ANALYSIS OF LOCALIZATION ALGORITHM IN WIRELESS SENSOR NETWORK

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Today, Wireless Sensor Network(WSN) are immensely used in multiple environments to perform various monitoring tasks such as exploration, research, disaster support, renewal, target tracking and number of many other tasks. Wireless Sensor networks are composed of large numbers of sensors that are provided with a memory, processor, sensing Capabilities, wireless communication abilities, and a power source. The nodes have the capability to perception environmental changes and task it and then report them to another node over flexible network architecture.There are many range based and range free localization algorithms that can determine the location of sensor nodes (Anchor node and Unknown node). In this, one proposed a range free Centroid localization algorithm which is better than range-based Centorid localization algorithm. The simulation results show that this Centroid algorithm improves the localization accuracy which is very useful localization algorithm in WSN. This localization accuracy will be better and localization error rate will be decrease.

Keywords: *Wireless Sensor Network, GPS, localization node, Centroid algorithm, weighted centroid algorithm, localization accuracy, error rate.*

1. Introduction

A Wireless Sensor Network or WSN is composed of plenty of sensors nodes. These nodes have the ability of sensing, computation and wireless communication, a transceiver, processing unit, sensors and battery [1] [2].Due to its powerful purpose and low energy cost, the WSN has been widely used .In WSN, the position information is crucial. When an abnormal events occurs, the sensor node detecting the events and report to the base station. Without position information, WSN cannot work properly. Wireless Sensor Network are a kind of self- organized, autonomous, ad-hoc Wireless Personal Area Networks (WPAN) collects of hundreds or even thousands of mart low-rate battery-powered sensor nodes. In Wireless Sensor Network, sensor nodes normally exist of a processor, a power supply, a radio module and one or more sensors mounted on the node itself or connected to it. The processor rule all the node’s functions such as control of communications, access to sensors, battery saving, execution of algorithms, energy source management.

1.1 Problem Definition

The problem of Localization accuracy in wireless sensor network is one of the great requirements for a senor network. As we reduce the localization error rate then we improve localization accuracy over the Network. To achieve the accuracy effectual network, there are different existing approaches, to perform the authentic communication over the network. One of the most approaches is localization algorithm. Localization algorithm is to perform the effective to localize the nodes so that genuine communication will be drawn. In this localization algorithm, we use a weighted centroid localization algorithm to design the improved weighted centroid localization algorithm. In this current work, an effective localization algorithm is suggested that will define a balanced, network in terms of anchor and unknown nodes. The anchor nodes can perform direct communication with centroid whereas the unknown nodes will perform multihop communication.

1.2 Problem Objectives and Scope

The objectives related with presented work are listed as follows:

- The main objective of the work is to design a successful improved weighted centroid localization algorithm so that the accuracy over the network will be increased.
- The objective of the work is to implement the work in MATLAB domain.
- The objective of the work is to reduce the localization error and improve the accuracy in Wireless senor network.

1.3 Significance of Work

The significance of presented work is listed a follows:

- The presented work will perform the range free centroid localization algorithm which is better than weighted centorid localization algorithm.
- The presented work will reduce the localization error over the network.
- The presented work will provide localization accuracy.

2. Research Approach

The current work is defined to reduce the localization error rate in the case of centroid localization algorithm. To find out such an algorithm this provides better accuracy as compared to previous given algorithm. In this work, the centorid algorithm is defined under the error rate and accuracy parameters. In this stage, when the localization accuracy will be increase as the localization error rate will be decrease. Now, the nodes communicating with centroid node will be specified with a sensing range specification. The nodes within the sensing range are called anchor nodes and outside the range are called unknown nodes. In this proposed work, we define a method to reduce the localization error rate and improve the localization accuracy of the weighted centroid algorithm. In this, communication range is suggested outside the network area.

