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Localization in Wireless Sensor Networks: An Introduction

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Abstract

Collection and forward the data to its destination is vital function of a sensor network. Therefore, it is extremely important to have complete knowledge of the location of collected data. Localization technique in wireless sensor networks helps in acquiring information about the collected data. Localization determines the location of sensor nodes, which is an interesting research area. This interest is expected to grow further with the proliferation of wireless sensor network applications. To design efficient, scalable and cost effective localization mechanisms for wireless sensor networks is desirable. This article is just an introduction to the beginners.

Key Words: Localization, Sensors, Network, Virtual coordinates, Wireless

INTRODUCTION

Localization is estimation of the spatial coordinates or location of wireless sensor nodes in WSNs. It is an unavoidable challenge in reference to wireless sensor network for many years. Sensor Nodes can be set up with a Global Positioning System (GPS) device, but this is expensive in terms of volume, power consumption, and money.

Most of the existing position finding scheme is made of two phases:

1) Angle (or distance) combining and

2) Angle (or distance) estimation.

The methods for estimating the angle (or distance) between two wireless sensor nodes are: RSSI (Received Signal Strength Indicator) technique which measures the signal power at the receiver end [1]. In this technique transmit power is known and with this power, we can calculate the loss in the effective propagation. This technique is mainly used for RF signals.

AOA (Angle of Arrival) technique approximately calculates the received signal angle and then calculates sensor node location with the help of some geometric relationships. A broad discussion of these localization schemes is given in [2].

Several researches have been done in localization for last many years. There are many approaches and research work in the fields of localization [3]. Localization problem is carefully considered without the presence of beacon nodes. Doherty et al. (2001) described a scheme which is totally based on connectivity-induced constraints for estimating the unidentified sensor node positions in wireless sensor network [4]. Several other algorithms for localization have been implemented and proposed for outdoor localization [5-8] and indoor localization [9, 10-11].

LOCALIZATION USING VIRTUAL COORDINATES FOR GEOGRAPHIC ROUTING

The physical position of a sensor node device is replaced by a virtual position in virtual geographic routing. The virtual geographic routing was developed solely by using information regarding the connectivity of the sensor nodes. In virtual coordinate system we use a metric which is totally based on a device's (sensor nodes) distance (in numbers of hops) from a set of beacon nodes. The main application of virtual coordinates System is in Geometric routing.

It is argued by Leong et al. (2007) that virtual coordinates in combination with geo-routing gives far better performance than other routing approaches, especially in case of high mobility of wireless sensor nodes because they tend to become more stable [12]. Various other applications of this system include obtaining Meta information or position-sensitive queries on the sensor network. This system is used as an efficient and effective means of anycast services i.e. which service nodes is nearest to me [13].

The AVCS [14] virtual coordinate system (with alignment) performs better than VCS in terms of

greedy routing success but in large WSNs its performance degrades highly.
Load balancing routing for WSNs is given by HVC (hexagonal virtual coordinates) in [15], which is appropriate for a variety of sensor network shapes, and the sensor nodes in the WSNs can distribute the load evenly for forwarding the data.

Sheu et al. (2007) demonstrated that GSpring improves the routing efficiency and can rapidly derive a set of coordinates which are relatively fine and usable instantly, but it does not support the sensor network with non-mobile sensor nodes [16].

MEASUREMENT OF LOCALIZATION

Localization is measured with the help of communication between localized node and un-localized node for determining their geometrical position or placement. Location is determined by means of angle and distance between nodes. There are huge number concepts used in localization. Some of the important concepts are as follow:

1. **Lateration**: It occurs when distance is used to measure between nodes to estimate the location.

2. **Angulation**: It occurs when angle between nodes is used to get the location.

3. **Trilateration**: When distances between the three nodes are measured to identify the location then trilateration occurs. Intersection of three circles is calculated, which gives a single point which is considered as position of un-localized node.

4. Multilateration: More than three nodes are used in location estimation.

5. Triangulation: It occurs when as a minimum two angles of an un-localized node from two localized nodes are measured to estimate its location. Law of sines and cosines of trigonometric are used to estimate node position [17].

LOCALIZATION SCHEMES

Localization schemes are classified as anchor based or anchor free, centralized or distributed, GPS based or GPS free, fine grained or coarse grained, stationary or mobile sensor nodes, and range based or range free.

Anchor Based and Anchor Free

The positions of few nodes are known to us. Un-localized nodes are positioned by these known nodes positions. Accuracy of this scheme is very much dependent upon the number of anchor nodes.

Centralized and Distributed

In this scheme, one central point or node generally known as sink node or base station is responsible to pass the information. Centralized scheme takes less energy and it is computationally less expensive in comparison to individual nodes systems. Clustering is absent in distributed schemes, and every node calculates its own position [18-21].

GPS Based and GPS Free

GPS based scheme is very efficient and accurate. However, it is costly as one has to place a sensor at every node. GPS-free algorithms do not have GPS, and they measure the distance between the nodes relative to local network. The GPS free schemes are less costly as compared with GPS-based schemes [22, 23].

Coarse-Grained and Fine-Grained

Coarse-grained localization schemes result without using received signal strength. Whereas, Fine-grained localization schemes result when localization methods apply features of received signal strength.

