Analysis of Some Localization Algorithm in Wireless Sensor Networks

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Abstract-*Localization is an indispensable part in wireless sensor network, In Wireless sensor network (WSN), estimating the exact position of sensor node is an important research problem and its location accuracy impacts the efficiency of localization algorithms. comparison with conventional centroid is done by varying different parameters such as anchor nodes, communication range and node density. In this paper, we present analysis of two range free localization approaches- DV-Hop and Centroid algorithm, and comparison between these two algorithms is analyzed.The simulation results show the performance of DV-Hop algorithm is better as compared to*

Keywords –*Centroid, DV Hop Algorithm, distance based algorithm, range free algorithm, WSN.*

1. INTRODUCTION

A wireless sensor network is a distributed collection of nodes which are resource constrained and capable of operating with minimal user attendance. Some of the potential applications of wireless sensors include environmental monitoring, military surveillance, search-and-rescue operations, tracking patients and doctors in a hospital and other commercial applications. Wireless sensor nodes operate in a cooperative and distributed manner. Such nodes are usually embedded in the physical environment and report sensed data to a central base station; however, for a sensor network to achieve its purpose, it is essential to know where the information is sensed

We define the problem of localization estimating the position or spatial coordinates of wireless sensor nodes. Localization is an inevitable challenge when dealing with wireless sensor nodes, and a problem which has been studied for many years. Nodes can be equipped with a Global Positioning System (GPS) [1], but this is a costly solution in terms of volume, money and power consumption

While much research has focused on developing different algorithms for localization, less attention has been paid to the problem of range measurement inaccuracy[1]

Many localization techniques have been proposed to provide location information of the sensor node in WSN. We divide these localization protocols into two categories: Range Based and Range Free. Range based algorithms that use point to point distance to calculate location between neighboring sensors and provide high accuracy, require additional hardware, therefore involves high cost and are not suitable for low power WSN. In range free, the location is estimated on the basis of hop information. These methods provide approximate location results but are cost effective, consume less energy and do not require any additional hardware due to which more attention is given to range free methods[5].

DV-Hop algorithm is one of the most famous algorithms and it is simple and useful. Centroid is also simple and economic range free localization algorithm.

In this paper, we present analysis of two range free localization approaches- DV-Hop and Centroid algorithm, and comparison between these two algorithms is analyzed [5].

1.3 Related Work

We review research most relevant to our work. Range free localization algorithms are being pursued at a cost effective alternative to more expensive range base approach.

There are four major representative distributed range free localization algorithms [4]:

- DV-Hop
- Centroid
- APIT
- Amorphous

In our research paper we have also studied about Centroid and DV-Hop. Here we will study about rest of the range free algorithms i.e. APIT and amorphous

II. DV-HOP ALGORITHM

DV-Hop algorithm has been proposed by Niculescu and Nash, which is one kind of APS distributed localization algorithm. The algorithm can be divided into three steps Described as follows.

In the first step, all nodes get the minimum hop count values to all anchor nodes. Each anchor node broadcasts a beacon containing self position information and hops to its neighbor nodes to be flooded throughout the network. The initial value of hop field is 0.Receiving nodes record the minimum hops to each anchor node and ignore the message with larger hops from the same anchor node. Then, the beacons are flooded outward to their neighbor nodes with one hop increased. Through this mechanism, all nodes in the network get the minimal hop counts to every anchor node.[2]

In the second step, when an anchor node obtains hop Counts to other anchors, it estimates an average distance for one hop, which is subsequently flooded to the entire network. Anchor i estimates the average hop-size using the following formula:

$$\text{Avg Hop Size} = \frac{\sum \sqrt{(x-x_i)^2+(y-y_i)^2}}{\sum h_{ij}}$$

Where (x_i , y_i), (x_j , y_j)are the coordinates of anchor i and anchor j, *hij* is the hops between anchor i and anchor j.

Then, each anchor node broadcasts its hop-size to network by using controlled flooding. Unknown nodes receive the information of hop-size and preserve the first one. Simultaneously, they transmit the hop-size to their neighbor nodes. After all unknown nodes have received the hop-size from anchor nodes which have the least hops between them, they compute the distance to the anchor nodes based on two factors of hop-size and minimum hop count (labeled as h_{ij})[2].The formula is as follows:

$$D_i = \text{Avg Hop Size}_i \times \text{Hop Count}$$

Where D_i is distance of anchor node point i to (x,y).