3. Network Design

The proposed work is about to allocate the arrangement to the communication over the network based on distance vector. It means the higher the distance between nodes, higher the priority will be. The proposed work is about the propagation of such an approach that will solve the excess problem at the pervious stage but the work will be implemented dynamically by observing the communication over the network. The proposed system will give the benefit in terms of Efficiency and accuracy.

4. Parameters

All sensor nodes will have similar radio range. As we know in Centroid and DV-Hop localization method, we have to deploy anchor nodes or reference nodes within communication range where unknown nodes are deployed randomly in the particular coverage area.

After deploying anchor and unknown nodes, anchors start transmission of beacons of messages with communication range. Within the communication range unknown nodes receives beacon message and process the information which is received by anchor nodes.

This closed presence depends upon the communication ranges of neighbor anchor nodes to unknown nodes. The decision of neighbors is up to the connectivity metrics results. The simulation conditions or experimental situations are:

-The area of 100 x 100 $m^2$is taken.

-The anchor nodes are deployed grid wise and unknown nodes are deployed randomly.

-Each sensor node has similar radio transmitting power.

-Localization error can be calculated by

$$\text{Error} = \frac{\sqrt{(x_{est}-x)^2+(y_{est}-y)^2}}{R} \quad (8)$$

There are several network parameters that affect the localization error difference. These parameters affect when the sensor network is distributed. There can be different network parameters like

- **Network Size:** It is basically the area of the sensor network. In this case, the area as well as the number of sensor node is increased.
- **Array Node Density:** Array node or unknown are basically the nodes whose position is not known. The density is number of nodes per unit area. In this case, number of unknown nodes is increased in predefined area.
- **Anchor Node Density:** The number of anchor nodes is increased in predefined area. It is deployed grid wise.
- **Communication Range:** This is the range or area or the propagation distance to rest of nodes.
- **Node Density:** These are total number of nodes in a network. The total nodes are varied by varying anchor nodes or unknown nodes.

5. Results

In figure 5.1 represents that anchor nodes and unknown nodes are deployed. Anchor nodes are deployed grid wise and unknown nodes are deployed randomly.

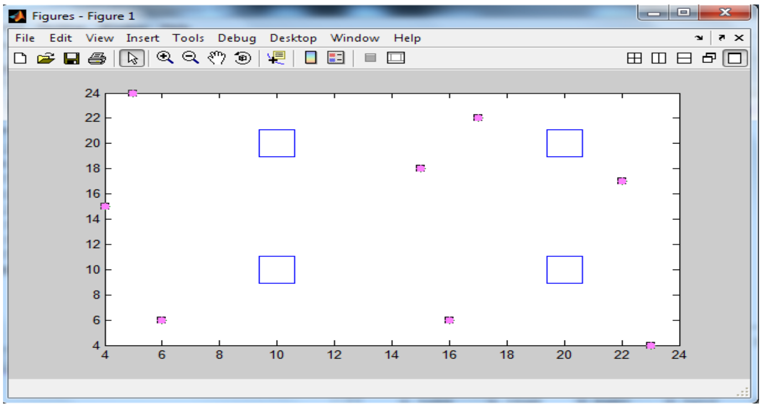

Figure 5.1: Anchor nodes and Unknown node are deployed

A. Anchor nodes are varied (4, 6, 8, 10, 12, 20)and unknown node and communication range are fixed.

In this simulation result, we evaluate the effect of change of number of anchor nodes on the localization error. Localization error is calculated on the weighted and proposed weighted centroid algorithm by expressing different values of anchor nodes as shown in table 5.1. In this table, Anchor node is varied and Unknown node and communication range are fixed.

TABLE 5.1: NUMBER OF ANCHOR NODE V/S LOCALIZATION ERROR (UN=17 and CR=7m).

ANCHOR NODES	LOCALIZATION ERROR	
	WEIGHTED CENTROID	IMPROVED WEIGHTED CENTROID
4	1.6367	0.6779
6	2.0623	0.9340
8	2.2443	0.8991
10	2.0195	0.7172
12	2.7314	0.6818

Fig 5.2 represents the location of nodes of localization. In this figure, the number of anchor nodes is 8, Unknown nodes are 17 and communication range is 7m.

