An Optimal approach for Node Localization Using Enhanced DV-Hop algorithm in Wireless Sensor Network

[1]Priyanka Tripathi, [2]Pooja Giri

[1]Student, [2]Student
DEEE of NITTTR Bhopal,
Madhya Pradesh, India,

***Abstract*: Now a day's wireless sensor network has become more attractive technology in various types of inventive environments. Node Localization identifies the positions of the given node. Node Localization is one of the significant subjects in wireless sensor network. Location information of mobile nodes is in demand for many wireless systems**
So many node localization algorithms like APIT, CPE and RSSI for WSN have been introduced to improve the accuracy of the node localization. DV-Hop is very demanding and tiring algorithm for node localization. In this algorithm reference node (anchor node) coordinates are used to estimate the position of unknown node. In our proposed algorithm enhanced DV-Hop algorithm we utilize hop distance for position estimation of nodes. In this dissertation, the proposed methodology enhances the hop distance between each anchor nodes which results the low localization error and high accuracy. The simulation result proves that the proposed algorithm enhanced DV-Hop algorithm is better than the IDV- Hop algorithm. We evaluated the localization error with respect to the no. of total sensor nodes, communication radius and anchors node and compare with IDV-Hop algorithm.

***Keywords*: DV-Hop algorithm, Node Localization, Average Localization error, Wireless sensor network.**

I. INTRODUCTION

By the advancement of remote correspondence innovations and MEMS 'Micro-Electronic-Mechanical Systems', distant sensors systems enclose turned into a vital research territory these days. The primary study in this region was aggravated by the armed services application like 'Smart Dust and 'Distributed Sensor Networks' (DSN) program. Subsequently, the researchers in 'Berkeley University' projected 'Pico Radio project' to build a omnipresent sensor network with minimum cost and less power consumption, which were believed to be useful in residential area. Afterward, lots of wireless sensor network systems projected, for instance, 'OCARI' by the researcher in France. In recent times, inhabitant purposes of sensor network have been measured including environmental monitoring, hospital supervision, digitally smart home and object tracking.
A wireless sensing element network may be an assortment of sensing element nodes structured into a joint network. Every sensing device has generally many components, as display in (Fig:1). A sensing device (called sensor node) is sometimes a small gadget prepared with electric battery for a power supply. These sensors are very useful for work surroundings situation like sensing pressure, sound, vibrations humidity temperature variation and motion. A wireless transceiver is built-in for 2 manner communications with the sensor which are different.
A device which is called sensor node that has the subsequent uniqueness: (a) a little low structural size, (b) short power utilization, (c) restricted process power, (d) short-term interactions and (d) a little quantity of storage capacity.
By highly developed networking protocol, wireless device called 'sensor node' be able to form different types of wireless networks that make human being life easy. For instance, in a doctor's facility, patients were able to be outfitted with imperative sign sensor hubs.
Wireless devices like mobile phone, wireless device (sensor nodes) can't able to connect directly to the nearby next base station or dynamic tower, however exclusively with their neighbor node. Rather than hoping on a pre-deployed network structure, every device node becomes a part of the network structure. This unplanned networking topology provides a mesh-like association during a multi hop manner. The versatile mesh design with dynamism adapts to maintain the adding up of recent nodes and also the reward for node breakdown.

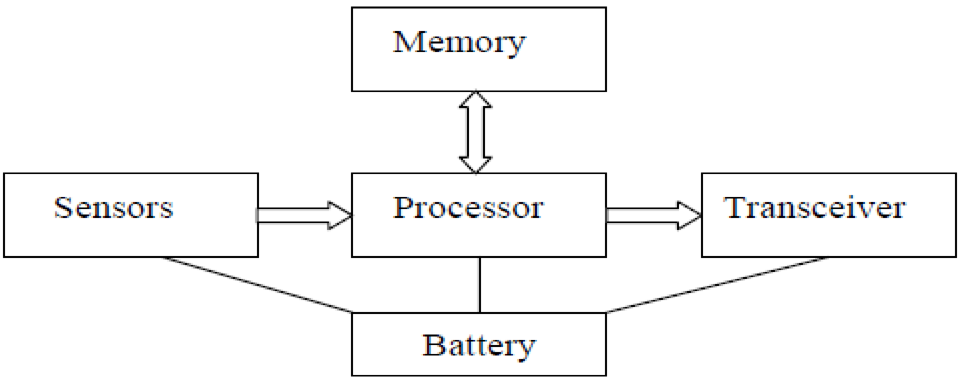

Figure 1:- Configuration of a Sensor Node

II. LITERATURE REVIEW

“Shrawan Kumar, D. K. Lobiyal [2016]” [1] introduces taking into consideration the disadvantages of “DV-Hop” algorithmic rule & it is enhancements “RNLEDV-Hop & IDV-Hop” in conditions of your power & time utilization, I tend to designed“NDV-Hop” localization algorithmic rule during this paper. The planned algorithmic rule NDV-Hop provides economical localization with less important communicatory value and while not requiring extra hardware. The NDV-Hop algorithmic rule fully eradicates communication from start among the pace by hard hop-size at unidentified nodes. That will drastically lessens the energy consumption & time, that's a vital enhancement above “DV-Hop–based” algorithms. The performance of “NDV-Hop (L)” validates with the intention of removal of single communication step collectively enhances “localization accuracy” above “DV-Hop”. what's additional, localization accuracy is inflated by minimizing error terms among the derived distance between beacon nodes and unidentified node by exploitation free optimization. “Log-normal shadowing path loss” model is incorporated to replicate plenty of practical surroundings.Implementation outcomes validate that the planned algorithmic program, “NDV-Hop (U)” provides, on the common error nothing lower localization error than DV-Hop and nothing minor localization error than “IDV-Hop” and “RNLEDV-Hop”. The planned algorithmic program against “DV-Hop”, “IDV-Hop”, and “RNLEDV-Hop”, in all the eventualities consideration of, gives higher performance.

