influences the feasibility and Quality of Service (QoS) for WSNs. Generally, the node deployment methods can be classified into static deployment scheme and dynamic deployment scheme. And the static deployment schemes are mainly applied in WSNs with non-mobility nodes; it concludes determinate deployment methods and random deployment methods.

In the random deployment scenario, sensor nodes are scattered via airplane or other aided measures into the Area of Interest (AOI) to which human being cannot get conveniently. Random static deployment methods ensure the supervision performance via sensor node redundancy. While the dynamic deployment methods are mainly used in a mobile WSNs (i.e., the sensor node has mobility), after being scattered in AOI, the sensor nodes accomplish deployment autonomously. The autonomous deployment of mobile WSNs is a process in which the mobile sensor nodes adjust their positions dynamically according to a certain algorithm, until the predefined coverage requirement is achieved.

By adopted dynamic deployment method, the coverage performance is improved, while the overhead of hardware is decreased. However, the self-deployment scheme designing in three-dimension scenario is difficult; aside from this, the obstacle and area boundary may disturb the deployment process. Aimed at solving these problems aforementioned, we proposed a 3D self-deployment (3DSD) algorithm to fulfill the nodes autonomous deployment in 3D area with obstacles. Virtual force model is introduced in 3DSD method. The network connectivity and nodes distribution density are also took into account to provide the feasibility of 3DSD.

Extensive simulations are conducted, and experiment results indicate that the deployment duration of 3DSD is comparatively short, and the coverage ratio of 3DSD approximates the theoretical maximum value. The main contributions of our work can be summarized as follows: (1) the virtual force model is extended to three-dimensional space, and the optimal coverage ratio of 3D deployment is defined and calculated, (2) a density control tactic is explored, node density of each cluster is under control to ensure the node distribution of clusters is balance, (3) the network connectivity is concerned, and a negotiation protocol is designed to provide the practicability of 3DSD.

For the node deployment in WSN, there are certain coverage performance criteria required to be satisfied. According to the application scenario of WSN, deployment coverage category can be classified into blanket coverage, barrier coverage, and scan coverage. Our work belongs to the blanket coverage.

METHODOLOGY OF DEPLOYMENT

The node deployment is an enabling issue for WSN, so a large number of deployment methods are presented by scholars. There are mainly three categories of research methods in node deployment: incremental deployment method, geometric analysis method and virtue force based method.

The incremental deployment method is appropriate for the scenario that the prior information of the monitored area is unknown, but the deployment duration is too long. Geometric analysis method cannot guarantee network connectivity, and it is hard to be applied to some scenario with obstacles. Zou and Chakrabarty first proposed deployment method using virtual force model (VFM) in WSN. In VFM, sensor nodes are supposed to be subjected to some kinds of forces which come from area border, other nodes, and so forth. The force balance is regarded as the final state of network. Due to the intuition and the descriptive ability of VFM, it is widely used in deployment issue of WSN. There certainly are some hybrid methods used in node deployment.

STATIC DEPLOYMENT AND DYNAMIC DEPLOYMENT

The node deployment issue can also be classified into static deployment and dynamic deployment according to whether nodes have moving ability. In dynamic blanket deployment, one subissue is how to mend deployment holes formed in static deployment process using mobile nodes. Another subissue is self-deployment of some mobile enabling nodes after they are launched in AOI. Our work focuses on the latter. A geometric analysis method is proposed in; however, there is still the problem that it is hard to be employed in scenarios with obstacles. Zhang and Fei present a deployment scheme to enhance the coverage while keeping the network connected at each step of the deployment. However the obstacle is not taken into consideration.

3D SURFACE DEPLOYMENT AND 3D SPACE DEPLOYMENT

According to the dimensionality of AOI, the node deployment method can be divided into two classes: deployment in 2D space and deployment in 3D space. In 3D space deployment, there are two subissues, one is 3D area coverage (e.g., underwater sensor deployment) and the other is 3D surface deployment (e.g., mountain surface deployment). An underwater acoustic sensor self-deployment scheme is proposed, which achieved relative good performance. Our work is about the former. A lot of applications of WSN are 3D scenario, so the autonomous deployment of mobile WSN in 3D space is of great significance. It is hard to directly utilize 2D deployment method in 3D space. One kind of solution for 3D coverage or 3D deployment is dimensionality reduction, such that presented an efficient polynomial-time algorithm to solve the coverage problem in three-dimensional wireless sensor networks by translating the problem to 2D and 1D. However, it is not suitable for autonomous self-deployment algorithm.

