Research Article

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Localization of WSN using IDV and Trilateration Algorithm

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Abstract: Localization of Sensor Node is the basis for the whole of or entire wireless sensor networks. Due to the restricted energy of the sensor nodes, the location error cost of communication and computation should be considered in all the Localization Algorithms. DV-Distance is similar to DV-Hop but with the difference that distance between neighboring nodes are measured using RSSI and is propagated in meters rather than more distances from anchors, then we use Trilateration to calculate their localization. The Algorithm hops, then uses the method similar with distance vector is easy for implementation. But as the with ranging error increasing the localization error is also increases, since this algorithm is still not perfect. In this paper, an improvement of DV-Distance localization algorithm has been proposed.

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INTRODUCTION

In recent years, WSN(wireless sensor networks) have a wide applications. In most applications the detected information are meaningless without knowing the location where the data is obtained. Here knowledge of the positioning of the nodes is the integral Key region of many sensor networks operations and applications. GPS (Global Positioning System) is the most accurate positioning technology, which is having high accuracy and strong anti-interference moreover it can locate the position in time. But if we are using GPS to positioning the sensor node, the cost of the node will be two times higher than the ordinary nodes. For example say when the nodes of 10% are equipped with GPS, the cost for the entire network will be increasing 10 times around. Moreover the sensor nodes are using battery powered; GPS equipment with high energy consumption of battery is not suitable for this type of extensive application with limited energy of sensor nodes. So usually we do not welcome using GPS for positioning all nodes, but through some nodes which are of known location in order to locate the other nodes we can use GPS. In Upcoming day's research on localization on WSN has vast or wide improvement in the areas of Localization of WSN. The disadvantage of DV-distance algorithm is that at the time of multi-hop transmission, the measuring error of nodes could result in error producing accumulation effect. When we have large network and number of anchor nodes the error while measuring the distance would be relatively large. In this paper we propose improved DV-distance Algorithm in order to determine the location of the sensor nodes.

The main concept of this improved scheme is : (1) Introduce the hops between anchor nodes and unknown nodes to evaluate or to determine the calibration value of the distance (2) Furthermore, a method of new distance correction which is based on hops and as well as Straight Line distance is proposed. Improved DV-Distance Localization of algorithm can be used to find out location of the sensor in a particular region and also in this algorithm distance vector routing algorithm can be used to determine the location of sensor.

DV-DISTANCE ALGORITHM

The DV-Distance localization algorithm uses the method which is similar with the distance vector routing algorithm to obtain the cumulative distance. Here when an each unknown node obtains three or more cumulative distance from its nearest or known anchors, This methods allows nodes to compute their position by communicating to their neighbors only DV-Distance localization algorithm uses distance vector routing in order to get the cumulative distance. When an each unknown node obtains three or more cumulative distances fromthe anchor nodes It uses the trilateration to calculate their localization of nodes. "Fig 1" depicts DV-Distance localization of algorithm. Let us discuss the DV-Distance Algorithm as below with three steps:

In the first step of DV-Distance Algorithm, each anchor nodewould pass or broadcasts a beacon or a signal to be flooded throughout the network containing the anchors localization with node ID and RSSI. Each receiving node would calculate the distance between its adjacent nodes based on the RSSI theoretical model. Then they will count the cumulative distance or the polyline-distance (dis i.j) from themselves to

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anchors that they could receive by cumulating the polyline-distance from node to node or between hop to hop.

In the second step, once an anchor node igets the polyline-distance to another anchor node j, it would calculate an correction ratio(cori.j) of the polyline-distance(dis i.j) to Straight-line (Dis i.j) between the two anchors i and j based on following factors (1), which is then flooded to the entire network as a network correction. When an unknown node k accepts theinformation from one anchor node j, it uses the polyline-distance (dis k.j) from anchor nodes to compute the amended distance (DisCorrk.j) between itself and the anchornodes.

In the last step, when an unknown nodes receives or obtains three ormore distances from the anchors nodes, and then unknown nodes would calculate their localization by trilateration or maximumlikelihood estimation.

DV-Distance replaces the hops in DV-Hop with the polyline-distance which is calculated based on the RSSI model. Thus it reduces the error due to consideration that the rough distance of each hop is equal.

The disadvantage or the drawbacks of DV-Distance algorithm are: (1) this algorithm is easy to implement but ranging error increases localization error also sharp increases.(2) High number of nodes is required (3) Not all the nodes can be able to compute their position. (4) The resulting positions are less precise. (5) This algorithm is still not perfect.