Stationary and Mobile Sensor Nodes

Stationary nodes are static in nature and are fixed at one place. Static nodes are used in majority of applications. Mobile sensor nodes are applied in very few applications.

CONCLUSION

There are large numbers of applications in which sensor nodes collect data from a location and process it. The location of data from where it is collected is important to be positioned. Localization is a mechanism in which nodes are located. There are many approaches for localization but their suitability exists as per the available resources. Such approaches are desirable which can take care of limited resources of sensor nodes.

CONFLICT OF INTEREST: None

REFERENCES

[1] Ramadurai V, Sichitiu ML. Localization in Wireless Sensor Networks: A Probabilistic Approach. Department of Electrical and Computer Engineering North Carolina State University Raleigh, NC. (Weblink: http://www4.ncsu.edu/~mlsichit/Research/Publications/probabilisticLocalizationICWN.pdf).

[2] Gibson J (1999). The Mobile Communications Handbook", IEEE Press.

[3] Capkun S, Hamdi M, Hubaux JP(2002). GPS- free positioning in mobile ad-hoc networks. Cluster Computing.5(2): 1-15.

[4] Doherty L, Pister KSJ, Ghaoui LE (2001). Convex position estimation in wireless sensor networks, in Proc. IEEE Infocom, Anchorage AK. 3: 1655–63.

[5] Bulusu N, Heidemann J, Estrin D (2000). GPS-less low cost outdoor localization for very small devices. IEEE Personal Communications Magazine. 7: 28–34.

[6] Girod L, Estrin D (2001). Robust range estimation using acoustic and multimodal sensing, in Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems, Maui,Hawaii.

[7] Whitehouse K, Culler D (2002). Calibration as parameter estimation in sensor networks," in First ACM International Workshop on Wireless Sensor Networks and Applications, Atlanta, GA.

[8] Savvides A, Park H, Srivastava M (2002). The bits and flops of the n-hop multilateration primitive for node localization problems, in First ACM International Workshop on Wireless Sensor Networks and Applications, Atlanta, GA.

[9] Bahl, P. and Padmanabhan, V.N. (2000), ''RADAR: an in-building RF-based user location and tracking system'', Proceedings of 19th Annual Joint Conference of the IEEE Computer and Communications Societies. 2: 775-84.

[10] Ladd AM, Bekris KE, Marceau G et al. (2002). Robotics-based location sensing using wireless ethernet, in Proc. of Eighth ACM International Conference on Mobile Computing and Networking. Atlanta, Georgia.

[11] Hel´en M, Latvala J, Ikonen H et al. (2001). Using calibration in RSSI-based location tracking system, in Proc. of the 5th World Multiconference on Circuits, Systems, Communications & Computers.

[12] Bischoff R, Wattenhofer R (2004). Analyzing Connectivity- based, Multi-hop Ad hoc Positioning. In Proceedings of the IEEE Intl. Conference on Pervasive Computing and Communications.

[13] Nicol DM, Goldsby ME, Johnson MM (2004). Simulation Analysis of Virtual Geographic Routing. In Proceedings of the Winter Simulation Conference.

[14] Liu K, Abu-Ghazaleh N (2006). Aligned Virtual Coordinates for Greedy Routing in WSNs. IEEE International Conference on Mobile Ad Hoc and Sensor Systems. 377-386.

[15] Sheu JP, Ding ML, Hsieh KY (2007). Routing with Hexagonal Virtual Coordinates in Wireless Sensor Networks. Reviewed at the direction of IEEE Communications Society for publication in the WCNC proceedings.

[16] Leong B, Liskov B, Morris R (2007). Greedy Virtual Coordinates for Geographic Routing. Proceedings of the 15th IEEE International Conference on Network Protocols, Beijing, China.

[17] Youssef A, Youssef M (2007). A taxonomy of localization schemes for wireless sensor networks in Proceedings of the International Conference on Wireless Networks. 444–450.

[18] Langendoen K, Reijers Z (2003). Distributed localization in wireless sensor networks: a quantitative comparison, Computer Networks. 43(4): 499–518.

[19] Moore D, Leonard J, Rus D et al. (2004). Robust distributed network localization with noisy range measurements in Proceedings of the 2nd International Conference on Embedded Networked Sensor Systems. 50–61.

[20] Savarese C, Rabaey JM, Langendoen K (2002). Robust positioning algorithms for distributed ad-hoc wireless sensor networks in Proceedings of the Annual Technical Conference on General Track. 317–327, USENIX Association, Berkeley, Calif, USA, 2002.

[21] Liu J, Zhang Y, Zao F (2006). Robusr distributed node localization with error management," in Proceeding of the 7th ACM International Symposium on Mobile Ad-Hoc Networking and Computing. 250–261, Florence, Italy.

[22] Qureshi S, Asar A, Rehman A et al. (2011). Swarm intelligence based detection of malicious beacon node for secure localization in wireless sensor networks. J Emer Tren Eng App Sc. 2 (4): 664–72.

[23] Kim E and Kim K (2010). Distance estimation with weighted least squares for mobile beacon-based localization in wireless sensor networks. IEEE Sig Proc Lett. 7(6): 559–62.