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Implementation of a Localization Technique in Wireless Sensor Network

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Abstract

There are many techniques to implements Localization of mobile node in WSN. DV-Hop is the most popular localization techniques that can be implemented in WSN. DV-Hop algorithm can calculate the unknown node's location which is far away from beacons. And it does not need extra information. However, the level of errors can vary based on the difference of bending degree. Because one unknown node can only get hop count through one path it needs the average single hop distance to calculate its own location, which leads to the large error. This paper analyzes DV-Hop algorithm and implement DV- Euclidian distance algorithm.

Keywords

WSN, Euclidian distance, Distance derivative, Gauss-Newton method, Root Mean Square Error, DV Euclidian distance algorithm

Introduction

There are many techniques to implements Localization of mobile node in wsn. DV-Hop is the most popular localization techniques that can be implemented in wsn. DV-Hop algorithm can calculate the unknown node's location which is far away from beacons. And it does not need extra information. However, the level of errors can vary based on the difference of bending degree. Because one unknown node can only get hop count through one path it needs the average single hop distance to calculate its own location, which leads to the large error.

This section of the thesis describes implementation of localization technique of wireless sensor network for this we took four anchor node and one unknown mobile node and using DV- Euclidian distance algorithm .We also describe the formulas used to calculate distance, position, distance derivative, estimate and corresponding error.

After that different cases were taken to explain it.

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Formula used To implement localization technique of wireless sensor network DV Euclidian distance algorithm is used. The following formulas are used.

1. Euclidian distance formula [2]:

$$d(p, q) = \sqrt{(q_1 - p_1)^2 + (q_2 - p_2)^2 + ---(q_n - p_n)^2}$$

$$= \sqrt{\sum_{i=1}^{n}(q_i - p_i)^2}$$

Cartesian coordinate if p = $(p_1, p_2 ----- p_n)$

q = $(q_1, q_2 ----- q_n)$

2. Euclidean length or magnitude of a vector measures the length of the vector. If p and q are Euclidian vector starting from the origin [2].

$$||p|| = \sqrt{p_1^2 + p_2^2 + ------ + p_n^2}$$

$$= \sqrt{p.p}$$

3. Distance derivative [3]:
Let p (x ,y) be a variable point and A (a, b) be a given point.
Then the perpendicular distance D between then is

$$D = \sqrt{[(x-a)^2 + (y-b)^2]}$$

$$D^2 = (x-a)^2 + (y-b)^2$$

Differentiating both side with respect x.

$$D^1 = \frac{dD}{dx}$$

$$[(x-a) + (y-b)\frac{dy}{dx}] / [D]$$

4. Noisy Measurement using the Gauss – Newton method
The sum of squares s may not decrease at every iteration. However since Δ is a descert. Unless S (β^s) is a stationary point ,it holds that
S ($\beta^s + \alpha\Delta$) <S(β^s) for all sufficiently small $\alpha > 0$. Thus if divergence occurs, one solution is to employ's a fraction α of the increment vector, Δ in the updating formula $\beta^{s+1} = \beta^s + \alpha\Delta$.

5. Root Mean Square Error the root mean square error for Euclidean distance can be computed as follows[4].

Error = $\sqrt{\frac{1}{N_t}\sum_{i=1}^{N_t}((\widehat{x_i} - x)^2 + (\widehat{y_i} - y)^2)}$

The Root Mean Square Error for Manhattan distance can be computed as follows:

