The Study on Localization in Wireless Sensor Network

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Abstract - Now a day's man wants to live in an intelligent and smart environment, an environment that would make life more easy and comfortable, enhancing the quality of his living, with various intelligent automation devices and services. The application of Wireless Sensor Network, forming a network of various sensors interlinked wirelessly and working together to perform a particular function. It include perceives the environment and searches for event occurrences by sensing different physical properties, such as temperature, humidity, pressure, ambient light, movement, and etc. In such cases the location information of both phenomena and nodes is usually required for tracking and linking purposes. The position information of nodes is crucial. Here in this paper, we proposed an improved DV-HOP location algorithm basis of local estimating and correction in location for WSN. We introduce the anchor nodes are shortest distance nodes from the origin as the main participants to estimate the location of unknown node, namely, we use different average hop distance to estimate the distance between the anchor node and the unknown node according to the number of anchor nodes with the given the communication range, the local information can better produce the location of the unknown nodes. Meanwhile, we are taken the anchor nodes without using the GPS[1].

Keywords: Wireless Sensor Network (WSN), Anchor nodes ,Localization algorithm, DV-hop algorithm.

I. INTRODUCTION

A WSN is composed of thousands of sensor nodes which has the capacity to sense ,communicate ,process and monitor physical and environmental activity such as temperature, humidity, moisture, fire detection and etc[2].There are many issues in WSN one of them is localization problem i.e. the nodes position information is crucial. Localization is the process to know the position information of sensor nodes which is required to detect any event occurs and that needs to report to the base station. For successful applications depend on a localization, i.e. to compute their positions in some fixed coordinate system, for this it is importance to design efficient localization algorithms. Localization systems can be divided into three distinct components, as Distance/angle, position and location . The distance estimation phase involves measure the relative distance between the nodes. The Position computation consists of algorithms to calculate the coordinates of the unknown node with respect to the known anchor nodes or other neighboring nodes.The localization algorithm determines how the information concerning distances and positions, is manipulated in order to allow most or all of the nodes of a WSN to estimate their position. Optimally the localization algorithm may involve algorithms to reduce the errors and refine the node positions. Many localization algorithm for sensor networks have been proposed. Most of them includes some anchor nodes, which know their own positions by using GPS and the other nodes, called unknown nodes, it don't know its position. DV-Hop is one of the simplest methods which have been used in many fields. In this paper we will modified DVHop for the best result.

This paper is consists of as follows section .Section 2 discusses previous related work in localization for sensor networks. Section 3 describes modified-Hop. Section 4 describes our simulation and we conclude in section 5.

II. BACKGROUND AND RELATED WORK

According to the ways of sensors implementation, we classify the wireless sensor network localization algorithms into Range-free vs Range-based algorithm. The range-based algorithm uses point-to-point distance or angle estimates for calculating the location, which are comparatively specific and require additional hardware which affect their cost and makes it relatively expensive, On the other hand, the range-free algorithms use estimated distance instead of metrical distance to localize nodes. It provide more economic and simpler. estimates and cost effective than the range-based ones, but their results are not fix as in range-based[4].

In range based localization algorithm we include different type of technique. For distance/angle estimate there are four common technique are used: **Angle of arrival**

method(AOA) allows each sensor to evaluate the relative angles between received radio signals.**Time of arrival (TOA)**method tries to estimate distances between two nodes using time based measures.**Time different of arrival(TDOA)** is a method for determining the distance between a mobile station and nearby synchronized base station. **Received signal strength indicator(RSSI)** techniques are used to translate signal strength into distance[3]. The common methods for position computation techniques are: **Trilateration and Multilateration** ,this technique use three reference nodes using intersection of three circles,we calculate the position of unknown nodes using distance formula**. Triangulationg** method is based on information about angles instead of distance. **Probabilistic approaches ,**the uncertainty in distance estimations has motivated the appearance of probabilistic approaches for computing a node's position[3].

In range- free localization algorithm we calculate the distance considering the anchor nodes which know their position using GPS but GPS is not always feasible because:

- The presence of dense forests, high mountains or other obstacles will block the line-of-sight from GPS satellites, GPS implementation is difficult.
- The battery life of the sensor nodes reduce due to the power consumption of GPS, which effect the lifetime of the entire network.
- For a large network where a large number of nodes were used ,the use of GPS will effect on cost factor .
- The sizes of sensor nodes are to be small. But the size of GPS and its antenna increases the size sensor node[4,5].

In this paper we proposed a GPS free localization algorithm. The anchor nodes are the shortest distance nodes from the origin. We take into consider the coordinates of shortest nodes (anchor nodes) and calculate the position of unknown nodes.

III. MODIFIED DV-HOP ALGORITHM

The modified DV-hop algorithm consists of five steps. In this algorithm we proposed each node makes itself coordinate from origin to establish a local reference frame.

