Journal of Theoretical and Applied Information Technology
28th February 2013. Vol. 48 No.3

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

DV-HOP LOCALIZATION ALGORITHM IMPROVEMENT OF WIRELESS SENSOR NETWORK

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ABSTRACT

The gain of SVC depends upon the type of reactive power load for optimum performance. As the load and input wind power conditions are variable, the gain setting of SVC needs to be adjusted or tuned. In this paper, an ANN based approach has been used to tune the gain parameters of the SVC controller over a wide range of load characteristics. The multi-layer feed-forward ANN tool with the error back-propagation training method is employed. Loads have been taken as the function of voltage. Analytical techniques have mostly been based on impedance load reduced network models, which suffer from several disadvantages, including inadequate load representation and lack of structural integrity. The ability of ANNs to spontaneously learn from examples, reason over inexact and fuzzy data and provide adequate and quick responses to new information not previously stored in memory has generated high performance dynamical system with unprecedented robustness. ANNs models have been developed for different hybrid power system configurations for tuning the proportional-integral controller for SVC. Transient responses of different autonomous configurations show that SVC controller with its gained tuned by the ANNs provide optimum system performance for a variety of loads.

Keywords: *Wireless Sensor Network, DV-Hop Algorithm, Average Localization Error, Localization Coverage*

1. INTRODUCTION

American scholar Niculescu [1] proposes DV-Hop (Distance Vector-Hop) Algorithm which is localization method based on multi-hop ranging and similar with Distance Vector Routing Mechanism of traditional network. Large number of document literature at home and abroad improves and optimizes DV-Hop Localization Algorithm as researches on DV-Hop become more and more. Literature [2] adopts minimum mean square error criterion to calculate distance of each average hop and uses trust region seqential quadratic programming to better determine node position. Literature [3] proposes a estimation algorithm based on weighting to calculate distance value of each average hop. Aiming at error analysis of localization system, literature[4] uses measuring radius of nodes to build error analysis model based on detection probability. DV-Hop Algorithm is simply achieved and has low hardware requirement on nodes. However, disadvantages will lead to error. First, misbehavior nodes will come into being[5]. Deployment of sensor network often randomly finishes like disseminating which will make nodes in network distribute unevenly. Then misbehavior nodes may appear during localization process. Second, algorithm localization error is greatly influenced by the distribution and number of anchor nodes. Specific position of anchor nodes is often obtained through manual deployment or Global Positioning System (GPS). Under dangerous environment or environment which cannot be entered, manual deployment is impossible. Also this will increase cost of network deployment. These conditions limit even distribution of anchor nodes which will lead number of piece of distance information between some unknown nodes and anchor nodes to be less than 3. Then localization is impossible. Even though multi-hop broadcast helps get enough distance information between some unknown nodes and anchor nodes, calculating result also increases localization error. Third, sensor nodes are often distributed randomly. Distance between nodes calculated through DV-Hop Algorithm is not straight-line distance which must produce error when calculating node position. Generally speaking, the more hops between unknown nodes and anchor nodes, the bigger error of localization. Therefore straight-line distance between nodes estimated by average hop distance will lead to error.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

At the moment Range-based Localization Algorithm utilizes static geometrical relationship to determine node position. When anchor nodes distribute evenly and intensively, unknown nodes can be accurately positioned. As constructing cost of anchor nodes is higher than that of common nodes, cost of deploying network will increase when they are distributing largely and densely. Therefore one of the key problems of node localization comes into being. It is how to use the lowest cost to get accurate information of unknown nodes. Under this condition, localization method of mobile anchor node is proposed in which one node that can confirm its own position traverses the whole monitoring area according to one specified route or motion model, connects with its neighbor nodes, broadcasts its position information every once in a while and helps fixed anchor nodes to locate unknown nodes.