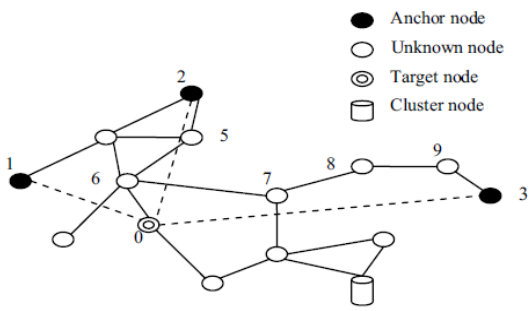

Figure 1: DV-Distance Localization of Algorithm

PROPOSED SYSTEM-IMPROVED DV-DISTANCE ALGORITHM

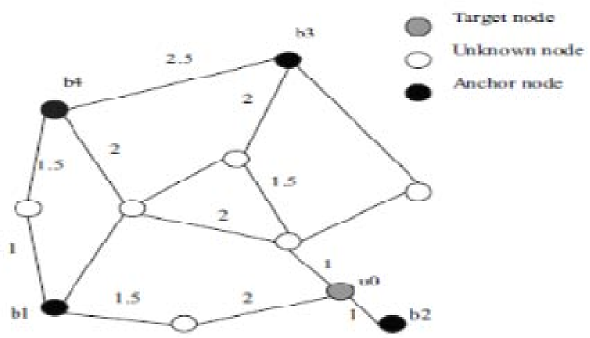

Figure 2: An Improved DV-Distance Example

In this paper, we have come up with an improvement of DV-Distance localization algorithm. To overcome the problem of DV-distance algorithm we have proposed an improved DV-distance localization algorithm. In improved DV-distance algorithm each unknown node selects the distance correction parameter of the nearest anchor node This Algorithm will Work both isotropic and unisotropic network. As shown in "Fig 2" When the network is not enough dense and well-distributed, as the increasing of the hops between positioning node and anchor, the ratio error between polyline-distance and Straight-line distance will be increasing. At the same time, in the anisotropic network, the correction ratio of a node in all directions is not equal. If using the same correction ratio to correct the Pollyanna-distance in all directions, obviously, it will increase the positioning error.

Furthermore, DV-Distance is improved from DV-Hop where it has the ability of cumulating hops from anchors, but DV-Distance does not use the hops. In this Paper, we discuss an improvement of DV-Distance based on difference, it considered the hops and the jumping segment of some unknown node and anchors from its nearest anchor node to other anchors are overlap, but it didn't consider the binding from Straight-line distance between node and node .At the same time, it overestimated the node hardware. It requested all nodes have the capability to save all the Corrections.

To solve these problems, in this paper, we propose an improvement of DV-Distance, Similarly, with the algorithm, Taking into account most of the jumping segment of the unknown node and anchors from its nearest anchor node to other anchors is overlapped. So, when unknown node selects the distance correction parameter (Correction), the unknown node selects the original distance correction parameter which has been broadcasted in the networks at the second step, if the anchor is the closest node to this unknown node. Otherwise, the unknown node uses Corrections of its nearest anchor node to the other anchor nodes, instead of the unknown node to the other anchor nodes. Our algorithm only requests the anchors have the capability to save the Corrections

The advantages of this improved DV-Distance Algorithm are (1) This decreases the ranging error (2) This algorithm can work for both isotropic and unisotropic network.(3) This algorithm increases the positioning accuracy of the sensor node.

TRILATERATION MODULE

Linearizing system of equations is one of the trilateration technique used to find out the final localization coordinates of the sensor nodes. The solution of the linear system $A\vec{x} = \vec{b}$is an improvement over solving for intersection of spheres. Linearizing the system of equations geometrically it converts

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the problem into finding the point of intersection of several planes. Constraints are defined as the equations of sphareswith Radiiri

$$(x - x_i)^2 + (y - y_i)^2 + (z - z_i)^2 = r_i^2 \qquad (i = 1,2,, \ldots .n) \qquad (1)$$

The j^{th}constraint is used as a linearizing tool. Adding and subtracting x_j, y_j, z_j, in (1) gives

$$(x - x_j + x_j - x_i)^2 + (y - y_j + y_j - y_i)^2 + (z - x_1 + x_1 - z_1)^2 = r_i^2 \quad (i = 1,2,, \ldots j-1, j+1,..n)$$

Expanding and regrouping the terms, leads to (2)

$$(x - x_j)(x_i - x_j) + (y - y_j)(y_i - y_j) + (z - z_j)(z_i - z_j)$$

$$= 1/2\left[(x - x_j)^2 + (y - y_j)^2 + (z - z_j)^2 - r_i^2 + (x_i - x_j)^2 + (y_i - y_j)^2 + (z_i - z_j)^2\right] \qquad (2)$$

$$= 1/2[r_j^2 - r_i^2 + d_{ij}^2]$$

$$= b_{ij}, where\, d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2 + (z_i - z_j)^2}$$