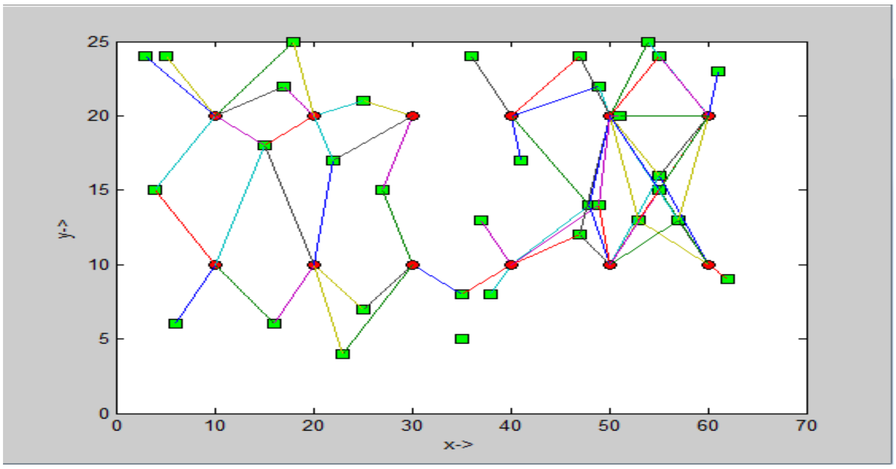

Figure 5.2: Nodes (AN & UN) deployed in a network.

Fig 5.3 represents that the number of error increases as the localization error decreases. In this, Centroid localization strategy shows that constantly increase in anchor nodes as the localization error decrease. As it can also realized that proposed weighted centroid algorithm has small number of location error in general with respect to various number of anchor nodes.

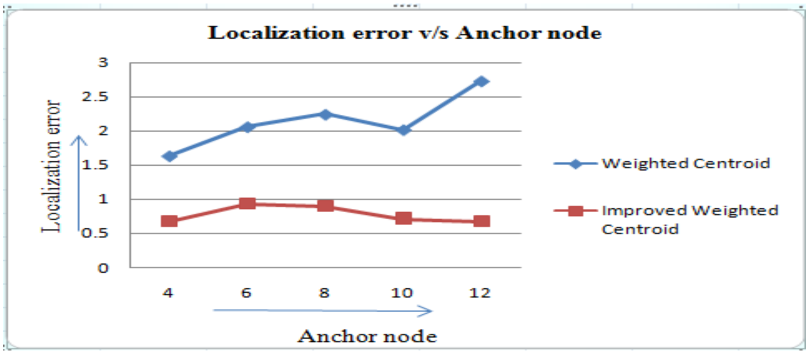

Figure 5.3: Graph represents Localization Error w.r.t anchor nodes.

B. Unknown nodes are varied (8, 10, 12, 14, 16, 22) and Anchor nodes and communication range are fixed.

In this simulation result, we evaluate the effect of change of number of node density on the localization error. Localization error is calculated on the weighted algorithm and proposed weighted centroid algorithm by expressing different values of node density as shown in table 5.4.

TABLE 3.2: NUMBER OF COMMUNICATION RANGE V/S LOCALIZATION ERROR (AN=8 and CR=7m)

UNKMOWN NODE	LOCALIZATION ERROR	
	WEIGHTED CENTROID	IMPROVED WEIGHTED CENTROID
10	1.6367	0.6779
12	1.7479	0.9274
16	1.7479	0.6673
20	1.6367	0.4818
24	1.6367	0.3960

Fig 5.4 represents the location of nodes of localization. In this figure, the number of anchor nodes is 8, Unknown nodes are 19 and communication range is 7m.