2. CHOOSE OF MOBILE MODEL

One important direction of Mobile Anchor Node Localization Algorithm is the mobile model of anchor nodes which greatly influences the network cost and positioning performance. Firstly, it must be confirmed that mobile anchor nodes can lead all unknown nodes to get enough localization information and locate preventing positioning blind area from appearing. Secondly, under the circumstance that all unknown nodes get enough positioning information, it must be guaranteed that the whole localization area is quickly traversed and unknown nodes finish localization as soon as possible. Finally, mobile model influences energy consumption of system. That is the less mobile anchor nodes broadcast their positions, the lower energy consumption of network is. Therefore the design of mobile model must not only guarantee positioning accuracy of nodes but also consume less energy to locate quickly.

At present, scholars do in-depth study on mobile model of anchor nodes and raise some good route traversing methods. In literature[6] Dimitrios Koutsonikolas presents three famous mobile models: Scan Model, Double Scan Model and HILBERT Model. As Scan Model is easier and its route is shorter than others', here it is chosen as the model of mobile anchor nodes shown in Fig.1.

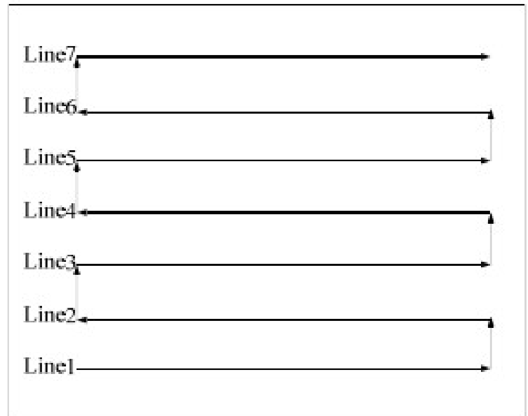

Fig.1 Scan Mobile Model

Mobile anchor nodes move along horizontal direction (also move along vertical direction). In Fig.1 distance between two horizontal lines determines motion trail of anchor nodes. If nodes' communication radius is R, area side length is L, moving range S can be no more than 2R to guarantee that all unknown nodes can receive the broadcasted localization information from mobile anchor nodes. Therefore if moving range S is set to be R, Formula 1 can be used to calculate moving distance D of motion beacon node.

$$D=(\frac{L}{R}+1)\times L+\frac{L}{R}\times R=(\frac{L}{R}+2)\times L \qquad (1)$$

Scan Model can evenly cover the whole network and lead each place to be full of position information from mobile anchor nodes. Also it can decrease localization error. However, it keeps collinear problem. When it is applied for large scale of network, unknown nodes will receive localization information from only one line and only one direction which leads localization to be uncertain. To prevent this, mobile model in horizontal direction must be dense enough to guarantee that unknown nodes receive localization information from motion beacon node on less than two mobile models.

3. IMPROVED DV-HOP ALGORITHM BASED ON MOBILE ANCHOR NODE

According to disadvantages of DV-Hop Algorithm and advantages of Mobile Anchor Node Localization Algorithm, this paper proposes an improved algorithm-the improved DV-Hop Algorithm based on mobile anchor node.

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3.1 Achievement Flow of the Improved DV-Hop Algorithm

The improved algorithm combines DV-Hop and Mobile Anchor Node Localization Algorithm and also introduces weighting factor to calculate distance of each average hop to prevent the problem of collinear and selectively calculate coordinates of unknown nodes. This helps finish localization of more unknown nodes and further increase localization coverage rate. Meanwhile it keeps fine positional accuracy. Positional flow is shown in Fig.2.