Error= $\sqrt{\frac{1}{N_t}\sum_{i=1}^{N_t}(|\hat{x}_i - x| + |\hat{y}_i - y|)}$

Flow Chart

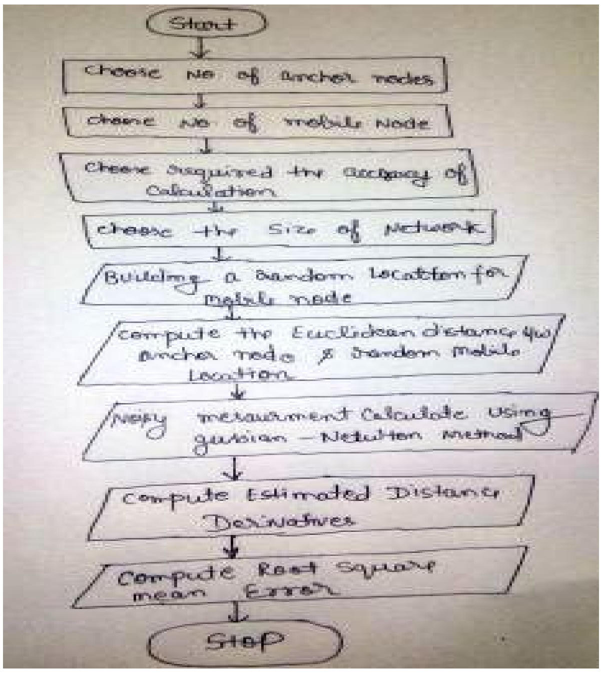

Figure 1: Flowchart of work

Flow Chart Explanation

In the above Flow chart following steps are explained

Step 1: We choose number of anchor nodes N=4

Step 2: We choose number of mobile node M=1

Step 3: We choose accuracy of calculation, Noise power = 20

Step 4: We choose the site of network for network N =100

Step 5: A random Location for mobile node was build

Step 6: The Euclidean distance between anchor nodes and Random mobile node where computed.

Step 7: We calculate Noisy measurement using Gaussian Newton Method.

Step 8: Calculate Estimated Distance Derivatives.

Step 9: Calculate Mean Square Root Error.

Experiment Assumptions for every case

1. Four Anchor nodes which are fixed and their positions are pre defined.
2. Position of the mobile node each changeable, not fixed.
3. Mobile node cannot move out of the fixed network region

Case1

S. N	Distance from A	Distance from B	Distance from C	Distance from D	Noisy Measurement	Distance Derivative A	Distance Derivative B	Distance Derivative C	Distance Derivative D
1.	82.9167	82.9167	82.9167	82.9167	86.1476	.7546,.6562	.2014,.9795	.2013, 9795	.2013, 9795
2.	0	122.1988	122.1988	122.1988	117.7287	-.8270, .5622	-.6965, .7176	-.6977, .7164	-.6977, .7164
3.	0	0	20.1499	20.1499	21.9643	.5786, -.8156	.7595, -.6506	.7532, -.6578	.7535, -.6575
4.	0	0	0	91.9966	83.4308	-.6720, -.7405	-.9839, -.1785	-.9835, -.1812	-.9835, -.1811

TABLE CONTINUE.............................

Mobile Location Estimation from	Mobile Location Estimation from A	Mobile Location Estimation from B	Mobile Location Estimation from C	Mobile Location Estimation from D
17.4804, 850259	17.4208, 84.7872	17.4267, 84.7949	17.4265,84.7945	17.4265,84.7946

Table 1: Experimental results for Case 1

Case 2

S. N	Distance from A	Distance from B	Distance from C	Distance from D	Noisy Measurement	Distance Derivative A	Distance Derivative B	Distance Derivative C	Distance Derivative D
1.	110.379	110.379	110.379	110.379	103.466	.6849,.7286	.6919,.7220	.6917,.7222	.6917,.7222
2.	0	82.9051	82.9051	82.9051	82.7354	-.3594,.9332	-.3191,.9477	-.3191, .9477	-.3191, .9477
3.	0	0	79.2439	79.2439	78.3815	.9451,-.3268	.9557,-.2942	.9558, -.2939	.9558, -.2939

4.	0	0	0	31.1329	32.0439	-.7642,-.6450	-.7521,-.6590	-.7527, -.6584	-.7526, -.6584

TABLE CONTINUE..............................