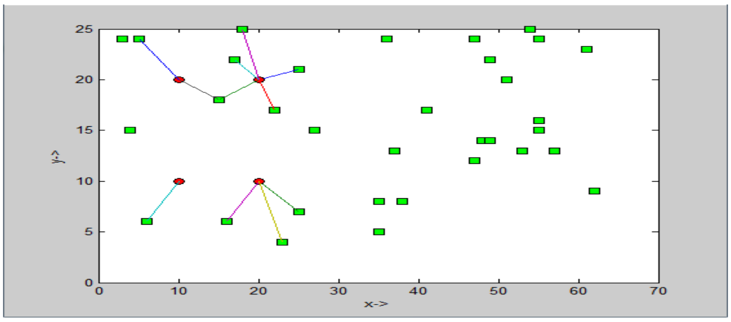

Figure3.4: Nodes deployed in a network

Fig 3.5 represents that the number of error increases as the localization error decreases. In this, weighted centroid localization strategy shows that decrease in unknown nodes and then constant. As it can also realized that proposed weighted centroid algorithm has small number of location error in general with respect to various number of unknown nodes.

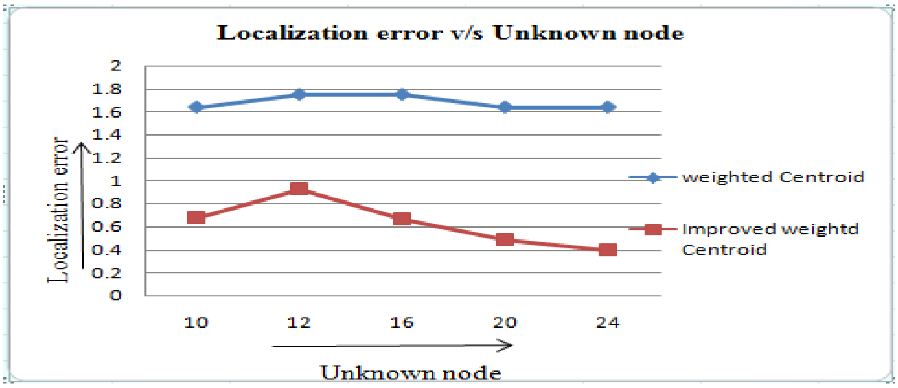

Figure 5.5: Graph represents Localization Error w.r.t unknown nodes.

C. Anchor nodes and Unknown nodes are fixed and communication range are varied (7, 10, 14, 18, 25, 30).

In this simulation result, we evaluate the effect of change of number of communication range on the localization error that is anchor node to unknown node range changes.. Localization error is calculated on the weighted algorithm and proposed weighted centroid algorithm by expressing different values of communication range as shown in table 5.3. In this table, Anchor node and Unknown node are fixed, and only communication range is varied.

TABLE 5.3: NUMBER OF COMMUNICATION RANGE V/S LOCALIZATION ERROR (AN=8 and UN=17).

COMMUNICATION RANGE	LOCALIZATION ERROR	
	WEIGHTED CENTROID	IMPROVED WEIGHTED CENTROID
6	1.4973	1.4037
7	1.7479	0.9274
10	1.5038	0.5501
13	1.1296	0.3068
20	0.9205	0.2733

Represents the location of nodes of localization. In this figure below, the number of anchor nodes is 8, Unknown nodes are 17 and communication range is 14m.

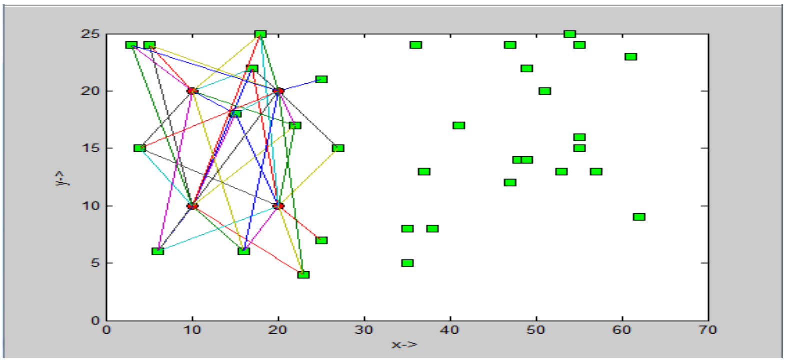

Figure 3.6: Nodes deployed in a network.

