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Distribution of Nodes on Square Method for Wireless Sensor Networks

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***Abstract*– This paper focuses on distribution of nodes on square method for wireless sensor networks by using multi-dimensional scaling algorithm for position estimation. Nowadays Wireless networking is used to meet a variety of needs. Smart environments represent the next evolutionary development step in buildings, utilities, industrial, scientific, medical, home, shipboard, and military and transportation systems automation. Like any organism, the smart environment relies first and foremost the sensory data from the real world. In this paper it is propose a distributed algorithm that produces a large number of nodes are placed in the Squaring method for an arbitrary sensor network, with no constraints on communication model. Its correctness in 2D and further extends it to senor networks developed on 3D open and closed surfaces are done. Our simulation results show that the proposed algorithms can tolerate distance measurement errors, and thus work well under practical sensor network settings and effectively promote the performance a range of applications that depend square.**

***Index Terms*– Wireless Sensor Networks, Local Positioning, MDS Algorithm and Square Method**

I. INTRODUCTION

WIRELESS sensor networks have recently attracted much interest in the wireless research community as a fundamentally new tool for a wide range of monitoring and data gathering applications. Many applications with sensor networks are proposed, such as health caring, battle field surveillance and enemy tracing and environment observation and forecasting [1]. A general setup of a wireless sensor network consists of a large number of sensors randomly and densely deployed in a certain area. Each compact sensor usually is capable of sensors, processing data at a small scale and communicating through Omni-directional radio signal [2]. Because Omni-directional radio signal attenuates with distance, only sensors within certain range can communicate with each other [5-7]. This range is called as radio range. Wireless sensor networks significantly differ from classical networks on their strict limitations on energy consumption, the simplicity of the processing power of nodes, and possibly high environmental dynamics [2], [4].

Determining the physical positions of sensors is a fundamental and crucial problem in wireless Ad-hoc sensor network operation for several important reasons. The data collected by sensors and it is often necessary to have their position information stamped. For example, in order to detect and trace objects with sensor networks, the physical position of each sensor should be known in advance for identifying the positions of detected objects. In addition, many communication protocols of sensor networks are built on the knowledge of the geographic positions of sensors [3&4]. However, in most cases, sensors are deployed without their position information known in advance, and there is no supporting infrastructure available to locate them after deployment.

The work presented in the paper is Distribution of nodes on square method for wireless sensor networks by using multidimensional scaling algorithm for position estimation. Some challenges of position estimation problem in real applications are dealt in this paper. The conditions that most existing sensor positioning methods fail to perform well are the anisotropic topology of the sensor networks and complex terrain where the sensor networks are deployed. Moreover, cumulative measurement error is a constant problem of some existing sensor positioning methods [1&2]. In the paper a method that is able to position sensors on square. When a sensor or several adjacent sensors want to get location information, one of them initializes flooding and recovers a series of local maps to three or more anchors. Then, the location of the sensor(s) can be estimated as well as location information of sensors along the route from the sensor(s) to anchors [3] as shown in Fig. 1.

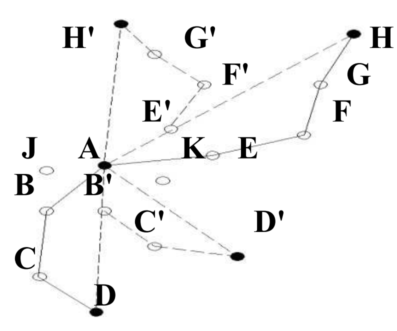

Fig . 1. Position estimation in the adjacent area of a starting anchor sensor

The focus of the paper is on distribution of nodes on square method for wireless sensor networks using multi-dimensional scaling algorithm for position estimation. The paper is organized as follows. Section II presents the previous work of localization problem in wireless sensor networks. The proposed method has been discussed in section III and problem localization in wireless sensor networks, in section IV. In section V, results, conclusions of the paper and the future challenges and directions to improve the localization in WSN technology are described.