Is the distance between beacons B_i and B_j.since it does not matter which constraint is used as linear tool, arbitrarily select thee first constraint (j=1).this is analogous to selecting the first beacon. Since $i = 2,3, \ldots n.$ this leads to a linear system of $(n - 1)$ equations in three unknowns.

$$(x - x_1)(x_2 - x_1) + (y - y_1)(y_2 - y_1) + (z - z_1)(z_2 - z_1) = 1/2[r_1^2 - r_2^2 + d_{21}^2]$$

$$= b_{21},$$

$$(x - x_1)(x_3 - x_1) + (y - y_1)(y_3 - y_1) + (z - z_1)(z_3 - z_1) = 1/2[r_1^2 - r_3^2 + d_{31}^2] = b_{31}, (x - x_1)(x_n - x_1) + (y - y_1)(y_n - y_1) + (z - z_1)(z_n - z_1) = 1/2[r_1^2 - r_n^2 + d_{n1}^2]$$

$$= b_{n1},$$

In matrix form, it can expressed as $A\vec{x} = \vec{b}$, where

$$\mathbf{A} = \begin{bmatrix} x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ x_3 - x_1 & y_3 - y_1 & z_3 - z_1 \\ & \vdots & \\ x_n - x_1 & y_n - y_1 & z_n - z_1 \end{bmatrix}, \quad \vec{x} = \begin{bmatrix} x - x_1 \\ y - y_1 \\ z - z_1 \end{bmatrix},$$

$$\vec{b} = \begin{bmatrix} b_{21} \\ b_{31} \\ \vdots \\ b_{n1} \end{bmatrix}$$

The linear system has (n-1) equations in three unknowns. Therefore theoretically only four beacons (n=4) are needed to determine the unique position provided no more two beacons are co-linear.

SIMULATION RESULTS

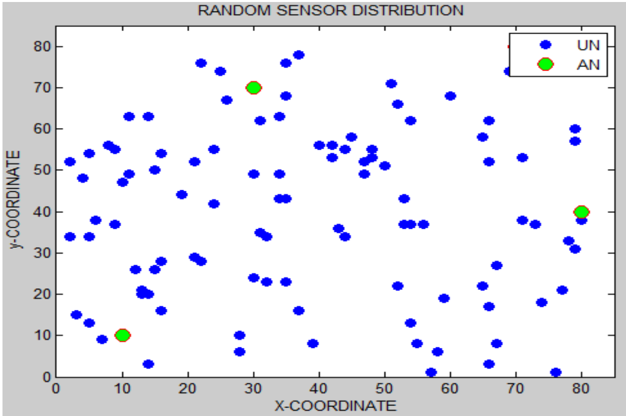

Figure 3: Distribution of Anchor and Sensor nodes in a Randomly manner.

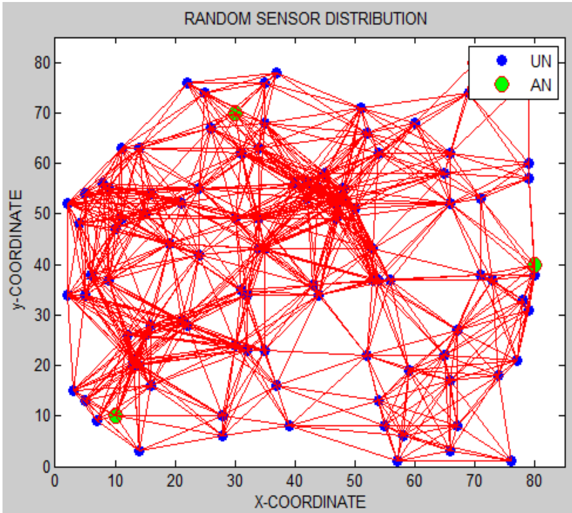

Figure 4: Connection between unknown nodes and anchor nodes over random sensor distribution of network

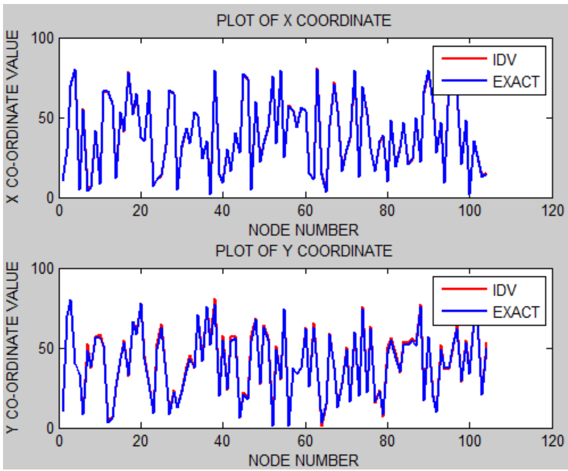

Figure 5: The difference between Exact Positon of sensor nodes and the position located through IDV can be shown in this diagram

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