Fig 5.7 represents that the number of error increases in communication range and then decreases in Weighted Centroid localization. In this, weighted Centroid localization strategy shows that constantly increases in communication as the localization error also increase due to the fact that anchor propagation distance result in larger collected error. Large numbers of communication range are wants for good calculation results. As it can also realize that proposed weighted centroid algorithm has small number of location error and higher the accuracy in general with respect to various numbers of communications range.

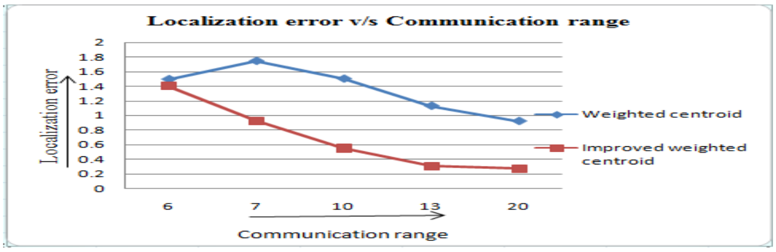

Figure 5.7: Graph represents Localization Error w.r.t communication range

6. Comparison Simulation Result And Performance Evaluation

In our experiment, to represent the performance of the proposed algorithm, we have set up the following simulation experiment states:

(i) Anchor nodes are deployed grid wise uniformly and the number of anchor nodes is put to 8.
(ii) Unknown nodes are deployed randomly in the 24 × 45 m^2 area.
(iii) The communication range for each sensor node is taken as 10m.

As shown in figure 6.1, 6.2, 6.3, represents the location of sensor nodes before and after localization. The average localization error is calculated by varying the Anchor node, Unknown node and Communication range. As the localization accuracy rate increases and the average localization error decreases.