Mobile Location Estimation from	Mobile Location Estimation from A	Mobile Location Estimation from B	Mobile Location Estimation from C	Mobile Location Estimation from D
74.0033, 77.2206	73.9929, 77.25002	73.9942, 77.2489	73.9941, 77.2490	73.9941, 77.2490

Table 2: Experimental Results for Case 2

Case 3

S. N	Distance from A	Distance from B	Distance from C	Distance from D	Noisy Measurement	Distance Derivative A	Distance Derivative B	Distance Derivative C	Distance Derivative D
1.	73.3611	73.3611	73.3611	73.3611	75.6368	.9425,.3343	.5311,.8473	.3969, .9179	.3968, .9179
2.	0	99.3044	99.3044	99.3044	92.6035	-.1174, .9931	.6997,.7144	-.7202, .6938	-7194, .6946
3.	0	0	42.2824	42.2824	39.0605	.8241,-.5664	.7188,-.6952	.6766, -.7363	.6785, -.7346
4.	0	0	0	79.1663	79.1404	-.0609,-.9981	-.8503,-.5263	-.9108, -.4128	-.9113, -.4118

TABLE CONTINUE..............................

Mobile Location Estimation from	Mobile Location Estimation from A	Mobile Location Estimation from B	Mobile Location Estimation from C	Mobile Location Estimation from D
39.0267, 62.2583	29.4036, 68.0311	29.4481, 68.1195	29.4404, 68.1134	29.4410, 68.1140

Table 3: Experimental Results for Case 3

Case 4

S. N	Distance from A	Distance from B	Distance from C	Distance from D	Noisy Measurement	Distance Derivative A	Distance Derivative B	Distance Derivative C	Distance Derivative D
1.	62.6602	62.6602	62.6602	62.6602	65.8091	.6805, .7327	.9089,.4169	.9440, .3300	.9454, .3259
2.	0	47.1269	47.1269	47.1269	44.8186	-.1130, .9936	-.7832, .6217	-.8874, .4610	-.8886, .4567
3.	0	0	97.214	97.214	97.3273	.9990, -.0456	.6663, -.7457	.6029, -..7978	.6030, -.7978
4.	0	0	0	88.0040	91.5079	-.9369,-.3496	-.4588,-.8885	-.4533, -.8914	-.4506, -.8927

TABLE CONTINUE..............................

Mobile Location Estimation from	Mobile Location Estimation from A	Mobile Location Estimation from B	Mobile Location Estimation from C	Mobile Location Estimation from D
63.3760, 29.0707	59.7761, 20.8984	59.9575, 20.6718	59.9615, 20.6649	59.9616, 20.6647

Table 4: Experiment Results for Case 4

After implementing each case we found estimate distance of four anchor nodes with respect to mobile node. We also found Distance Derivative for anchor nodes and then calculated noisy measurement. On the basis of distance derivatives and noisy measurement estimated mobile location were calculated. In every case mobile node changing its position randomly and so that distance derivatives change every time.

Results and Discussion

Case 1

In the simulation result showing two positions of mobile node in a specified region. Red one is estimated location where as blue one is true location of mobile node in case2.In this case we found that Estimation error is 8.0927 meter.