However, this centralized method is lack of pervasiveness, because it can only be used in static deployment. Liu et al. proposed a combined virtual force (CVF) algorithm for 3D autonomous deployment, and the performance of this algorithm is good, but the deployment duration is comparatively long.

THE GAP BETWEEN THE PROPOSED 3DSD AND RELATED WORKS

The topic of 3D node self-deployment in WSNs has already received considerable attention in the literature. However, our work is different from them because our proposed scheme is comprehensive. There are many practical requirements considered in our work, such as shortening the deployment process, avoiding the local optimum problem, handling the obstacles in AOI, and, meanwhile, maintaining the network connectivity.

PRELIMINARIES

PROBLEM STATEMENT

The 3D self-deployment problem can be defined as follows: “Given a connected network of sensors each of which has a fixed transmission and sensing range respectively, and are placed in a 3D space with a given area boundaries and some obstacles, our goal is to maximize the coverage area using these mobile sensors as rapidly as possible, meanwhile the network connectivity should be provided.” Taking the limited computation capacity into consideration, the deployment scheme should be lightweight. In the node self-deployment process, there may be some local optimum areas due to the obstacles; this situation must also be considered.

THREE-DIMENSIONAL SENSING MODEL

We adopted a sphere perception model that node in the center, and, is the radius of the sphere. As shown in Figure 1, within the sensing spherical region, the probability to be perceived is 1, while outside the sphere the probability to be perceived is 0. The perception function is expressed by

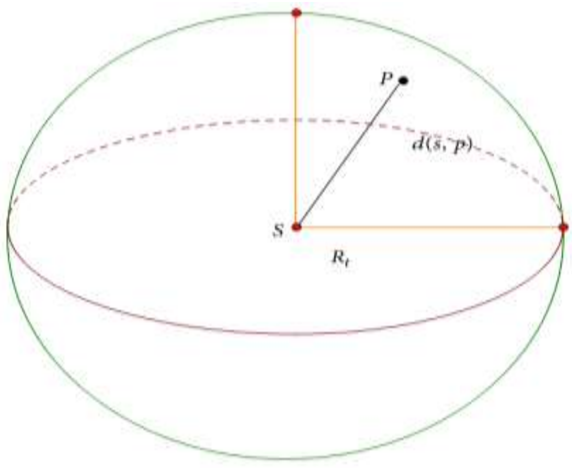

Figure 1: Ideal 3D perception model.

In Figure 1, node is an arbitrary point in sphere, represents the probability that can be perceived by sensor node , and denotes the Euclidean distance between the sensor node and the point . Every sensor node has the same transmit power, that is, the same perception radius. In fact, the coverage issues based on the three-dimensional perception model are a problem, that is, how to use balls with certain radius to cover a three-dimensional space completely. Taking the viewpoint of economic saving into consideration, we need to use fewer nodes to cover as many spaces as possible. Figure 2 is a schematic diagram of the ideal three-dimensional perception model in a three-dimensional perception space.

In the two-dimensional plane, seamless maximum effective coverage area of three circles is acquired when the three circles intersect at one point and their centers constitute a regular triangle.

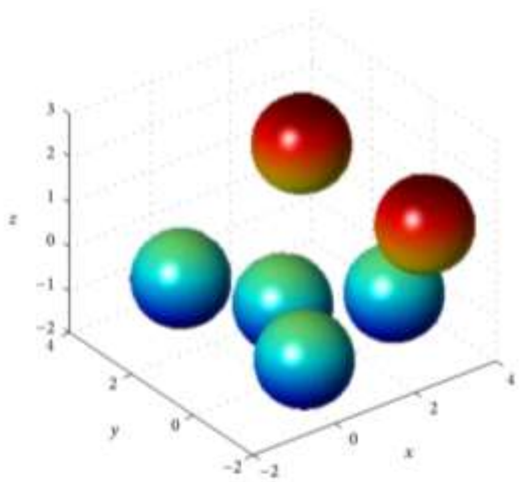

Figure 2: Sensor nodes in 3D space.