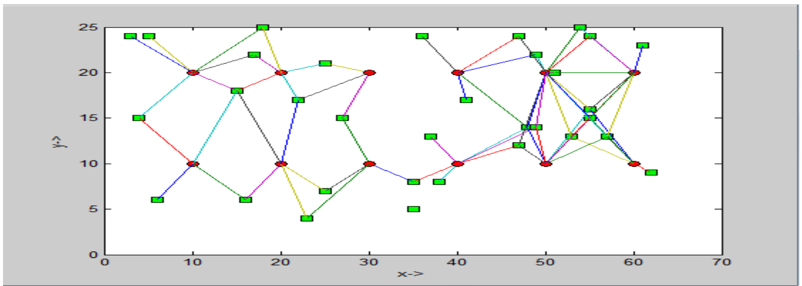

Figure 6.1: Nodes deployed in a network when AN is varying

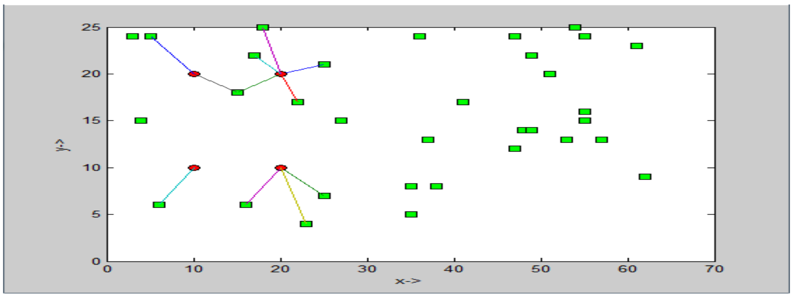

Fig 6.2: Node deployed in a network when UN is varying

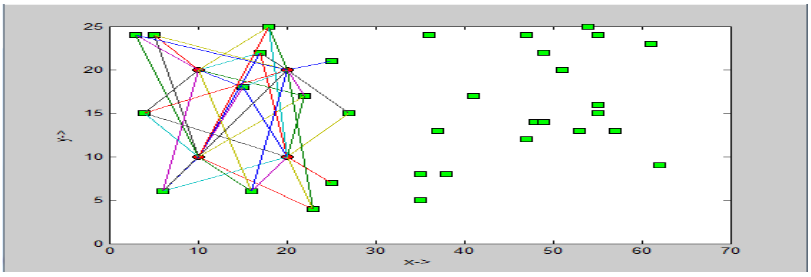

Figure 6.3: Node deployed in a network when CR is varying

TABLE 6.1: SYMBOL REPRESENTATION

	Solid red dots indicate anchor nodes.
	Filled square indicates unknown nodes.
	Colored lines indicate the difference between the actual position of error and estimated location.

In our experiment, we study several system-broad parameters that can influence localization error. These parameters are as follows:

- Anchor Node (AN): These anchor nodes are the nodes whose position is known and the values are set to 4, 6, 8,10 and 12 as deployed grid wise.
- Communication Range (R): This is the range or radius or area distance to rest of the nodes and is varied from (6, 7, 10, 13 and 20).
- Node Density (ND): This node density is the total number of nodes in a network and these total nodes are varied.
- Network Size**:** It is basically the area of the sensor network. In this case, the area as well as the number of sensor node is increased.

The localization error is evaluated which shows that formula (9):

$$\text{Error} = \frac{\sqrt{(x_{est}-x)^2+(y_{est}-y)^2}}{R} \quad (9)$$

(x_{est}, y_{est}) Represents the estimated coordinates of Unknown node's, (x ,y) are the actual coordinates , R is the communication range.

As shown figure 6.4, represents that localization error decreases as the localization accuracy rate increases. In this, by observing that proposed or improved weighted centroid algorithm has smaller localization error with respect to different number of anchor nodes, unknown nodes and communication range. This graph 6.4 shows that by varying the anchor nodes, unknown nodes and communication range the error value reduce and the accuracy rate increases.

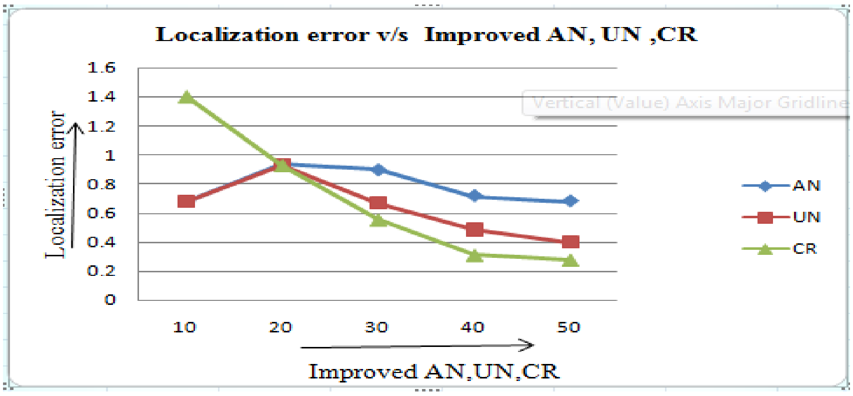

Figure 6.4: Graph represents Localization Error w.r.t AN, UN, CR.

7. Conclusion

Localization is the main problem in Wireless Sensor Network. To reduce this node localization, there are different existing approaches, to perform the reliable communication over the network. One of the most approaches in localization algorithm i.e. centroid localization algorithm. We can conclude that our accuracy based weighted centroid localization algorithm improves the positioning or localization accuracy significantly.The main purpose of my thesis is to find out the less error ratebetween the anchor nodes and unknown nodes. For this use the MATLAB software for finding the better accuracy rate and will less localization error between them.The simulation results shows that the more frequently beacon are placed, the lower the localization error and the higher the accuracy. We can place anchor nodes by manually, location or position performance can be improved.

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