II. PREVIOUS WORK

There have been many efforts on the sensor positioning problem. They can be classified into three classes: improving the accuracy of distance estimation with different signal techniques employing distance vector exchange to estimate positions, and piecing local maps together to estimate nodes' physical or relative positions [3]. The performance of these algorithms is deteriorated by range estimation errors and inaccurate distance measures, which are caused by complex terrain and anisotropic topology of the sensor network [9&10]. Moreover, the accuracy of these algorithms relies on the average hop distance estimation, and it tends to deteriorate when the topology of sensor network is anisotropic. Samples are illustrated in Fig. 2. A node with an unknown position receives range measurements (with low accuracy) from a large number (m=30) of neighbouring anchor nodes. Using a least-mean squares approach towards solving the over-defined triangulation problem yields a solution with an accuracy that is substantially higher than what could be expected from the unreliable range measurements. Fig.2 shows the simulated positioning results when many ranges are used for a triangulation solution [3].

III. PROPOSED METHOD

The multidimensional scaling technique, which is a technique that has been successfully used to capture the inter-correlation of high dimensional data at low dimension in social science is used [11]. A Square method is used to estimate all sensors' relative locations by applying MDS to compute the relative positions of sensors with high error-tolerance. In order to collect some of pair wise distances among sensors, we select a number of source sensors, and they initialize the whole network to estimate some of the pair wise distances [2]. These estimated distances are then transmitted to a computer or sensor for square computation of MDS. The paradigm of square computation is supported by some sensor system design or fly-over base-station. In this method, the number of nodes is more when compared to triangle positioning method algorithm and the coverage area is also more as shown in Fig. 3.

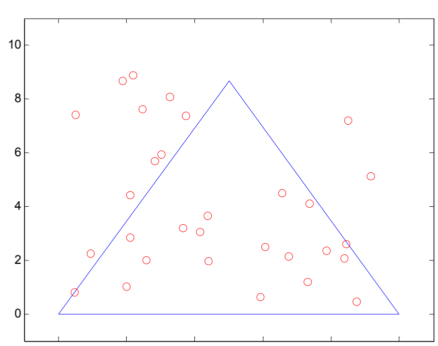

Fig. 2. Randomly distributed sensors in a triangulation method

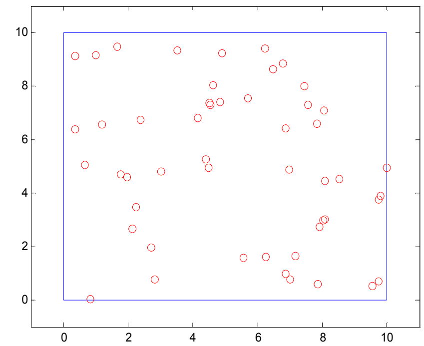

Fig. 3. Randomly distributed sensors in a Square method

IV. PROBLEM LOCALIZATION IN WIRELESS SENSOR NETWORKS

The multidimensional scaling (MDS), a technique widely used for the analysis of dissimilarity of data on a set of objects, can discover the spatial structures in the data. It is used it as a data-analytic approach to discover the dimensions that underlie the judgments of distance and model data in a geometric space. The main advantage in using the MDS for position estimation is that it can always generates relatively high accurate position estimation even based on limited and error-prone distance information. There are several varieties of MDS. On classical MDS and the iterative optimization of MDS, the basic idea of which is to assume that the dissimilarity of data are distances and then deduce their coordinates. More details about comprehensive and intuitive explanation of MDS are available in [7-13]. Inspired by the above multidimensional scaling techniques, present a multivariate optimization based iterative algorithm for sensor location calculation is presented in this paper. $T = [t_{ij}]\ n\times 2$ denotes the true locations of the set of n sensor nodes in 2-dimensional space. $d_{ij}(T)$ stands for the distance between sensor i and j based on their position in T and such as type (1)

$$d_{ij}(X) = \left(\sum_{a=1}^{m}(t_{ia}-t_{ja})^2\right)^{½} \rightarrow \qquad (1)$$