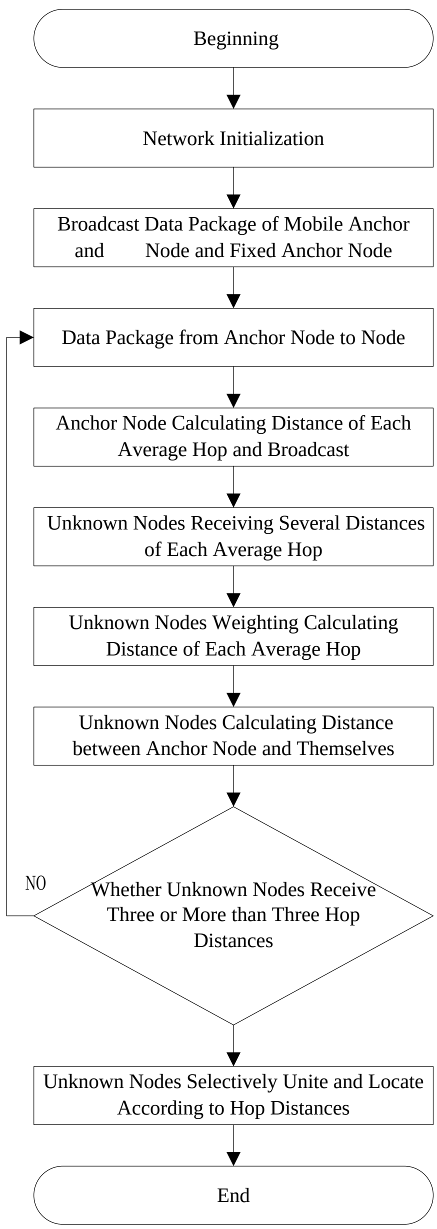

Fig.2 Flow Chart of Improved Algorithm

3.2 Description of Improved Algorithm

According to the shown flow chart, specific steps are analyzed.

First stage：Exchanging stage of distance vector.

This stage can be divided into two standalone parts: the first part is similar to DV-Hop Algorithm. Unknown nodes use distance vector routing mechanism to lead each node of network to get minimum hop count and coordinate of each anchor node. In the second part, mobile anchor node traverses the whole area along Scan Model. At the moment it will broadcast one information package to its neighbor nodes every other regular period. In this information package there lies its current position information and hop count information whose initial value is 1. When neighbor nodes receive information package, they add 1 to hop count and continue to broadcast namely through flooding way to spread. After nodes receive broadcast from anchor node and group, they contrast storage value with hop number from the same list. If their storage value is lower than that of hop number, this list will be updated and hop number adds 1 and then broadcasts this group. Otherwise the group is discarded to promise that the obtained hop count value is the lowest one from anchor node to it.

According to features of Scan Mobile Model, reasonable motion range will be set to lead each unknown node to receive less than one information package from mobile anchor node.

Second stage: Calculation of adjusted value and broadcast stage.

Calculating traditional DV-Hop Algorithm and analyzing its disadvantages, it is known that using average hop distance to estimate straight-line distance between nodes leads to error. The more hops between anchor node and them, the larger error becomes.

In this stage weighting factor can decrease error. Unknown nodes not only save the first received average hop distance but also preserve the later one transmitted by nodes. The closer node is to the unknown node, the large the weight is. On the contrast, its weight is smaller. Suppose that average hop distances received by unknown Node A from Anchor Nodes L1、L2、L3 are respectively D1、D2、D3 and the least hop counts from Node A to Anchor Node L1、L2、L3 are respectively H1、H2、H3, average hop distance of Node A is then shown in Formula 2.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

$$\bar{D}=\frac{\frac{1}{H_1}\times D_1}{\frac{1}{H_1}+\frac{1}{H_2}+\frac{1}{H_3}}+\frac{\frac{1}{H_2}\times D_2}{\frac{1}{H_1}+\frac{1}{H_2}+\frac{1}{H_3}}+\frac{\frac{1}{H_3}\times D_3}{\frac{1}{H_1}+\frac{1}{H_2}+\frac{1}{H_3}} \quad (2)$$

After unknown nodes calculating average hop distance, hop number saved in the first stage can be used to estimate the distance between node and fixed anchor node and also the distance between virtual anchor node and it $D_i = hops\times\bar{D}$.