Step 1-ANCHOR NODES SELECTION

We measure the distance from the origin of each node and some of the nodes are selected as anchor node which is at the shortest distance from the origin. By using the distance formula :

$$SDi=\sqrt{(xi-0)^2}+(yi-0)^2. \quad (1)$$

Where SDi is t he distance of each sensor nodes(xi,yi) from local frame origin The coordinates with least distance from the origin are consider to be the anchor nodes coordinates.

Step 2-INFORMATION EXCHANGE

After the selection of anchor nodes, each anchor node will transmit the location information to its neighboring nodes with hop count initialized to one. Communicating the information with format is (idi,(xi,yi,hopi)), where, idi, and (xi, yi) are the identity number and coordinates of sensor node i and every receiving node maintains, anchor node information and minimum hop count value per the anchor of all nodes it receives. If the receives packet has the same id, then It check each existing hop value and new hop count value. If the new hop count does less than the hop already exist then the new hop value will fill in the information of hop in the table otherwise the packet will be leftover .Every receiving node increment the hop count by one before transmitting it to other neighboring nodes.[2,6]

Step 3-:AVERAGE HOPSIZE CALCULATION

After anchors flood their information to all nodes, now all nodes know how far they are from the anchors (in terms of hop counts). The anchor node gets the hop values to other anchor node it estimate the hop size as

$$hopi=\frac{\sum_{j=1,i\neq j}^{m}\sqrt{(xi-xj)^2+(yi-yj)^2}}{\sum_{j=1,i\neq j}^{m}Hopcounti,j} \quad (2)$$

Where, m is the number of anchors in the network, Hopcounti,j is number of hops between anchor node i and j; (xi,yi) and (xj,yj) are coordinates of anchor node i and j. Then average hop size calculated as,

$$AvgHs=\sum hopi/m \quad (3)$$

Step 4-DISTANCE CALCULATION

Distance between the unknown node and the anchor nodes can be calculated by multiplying average hopsize with the minimum hop count value.

$$Distj=AvgHs\times Hopcounti,j \quad (4)$$

Where Distj is the distance calculated for between each anchor nodes and unknown node i.e j =1 to m.

Step 5-LOCATION COMPUTATION

Let (*x, y*) be the unknown node N location and (xi,yi) the known location of the i'th anchor node and di is the distance between i'th anchor node and unknown nodes[1,2] .

$$\begin{cases} (x-x1)^2+(y-y1)^2=d1 \\ (x-x2)^2+(y-y2)^2=d2 \\ \vdots \\ (x-xi)^2+(y-yi)^2=di \end{cases} \quad (5)$$

The coordinates of unknown node N is calculated by using trilateration or multilateration measurement formula:

$$A=2\times \begin{pmatrix} x1-xi & y1-yi \\ x2-xi & y2-yi \\ \vdots & \vdots \end{pmatrix} \quad (6)$$

$$B=\begin{pmatrix} d1^2-di^2-x1^2+xi^2-y1^2 2+yi^2 \\ d2^2-di^2-x2^2+xi^2-y2^2+yi^2 \\ \vdots \\ d(i-1)^2-di^2-x(i-1)^2+xi^2-y(i-1)^2 2+yi^2 \end{pmatrix} \quad (7)$$

$$U = A^{-1}B \quad (8)$$

$$U = (A^t A)^{-1} A^t B \quad (9)$$

Step6-EVALUATION OF LOCALIZATION ERROR AND ACCURACY

The location error and accuracy are the important factor which affect the distance, position an location calculation. The location error and accuracy can be calculated as:

$$errori=\sqrt{\sqrt{(xi-x)^2+(yi-y)^2}}/R \quad i=1.....m \quad (8)$$

Where errori is the error between anchor node i(xi,yi)and unknown node (x,y) and R is the given communication range.

Accuracy i =M/errori i=1....m (9)

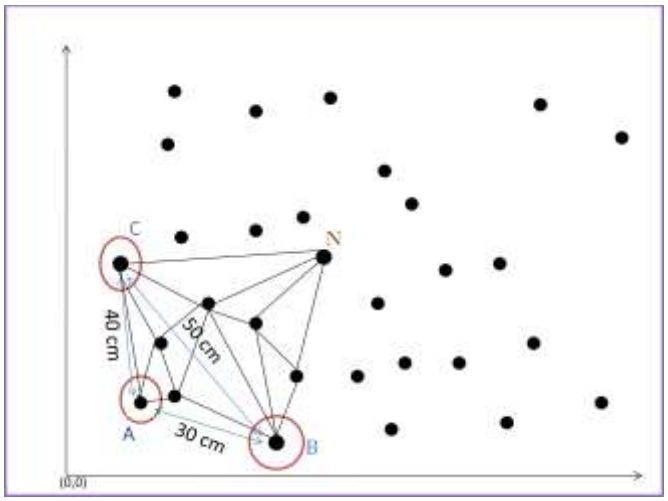

Fig .1 Position of sensor nodes and anchor nodes

Let's consider an example to explain the algorithm. In the figure we take an area which consists of 30 sensor nodes and each node makes itself coordinate from origin to establish a local reference frame. By using distance formula we calculate the three least distance sensor nodes as anchor nodes as A,B& C and N be unknown nodes whose location has to be calculate. The hop-size of A,B and C calculate as