In the third step, unknown nodes calculate their position according to the distance to each anchor node which is obtained in the second step. The coordinates representation of anchor i are (x_i , y_i), and (x , y) are coordinates of unknown node[2], there is the following formula:

$$\sqrt{(x-x_1)^2+(y-y_1)^2} = d_1$$

$$\sqrt{(x-x_2)^2+(y-y_2)^2} = d_2$$

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$$\sqrt{(x-x_n)^2+(y-y_n)^2} = d_i$$

$$\sqrt{(x-x_m)^2+(y-y_m)^2} = d_m$$

Where (x_m,y_m) be the location coordinate of the anchor node m; (x, y) represents the location coordinates of the UN node, and d_m represents the computed distance between UN nodes and the anchor nodes.[2]

$$X = \begin{bmatrix} X \\ Y \end{bmatrix} \qquad G = 2\begin{bmatrix} X_1 - X_m & Y_1 - Y_m \\ X_2 - X_m & Y_2 - Y_m \\ \ldots & \ldots \\ X_{m-1} - X_m & Y_{m-1} - Y_m \end{bmatrix}$$

$$A = \begin{bmatrix} X_1^2 - X_m^2 + Y_1^2 - Y_m^2 - d_1^2 + d_m^2 \\ X_2^2 - X_m^2 + Y_2^2 - Y_m^2 - d_2^2 + d_m^2 \\ \ldots \\ X_i^2 - X_m^2 + Y_i^2 - Y_m^2 - d_i^2 + d_m^2 \\ \ldots \\ X_{m-1}^2 - X_m^2 + Y_{m-1}^2 - Y_m^2 - d_{m-1}^2 + d_m^2 \end{bmatrix}$$

where $GX=A$ (4)

The least square solution of (4) is [21]:

$$X=(G^T G)^{-1}G^T A \qquad (5)$$

III. CENTROID ALGORITHM

N Bulusu et al. propose a coarse grained range free localization algorithm, In CLA, anchor node periodically broadcasts group information consisted of identification and location information to its neighboring nodes [3]. When the number of group information received by unknown node from different anchor nodes exceeds threshold k or the received time exceeds the threshold time, the unknown node will regard the centroid of the polygon composed of its neighbor anchor nodes as its location.[3] The computing equations are as follows:

$$(X_{est},Y_{est}) = \left(\frac{X_1+X_2+\ldots X_n}{N} , \frac{Y_1+Y_2+\ldots+Y_n}{N} \right)$$

Where the (x1, y1)…… (xn, yn) denote the anchor nodes' coordinates; (xest, yest) is node's estimate coordinate.

CLA is entirely based on network connectivity and anchor node's density. Location however computed by CLA is just estimated location, so the location is very rough. Estimated location's error has a great relationship with the anchor node's density and distribution. The greater the density is, the lower the localization error.[3]

IV. CENTROID AND DV-HOP LOCALIZATION RANGE FREE ALGORITHM FOR SIMULATION ENVIRONMENT AND PERFORMANCE EVALUATION

Anchor nodes are also deployed randomly to evaluate the performance of both the algorithms as shown in Fig. 1.1.

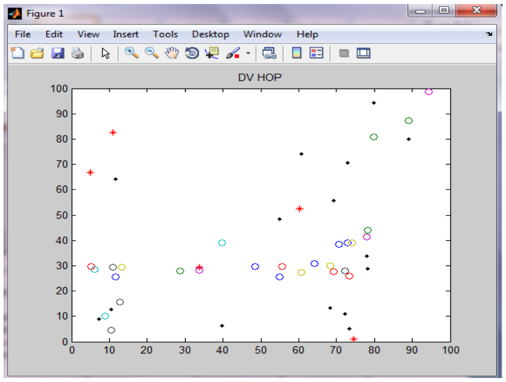


Fig. 1.1: Node Distribution in a Network (AN Deployed Randomly AN=16, UN=50, R=30)

I..Simulation result when Anchor node is varied and effect on Localization Error**:**

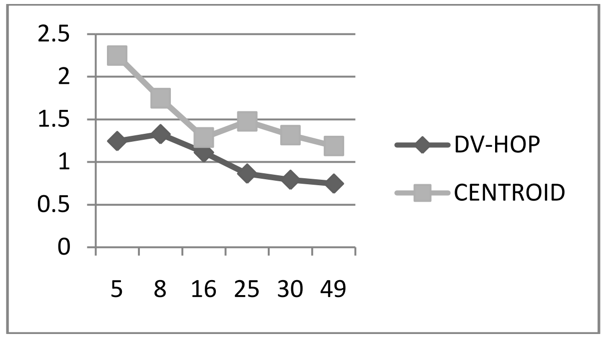
Simulation results are presented and analyzed. We simulated the Centroid and DV-Hop algorithm to evaluate the performance. The experiment region is a square area with the fixed size of 100mx100m. This experiment is performed in randomly way.