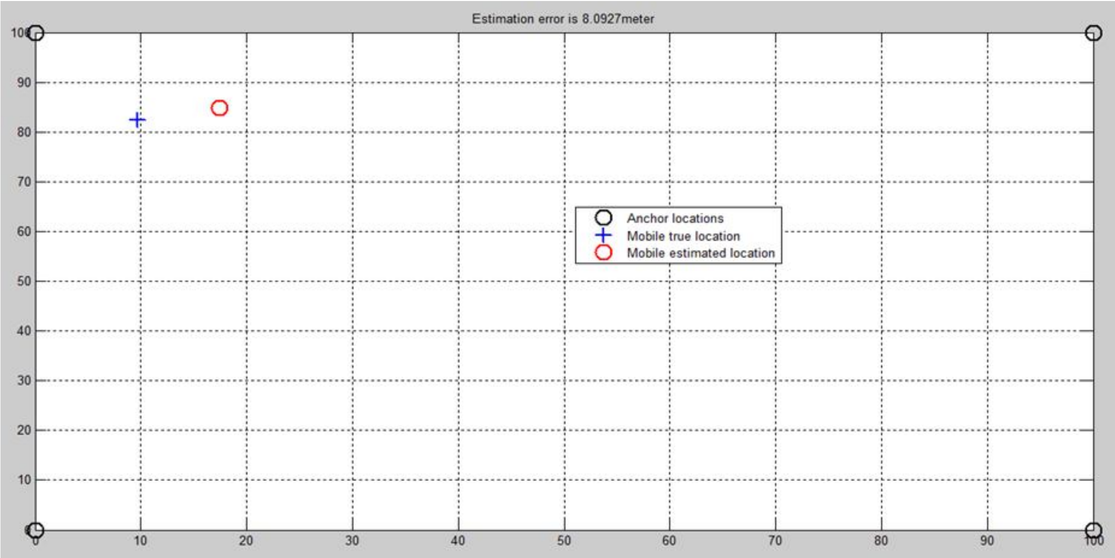

Figure 2: True and estimated location of mobile node in Case 1

Case 2

In the simulation result showing two positions of mobile node in a specified region. Red one is estimated location where as blue one is true location of mobile node in case3.In this case we found that Estimation error is 3.4203 meter.

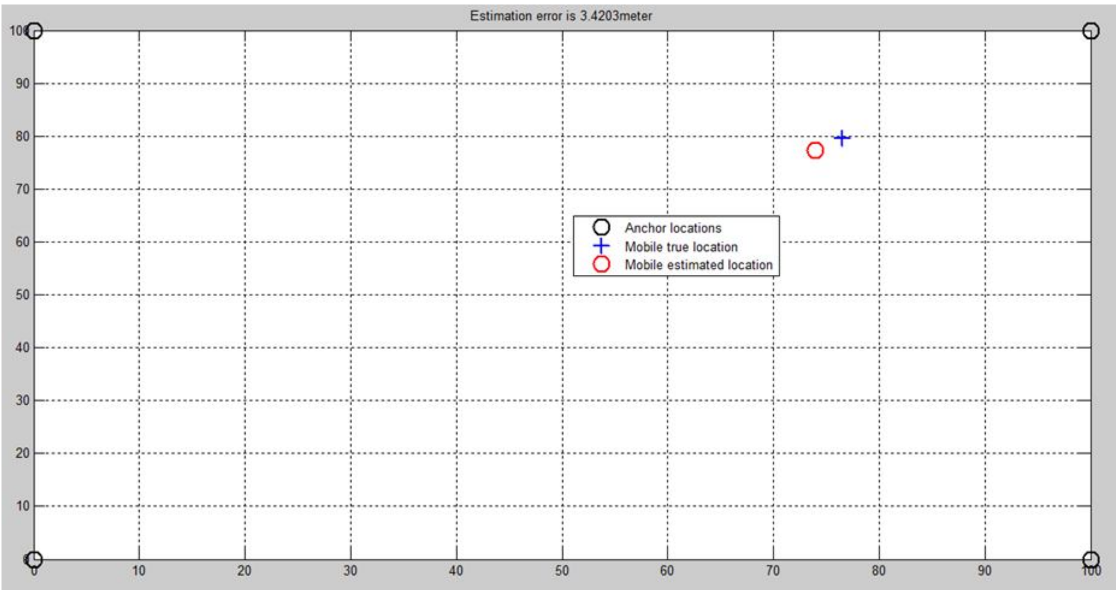

Figure 3: True and estimated location of mobile node in Case 2

Case 3

In the simulation result showing two positions of mobile node in a specified region. Red one is estimated location where as blue one is true location of mobile node in case4.In this case we found that Estimation error is 1.8441 meter.