A=(30+40)/(2+1)=23.3

B=(30+50)/(2+2)=20

C=(50+40)/(1+2)=30

Average hop size=(23.3+20+30)/3=24.43

Now the distance between unknown node N and anchor nodes as

NA=20×3=60

NB=20×2=40

NC=20×1=20

Coordinate calculation for the unknown node N using the

$$(x-x1)^2+(y-y1)^2=d1$$

$$(x-x2)^2+(y-y2)^2=d2$$

$$(x-x3)^2+(y-y3)^2=d3$$

The above equations can be written as

The above equations can be written as

$$P=2\times \begin{bmatrix} x3-x1 & y3-y1 \\ x3-x2 & y3-y2 \end{bmatrix}$$

$$Q= \begin{bmatrix} NA^2-NC^2-x1^2+x3^2-y1^2 \\ NB^2-NC^2-x2^2+x3^2-y2^2 \end{bmatrix}$$

$$X=\begin{bmatrix} x \\ y \end{bmatrix}$$

$X = A^{-1}B$

$X = (A^t A)^{-1} A^t B$

After getting the coordination value of unknown node we can easily evaluate the location error and accuracy using the equation (8) & (9) respectively.

IV. Simulation/Experimental Results

In this section we will present a framework for testing of localization algorithms .We experiment with a small region with the fixed size of 50 x 50 m2 and with any radio range of sensor nodes (R), taking 10 sensor nodes and three anchor nodes.

Please Enter the Number Of Node : 10

Please Enter Number Of maximum X-Coordinate : 10

Please Enter Number Of maximum Y-Coordinate : 10

----------: Generating Of Nodes :----------

Node Id :	X-coordinate :	Y-Coordinate :
1	2.108785660047663	9.719864513576583
2	8.572327503225392	1.0799005893894797
3	7.523353383750091	1.1137517773733907
4	7.470680096664472	4.322723055992851
5	5.79713811582442	1.7752119831684876
6	6.9776809452576	4.852185830016712
7	4.725266597940541	1.1882917213948574
8	7.683547545893231	2.5451464891288325
9	1.571729881321673	2.405613586967812
10	9.943137772838224	8.776729191478132

Number Of Nodes :10

Area Of Generating Of Nodes :10.0 X 10.0

Node Id :	Distance from Origin (0,0):
1	9.945991309181203
2	8.64008009832769
3	7.605346090638238
4	8.631164216113076
5	6.0628531170670215
6	8.498925738163969
7	4.872389725457943
8	8.094113511752026
9	2.8735538188180123
10	13.262615280184624

After Sorting

1	2.8735538188180123
2	4.872389725457943
3	6.0628531170670215
4	7.605346090638238
5	8.094113511752026
6	8.498925738163969
7	8.631164216113076
8	8.64008009832769
9	9.945991309181203
10	13.262615280184624

Beacon Positions

1	9
2	7
3	5

----------The three Beacon Nodes are----------

The Coordinates of beacon A
(1.571729881321673,2.405613586967812)
Node ID:1
The Coordinates of beacon B
(4.725266597940541,1.1882917213948574)
Node ID:2
The Coordinates of beacon C
(5.79713811582442,1.7752119831684876)
Node ID:3

----------Calculation Hop-Size----------

Please Enter the Number Of hops between Beacon between (A & B) 30

Please Enter the Number Of hops between Beacon between (A & C) 25

Please Enter the Number Of hops between Beacon between (B & C) 20
The average hop size calculated as
23.82238563950116

---------- DISTANCE CALCULATION----------
Let N be the unknown node ,the distance between the unknown node and anchor node is calculate by multiplying hop size by its minimum hop count
Enter the number of hops between N and anchor node A
10
Enter the number of hops between N and anchor node B
20
Enter the number of hops between N and anchor node C
30
Distance between unknown node and anchor node A203.9465414770318
Distance between unknown node and anchor node b407.8930829540636
Distance between unknown node and anchor node c611.8396244310953

---------- LOCATION CALCULATION----------
--------LOCALIZATION ERROR AND ACCURACY--------

V. CONCLUSION

In this paper we evaluate the location problem for wireless sensor networks with modified DV-hop localization algorithm without the help of GPS. Here we explore the placement of anchor nodes which is at the shortest distance from the origin of the local frame, make easier distance estimation, position computation and the localization evaluation. Here the neighbor anchor nodes plays a vital role to estimate the location of unknown node by using different average hop distance to estimate the distance between the anchor node and the unknown node according to the number of anchor nodes in the communication range .This means the local information can reproduce the location of the unknown nodes more easily. Simulation results show that how anchor nodes are placed, with lower the error and higher accuracy based on the total number of sensor nodes and with a given communication radius

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