The values of anchor nodes are varied randomly and communication range is set to 30m. Simulation results are presented as shown in following Table 1.2.

NCHOR NODES	LOCALIZATION ERROR	
	DV-HOP ALGORITHM	CENTROID ALGORITHM
5	1.2438	2.2453
8	1.3251	1.7455
16	1.1102	1.2853
25	0.8612	1.4737
30	0.7884	1.3118
49	0.7434	1.1862

Table 1.2: Data Table of Anchor Node v/s Localization Error

LOCALIZATION ERROR



ANCHOR NODES (AN)

Graph I: Localization Error w.r.t Anchor Nodes, (Random Placement)

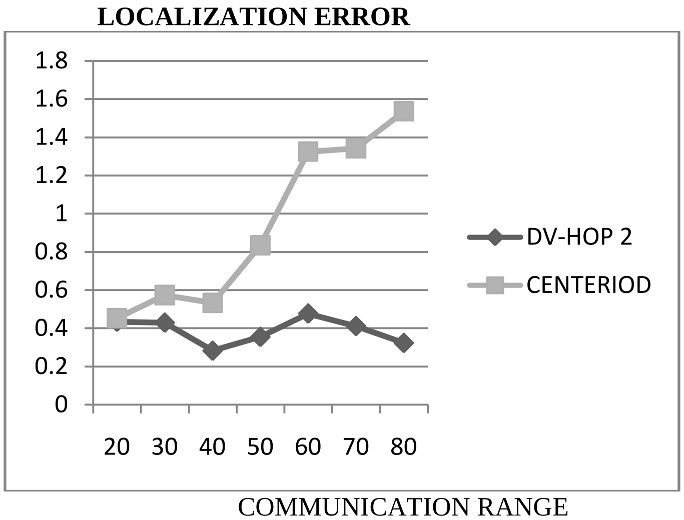
Graph I presents the same experimental results for random placement. B (random placement), we show that DV-Hop algorithm is more sensitive to irregular node placement than Centroid algorithm. This is mainly due to the fact that hop size estimation in the DV-Hop scheme is less precise in irregular deployment.

II. Simulation result when Communication range is varied and effect on Localization Error**:**

In this section how localization error for both the algorithm Centroid and DV-Hop algorithm changes with the change in communication range that is anchor to unknown node range changes in table 2.

COMMUNICATION RANGE	LOCALIZATION ERROR	
	DV-HOP ALGORITHM	CENTROID ALGORITHM
30	0.4338	0.4527
40	0.4291	0.5736
50	0.2825	0.5325
60	0.3547	0.8342
70	0.4765	1.3242
80	0.4112	1.3424
90	0.3232	1.5352

Table 2: Data Table of Communication Range v/s Localization Error



Graph.2: Localization Error w.r.t Communication Range

where Above graph1 and table2 represents that with the increase in communication range, estimation error increases. This is due to the fact anchor propagation distance result in larger accumulated error.. Large numbers of anchors nodes are desired for good estimation results. The cost of having such a large percentage of anchors is very high so instead of increasing anchor nodes, The estimation error of the Centroid algorithm increases more significantly with increase in range, in comparison to DV-Hop Algorithm.

Performance comparison between DV-Hop and Centroid algorithms

PARAMETERS	CENTROID	DV-HOP
Anchor Nodes (AN)	High Error	Low Error
Communication Range (R)	High error	Low Error
Accuracy	Fair	Good

Table 4: Performance Comparison b/w Two Range Free Algorithms

V. CONCLUSIONS

In this Paper evaluate the performance of compared of algorithm two algorithm(DV Hop algorithm and Centeriod algorithms).Form simulation curves results that DV-Hop algorithm provides better accuracy in finding the position of the unknown nodes in wireless sensor network i.e. Centeroid algorithm which is simple but has large estimation error.

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