The third stage: estimating information of positional nodes. Aiming at Scan motion route, its greatest disadvantage is that unknown nodes may receive distances between nodes and mobile anchor nodes from several pieces of collineation. In order to overcome the problem, distances between unknown nodes and anchor nodes should be united and then coordinate of unknown node will be calculated. According to calculation during the above two stages, unknown nodes at least receive distance between one mobile anchor node and this unknown node and also get distances between K（K=0,1,2……N） fixed anchor nodes and the unknown node. Combine the information from unknown node. Each combination includes two distances to mobile anchor node and one to fixed anchor node. Also it may be two distances to fixed anchor node and one to mobile anchor node. When all combinations are done, each one of them can determine one piece of positional information according to trilateration and use the calculated center of mass of positional coordinate to be estimating coordinate of the unknown node.

4. ALGORITHM SIMULATION AND RESULT ANALYSIS

This experiment introduces MATLAB7.0 to do simulation on DV-Hop and the new algorithm.

4.1 Number of Different Anchor Nodes

Simulation environment: Suppose that fixed anchor nodes and unknown nodes randomly distribute in a 100m×100m square area in which the number of fixed anchor node and unknown node is 100, communication radius R=10 meters and mobile anchor nodes broadcast positional information every other 10 meters. When anchor node is respectively 5，10，15，20，25，30, simulation experiment is done on two algorithms before and after improved in which each simulation experiment runs for 50 times. The difference of number of anchor node influences the average localization error and localization coverage rate which is respectively shown in Fig.3 and Fig.4.

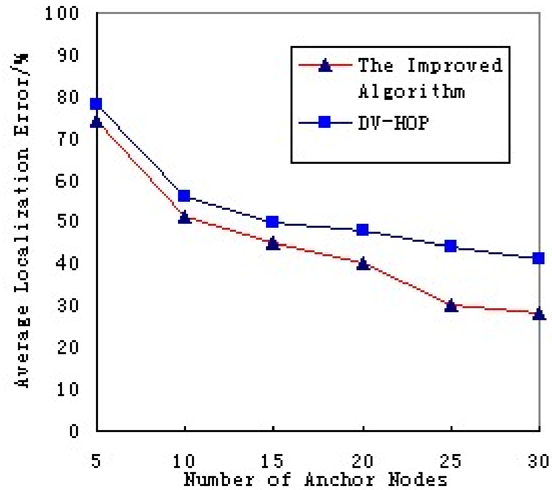

Fig.3 Change the number of anchor node，Localization error figure of two algorithms

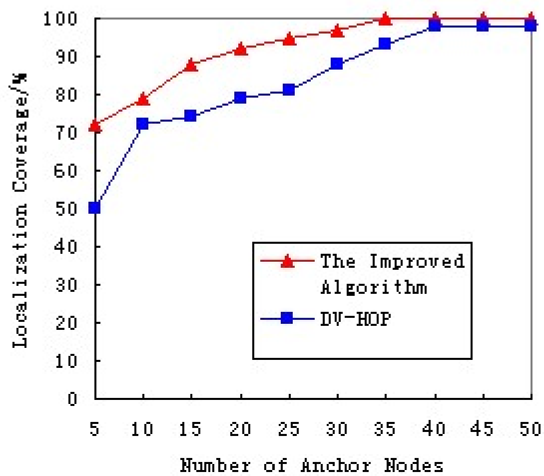

Fig.4 Change the number of anchor node，Localization coverage figure of two algorithms

It is seen from Fig.3 and Fig.4 that when the numbers of anchor nodes are different, average localization error of improved algorithm is about 31% lower than that of DV-Hop. When the number of anchor node is less than 30, localization coverage increases about 14%. When the number of anchor node increases, localization errors of two algorithms both decrease. In traditional DV-Hop Algorithm, unknown nodes can receive enough and effective distances to anchor nodes only when anchor nodes evenly distribute. By introducing mobile anchor node, distribution condition of anchor node is improved in order to increase positional accuracy. With increasing of anchor nodes' number, localization coverage of two

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

algorithms also increases. It is seen from Fig.3 and Fig.4 that the improved algorithm is less influenced by anchor node's proportion than DV-Hop. Therefore it is more suitable for sparse environment of anchor node distribution. As all nodes are static in DV-Hop Localization, arrangement of anchor nodes must be artificial to guarantee localization coverage. However, mobile beacon in the improved algorithm leads large number of virtual anchor node to come into being so that the whole network becomes one with relatively dense anchor nodes. Therefore when proportion of fixed anchor node is low, localization coverage of the improved DV-Hop is better than that of the traditional one. This also reduces deployment of fixed anchor node and saves network cost.