DESCRIPTION OF 3DSD ALGORITHM

The design scenario of 3DSD is presented in this section. The explanation and analysis of some design details are also illustrated, such as node density calculating, clustering strategy, and movement location calculation. Finally, we explain the concrete execution steps of 3DSD.

ASSUMPTIONS

The 3DSD algorithm is a theoretical model in 3D space. All the sensor nodes have mobility. To highlight the emphasis, some assumptions are proposed as follows.(1)The sensing area of each sensor node is a sphere; furthermore, the sensing radius and communication radius of each node are equivalent.(2)Each sensor node has mobility and also has the ability to calculate distance and angle using received signal strength and direction.(3)Each sensor node can detect obstacles in its communication scope and can estimate the relative position of obstacles.(4)The travelling speed of each node is very fast, so the time consumption of single movement of node can be ignored.(5)The sensor node movement in its route would not be hindered by other nodes.

CONCLUSION

A distribution autonomous deployment algorithm 3DSD is proposed in this paper. Aimed at the node deployment issue in 3D space, the virtual force model is adopted in 3DSD. The forces coming from boundaries of AOI, obstacles in sensing area, and the sensitive area are totally considered. The negotiation strategy is introduced to provide network connectivity. The node density control scheme is adopted such that the density between clusters is balanced. Simulation results show that the performance of 3DSD is preferable, and the coverage ratio of 3DSD is quite high.

The work focus on 3D autonomous deployment for WSN situates initially theoretical stage yet. In the future, the following issues should be considered: (1) to construct the 3D irregular sensing model, (2) to introduce error eliminating methods for computing and moving, and (3) to evaluate the feasibility of 3D node deployment algorithm in field experiment.

REFERENCES

1. F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, “Wireless sensor networks: a survey,” Computer Networks, vol. 38, no. 4, pp. 393–422, 2002. View at Publisher · View at Google Scholar· View at Scopus
2. R.-S. Ko, “Analyzing the redeployment problem of mobile wireless sensor networks via geographic models,” Wireless Communications and Mobile Computing, vol. 13, no. 2, pp. 111–129, 2013. View at Publisher · View at Google Scholar · View at Scopus
3. Y.-Y. Shih, W.-H. Chung, P.-C. Hsiu, and A.-C. Pang, “A mobility-aware node deployment and tree construction framework for ZigBee wireless networks,” IEEE Transactions on Vehicular Technology, vol. 62, no. 6, pp. 2763–2779, 2013. View at Publisher · View at Google Scholar
4. D. W. Gage, “Command control for many-robot systems,” inProceedings of the 19th Annual Technical Symposium and Exhibition on Expanding Missions, Unmanned Systems (AUVS '92), Huntsville, Ala, USA, June 1992.
5. R. V. Kulkarni and G. K. Venayagamoorthy, “Bio-inspired algorithms for autonomous deployment and localization of sensor nodes,” IEEE Transactions on Systems, Man and Cybernetics C: Applications and Reviews, vol. 40, no. 6, pp. 663–675, 2010. View at Publisher · View at Google Scholar · View at Scopus
6. Z. Lin, S. Zhang, and G. Yan, “An incremental deployment algorithm for wireless sensor networks using one or multiple autonomous agents,” Ad Hoc Networks, vol. 11, no. 1, pp. 355–367, 2013. View at Publisher · View at Google Scholar · View at Scopus
7. G. Wang, G. Cao, and T. L. Porta, “Movement-assisted sensor deployment,” in Proceedings of the 23rd Conference of the IEEE Computer and Communications Societies (INFOCOM '04), pp. 2469–2479, Hong Kong, March 2004. View at Publisher · View at Google Scholar · View at Scopus
8. Y. Zou and K. Chakrabarty, “Sensor deployment and target localization based

on virtual forces,” in Proceedings of the 22nd Annual Joint Conference on the IEEE Computer and Communications Societies, vol. 2, pp. 1293–1303, IEEE Computer Society, San Francisco, Calif, USA, April 2003. View at Scopus

9. Z. Jing and Z. Jian-Chao, “A virtual centripetal force-based coverage-enhancing algorithm for wireless multimedia sensor networks,” IEEE Sensors Journal, vol. 10, no. 8, pp. 1328–1334, 2010. View at Publisher · View at Google Scholar ·