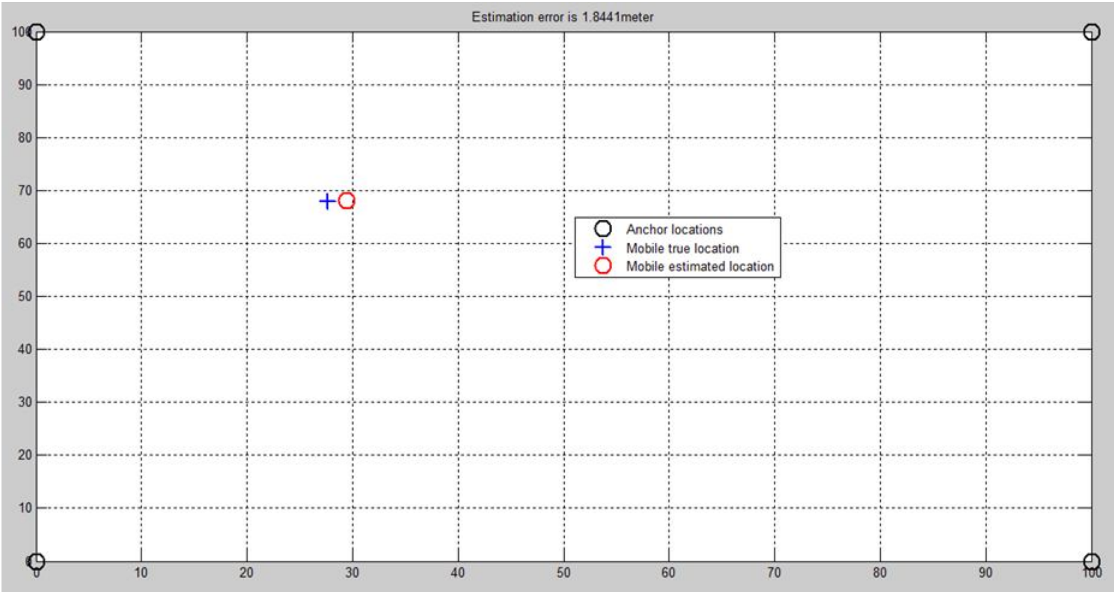

Figure 4: True and estimated location of mobile node in Case 3

Case 4

In the simulation result showing two positions of mobile node in a specified region. Red one is estimated location where as blue one is true location of mobile node in c. In this case we found that Estimation error is 2.2372 meter.

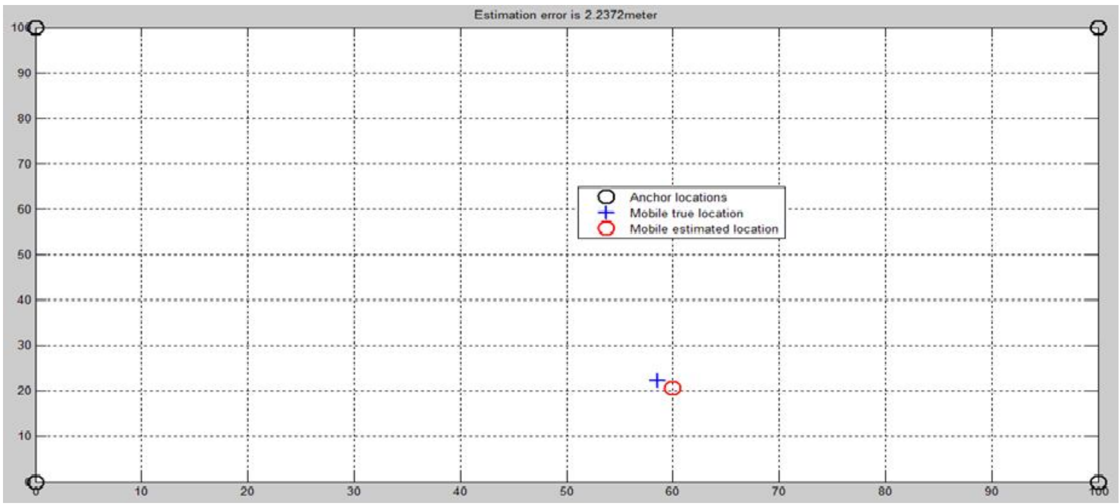

Figure 5: True and estimated location of mobile node in Case 4

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