4. 2 Different Communication Radiuses

Suppose that node communication radius is respectively 15m、20m、25m、30m、35m、40m, performances of both algorithms are shown in Fig.5 and Fig.6.

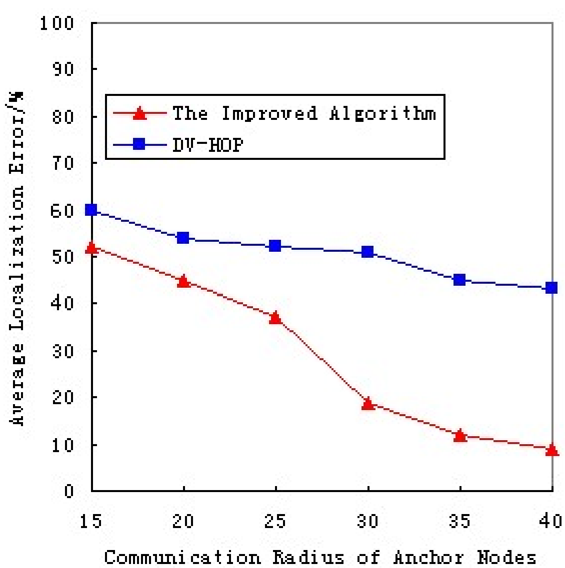

Fig.5 Change communication radius of anchor node, Localization error figure of two algorithms

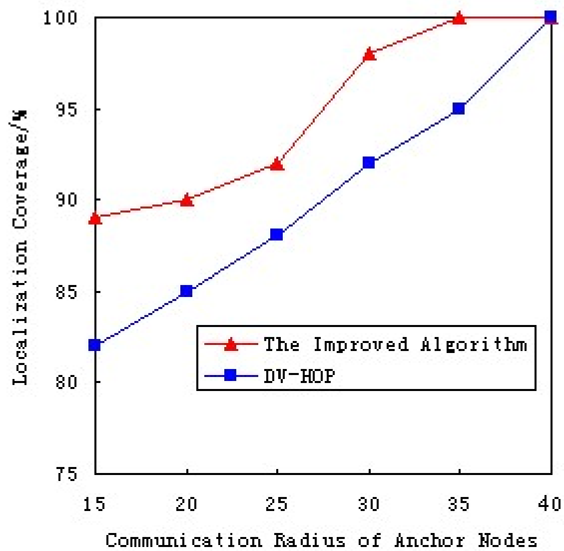

Fig.6 Change communication radius of anchor node, Localization coverage figure of two algorithms

It is seen from Fig.5 and Fig.6 that average localization error of improved algorithm is about 43% lower than that of DV-Hop when communication radiuses of anchor nodes are different. There exists inverse relationship between communication radius and localization error of nodes. The larger the radius is, the lower the error becomes. With the increasing of communication radius, localization error of DV-Hop decreases slowly. However, localization error of the improved one decreases quickly and its positional accuracy also improves. With the increasing of communication radius, more and more nodes finish locating. Unknown nodes receive more information from anchor nodes when communication radius increases. Therefore the improved algorithm helps some nodes which cannot locate in DV-Hop to find their own locations because of the increasing of communication radius of mobile anchor nodes in it.

4.3 Different Numbers of Node, the Same Proportion of Anchor Node

Suppose that proportion of anchor node is 20% and the whole numbers of node are respectively 100, 150, 200 and 300. Performances of both algorithms under the same proportion of anchor node are shown in Fig.7 and Fig.8.