The collected distance between nodes i and j is δ_{ij}. If the errors are ignored in distance measurement, δ_{ij} is equal to $d_{ij}(T)$. We will discuss the error effects to location estimation caused by differences between δ_{ij} and $d_{ij}(T)$ later. If only a portion of pair wise distances are collected, some δ_{ij} are undefined for some i, j. In order to assist computation, define weights w_{ij} with value1if δ_{ij} is known and 0 if δ_{ij} is unknown and assume as:

$$\delta_{ij} = d_{ij}(T) \quad \rightarrow \qquad (2)$$

Table I: Comparative analysis of square positioning over Triangle positioning method

Author Name	Description	No. of Nodes	Cost	Radio Range	Accuracy
Previous Work	The performance of the triangle position algorithms is deteriorated by range estimation errors and inaccurate distance measures, which are caused by complex terrain and anisotropic topology of the sensor network.	30	Less	Low	Low
Present work	A Square method is used to estimate all sensors' relative locations by applying MDS to compute the relative positions of sensors with high error-tolerance.	>50	Less	High	High

in the following induction. $X = [x_{ij}]_{n\times 2}$ denotes the estimated locations of the set of n sensor nodes in 2-D space. X randomly initialized as $X^{[0]}$ and will be updated into $X^{[1]}$,$X^{[2]}$,$X^{[3]}$ ….to approximate T with iterative algorithm. $d_{ij}(X)$ is the calculated distance between sensor i and j based on their estimated position X and as:

$$d_{ij}(X) = (\sum_{a=1}^{m}(x_{ia}-x_{ja})^2)^{1/2} \rightarrow \quad (3)$$

To find a position matrix X to approximate T by minimizing as:

$$\sigma (X) = \sum_{i<j} w_{ij}(d_{ij}(X) - \delta_{ij})^2. \rightarrow \quad (4)$$

This is a quadratic function without constraints. The minimum value of such functions is reached when its gradient is equal to 0.

The MDS algorithm to estimate the positioning of sensors is as given below:

- Compute the matrix of squared distance $D2$, where $D = [dij\ ]n\times n$.
- Compute the matrix J with $J = I - e*e^T/n$, where $e = (1, 1, \ldots, 1)$.
- Apply double centering to this matrix with $H = -½JD^2J$.
- Compute the Eigen- decomposition $H=UVU^T$
- To get the i dimensions of the solution (i=2 in 2-D case) , it is denoted that the matrix of largest i Eigen values by V_i and U_i the first i columns of U. The coordinate matrix of classical scaling is $X=U_iV_i^{1/2}$.

In many situations, the distances between some pairs of sensors in the local area are not available. When this happens, the iterative MDS is employed to compute the relative coordinates of adjacent sensors. We summarize the iteration steps as:

- Initialize $X^{[0]}$ as random start configuration, set $T = X^{[0]}$ and $k = 0$, and compute $\sigma(X^{[0]})$.
- Increase the k by one.
- Compute $X^{[k]}$ with the above update formula and $\sigma(X^{[k]})$.
- If $\sigma(X^{[k-1]}) - \sigma(X^{[k]}) < z$, which is a small positive constant, then stop; Otherwise set $T = X^{[k]}$ and go to step 2.

The ϵ is an empirical threshold based on accuracy requirement. It is usually set it as 5% of the average radio range. This algorithm generates the relative positions of sensor nodes in $X[k]$. The above methods can estimate the relative positions of sensor nodes based on their pair wise distances and position alignment techniques to map the relative coordinates to physical coordinates based on three or more anchor sensors.

V. RESULTS AND CONCLUSIONS

It is shown that the proposed algorithm works well for near-uniform radio propagation. However, in the real world, radio propagation indoors and in cluttered circumstances is far from uniform. Local distance estimation may also be poor. Further simulations will be needed to determine how robust MDS-based algorithms can be to such errors. As MDS-Square builds local positions of the estimated sensors.