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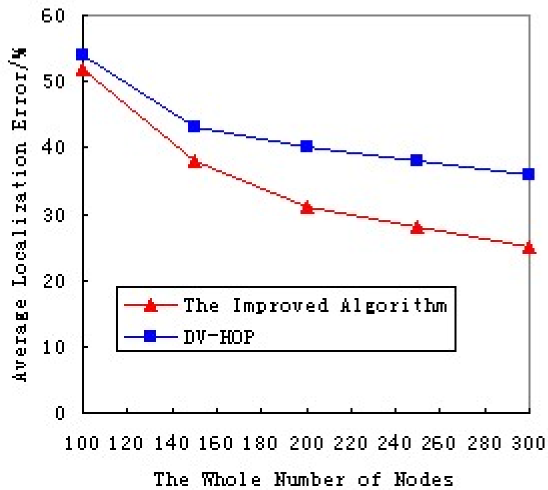

Fig.7: Different Numbers of Node，Localization error figure of two algorithms

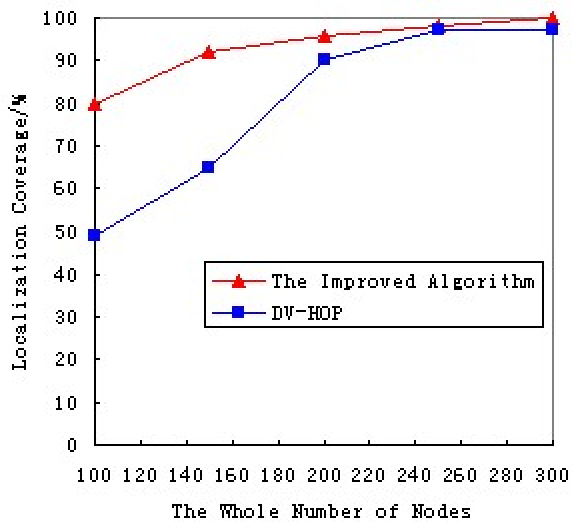

Fig.8: Different Numbers of Node, Localization coverage figure of two algorithms

5. CONCLUSION:

With the increasing of the whole number of node, localization errors of both algorithms decrease and both kinds of localization coverage increases. In terms of localization error, the increasing of nodes' number leads nodes to distribute more intensively and makes unknown nodes receive average hop distance which is closer to actual value. The introduction of mobile anchor node in the improved algorithm brings estimation of unknown nodes to be more precise. When nodes' number is less than 200, coverage of the improved algorithm increases about 22%. In terms of localization coverage, even distribution of nodes leads more unknown nodes to receive localization information. Coverage of the improved algorithm obviously increases especially when nodes' number is less than 200.

REFRENCES:

[1] D.Niculescu and B.Nath, "Ad Hoc Positioning System(APS)", *Proceedings of the IEEE GlobeCom*, San Antonio, November 25-29, 2001, pp. 2926-2931.

[2] Ji Wei-wei and Liu Zhong, "Study on the Application of DV-Hop Localization Algorithms to Random Sensor Networks", *Journal of Electronics & Information Technology*, Vol. 38, No. 4, 2008, pp. 970-974.

[3] Liu Feng, Zhang Han and Yang Ji, "An Average One-hop Distance Estimation Algorithm Based on Weighted Disposal in Wireless Sensor Network", *Journal of Electronics & Information Technology*, Vol. 38, No. 5, 2008, pp.1222-1225.

[4] Liu Ying, Qian Zhihong, Liu Dan and Zhong Hui, "A DV-Hop Positioning Algorithm for Wireless Sensor Network Based on Detection Probability", *Proceedings of 2009 5th International Joint Conference on INC, IMC and IDC*, Seoul, August 25-27, 2009,pp. 453-456.

[5] MA Zuchang and SUN Yining, "Positioning Algorithms of Wireless Sensors Network Node", *Computer Engineering*, Vol. 30, No. 7, 2004, pp.13-14.

[6] Koutsonilas D, Das S M and Hu Y Charlie, "Path planning of mobile landmarks for Localization in wireless sensor networks", *Computer Communication*, Vol. 30, No. 13, 2007, pp.2577-2592.