For applications that require absolute coordinates of nodes, waiting until large number sensor nodes has formed before transforming to absolute coordinates may be a poor choice. Using the method described here, Distribution of nodes on square method for wireless sensor networks using multidimensional scaling for position estimation that compute absolute coordinates of individual nodes or sub networks independently can be developed. One interesting feature of MDS-Square method is that it shows how information at different length scales can be used differently. Long distance shortest-path information is used only for rough layout decisions while two-hop information is used to determine precise node positions. It would be interesting to develop a framework that precisely characterizes the contribution of each datum to the position estimation.

The main question is whether an approach based on unified statistical inference could be as efficient as the special-purpose algorithms explored here. MDS-Square method can be extended by applying more advanced MDS techniques. Instead of classical metric MDS, other MDS techniques such as ordinal MDS and

MDS with missing data can be applied. We have done some limited experiments with MDS-Square method. Our results show that MDS-Square method is better than Triangle positioning algorithm using MDS when the connectivity level of the network is low, and is comparable with MDS-Square method when the connectivity level is high as shown in Table I.

Algorithms for positioning nodes in an ad-hoc sensor network have been presented. It has been shown that positioning errors resulting from inaccurate range measurements can be reduced significantly 50 or more reference points are used in a 2-dimensional square computation. Additionally, simulations show that cooperative ranging, an MDS-Square method algorithms, is capable of producing position estimates with errors as low as 5%.

REFERENCES

[1] Xianhui Yang; Rui Lv; "Improving Methods for Wireless Node Locating Calculation", in international conference on Networking, Sensing and Control (ICNSC), 2010 ,pp:710 - 714

[2] XiangiJi, and HongyuanZha, "Sensor positioning in wireless Ad-hoc sensor Networks using multidimensional Scaling", in 23rd annual joint conference of the IEEE computer and communication society, pp: 2652-2661, 2004.

[3] Xiang Ji and Hongyuan Zha, "Multidimensional Scaling Based Sensor positioning algorithms in Wireless Sensor Networks", proceedings 1st international conference on Embedded Networked Sensor Systems, November 2003,5–7, Los Angeles, California, USA.

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

[5] S. Capkun, M.Hamdi and J-P Hubanx, "GPS – free positioning in mobile ad-hoc networks", In Hawaii International conference on system sciences (HICSS-34), pages 3481-3490, Mani, Hawaii, January 2001.

[6] X. Ji, H. Zha, "A robust sensor localization algorithm in wireless ad-hoc sensor networks", in Proceedings of the 12th International Conference on Computer Communications and Networks, pp.527-532, October, 2003.

[7] I. Borg and P.Groenen,"Modern multidimensional scaling theory and applications", Springer, 1997.

[8] PE. Green, FJ. Caromone, and SM. Smith, "Multidimensional scaling concepts and applications", Newton, MA Allyn and Bacon, 1989.

[9] ASPNES J, EREN T. "A theory of network localization", IEEE Transaction on Mobile Computing, 2006,5 (12): 1663 -1678.

[10] Niu Dou, Guan Bo, ZhouWei, YuDaquan., "3D Localization Method Based on MDS-RSSI in Wireless Sensor Network", in IEEE International conference on Intelligent Computing and Intelligent Systems (ICIS), 2010 , 978-1-4244-6585-9/10/$26.00

[11] M. Kuorilehto, M.Hannikainen, T.D. Hamalainen, "A survey of application in wireless sensor networks", EURASIP Journal on Wireless Communications and Networking, 5, 2005,pp 774-88.

[12] C. Savarese, J. Rabaey, and J. Beutel, "Locationing in distributed ad-hoc wireless sensor networks", in IEEE Int. Conf. on Acoustics, Speech, and Signal Processing (ICASSP), pages 2037-2040, Salt Lake City, UT, May 2001.

[13] A. Mainwaring, J. Polastre, R. Szewczyk, D. Culler, and J. Anderson, "Wireless sensor networks for habitat monitoring", in proceeding of ACM International Workshop on Wireless Sensor Networks and Applications, September 2002.

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