“Zhang ying, Zhu Zhuling [2016]”[2] in this paper, creators proposed an novel DV-bounce area calculation to conquer the lack of the customary DV-jump area calculation. the deficiency of the standard DV bounce confinement recipe, the figuring of normal jump separate is enhanced, and enhances the restriction exactness of the equation.
"Stefan Tomic and Ivan Mezei [2016]”[3] In this editorial, three new calculations are planned, “iDVHop1, iDV-Hop2 and Quad DV-Hop”, as changes of the first “DV-Hop” calculation and reproduction outcomes are specified for 4 unique situations (standardized irregular, C formed arbitrary, lattice and C molded lattice topology). The “iDV-Hop1 and iDV-Hop2” calculations have additionally steps supplemental to the main “DV-Hop” to decrease the restriction blunder. Quad “DV-Hop” recipe enhances the limitation precision by goals the limited strategy for slightest squares disadvantage. Zhihua Cui , Bin Suna, Gaige Wang,.
Mohaddeseh Peyvandi,ali A. Pouyan [2015] [4] proposed improved algorithm, in this the effective hopsize presented to decrease the distance error and Levenberg-Marquardt as an iterative algorithm is used for position optimization. They reduced the role of anchor nodes. In simulation result shows the improved distance and position estimation.
Guo Qing GAO and Lin LEI [2010] [5], proposed a new CDDV-HOP algorithm method a model have been built for 1-hop node and 2-hop node. Exact length b/w anchor node and unknown node can be gained accuracy is enhanced. The reproduction results show the algorithm for getting elevated precise location or positional estimation than “DV-HOP” even in sparse network.
Hichem Sassi, N. Liouane and Tawfik Najeh [2014][6], proposed new algorithm by selecting three nearest anchor node. Simulation results have proven the validity of that method but this method increase the cost of calculation.

III. DV-Hop Algorithm

The DV-bounce (remove vector-jump) limitation calculation was planned by Niculescu. It is a reasonable answer for typical hubs having few neighbor grapples. As appeared in Figure 3.5, in spite of the fact that the conventional hub Nx has no neighbor stays, Nx will utilize the DV-bounce algorithmic program for localization. This is regularly one among the ordinary agents of sans range restriction algorithmic program. Its fundamental arrangement is that the space between the obscure hubs and furthermore the reference hubs is communicated by the stock of normal bounce remove and furthermore the jump check. The essential thought is: the hub itself just trade data with its adjoining hubs, the separation between the obscure hubs and the grapple hubs is spoken to by the result of system normal Hop remove and the most limited way between two hubs, and utilizations trilateral estimation to get the hub area data. This equation needs a few hubs have GPS situating instrumentation, diverse hubs decides their own position steady with grapple hub (utilizing GPS situating or manual preparing of the hubs already, their genuine area is known) and thusly the correspondence data among the hubs. The hubs don't might want have separate period or Angle feminine cycle work; furthermore don't might want additional area or Angle estimation instrumentation. Subsequently DV-Hop recipe is one in everything about premier wide connected equation inside the monstrous hub self-limitation calculations for remote gadget organizes.

The algorithm accomplishment is included three steps.

Step 1: Ascertain negligible jumps between obscure hubs and each stay hub. Signal hubs communicate their area data bundle to the neighbor, which included hopping segment of the field, and the esteem is introduced to zero. Accepting hub records the base bounce tally of every hub, while overlooking the bigger jump assemble from a similar grapple hub, at that point the hop number one is added and pass on to nearby node.

Step 2: Figure the genuine separation among obscure nodes and the stay nodes. Each stay nodes evaluates the real normal jump separate utilizing equation (3.1), as indicated by the area data and the bounce check of the other beacon motes.

$$HopSize_i = \frac{\sum_{i \neq j} \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}}{\sum_{i \neq j} h_j} \qquad (1)$$

Among them: (xi, yi), (xj, yj) area unit the coordinates of the anchor node i, j ; hj is that the hop account among anchor node i and also the anchor node j (i ≠ j). Anchor nodes broadcast the typical hop distance that use the grouping with a live field to the network. Unknown nodes, that solely record the primary received average hop distance and transmit the data to neighbor nodes. Then unknown nodes calculate the space to each anchor node, consistent with the records of hop in account.

Step 3: Compute the co-ordinates of unidentified motes. The unidentified motes uses the Triangulation or most chance estimation technique to compute the coordinates of the unknown nodes, in step with the records of hop distance to every anchor node, victimization the trilateral worth or most chance estimation technique to calculate the coordinates of unidentified motes. When the distances are known from all the beacon motes to the unidentified mote P, we can calculate the position by triangulation method.

IV. Proposed Method

Enhanced DV Hop Algorithm

We study and suggest an enhanced DV-Hop calculation, or, in other words a accompanying advances.

[1] Each and every Sensor Nodes are arbitrarily arranged on desired region.

[2] We calculate the mean hopdistance for anchor nodes to reduce the distance error.

[3] The obscure sensor nodes positions are gotten by the Least Square Trilateration Method.

The "Enhanced DV Hop" algorithm is used in our proposed research work. The proposed algorithm implementation is comprised four phases:

Phase 1: Initialization
Phase2: Distance Estimation
Phase3: Position estimation
Phase4: Error Estimation

Phase 1: In Initialization phase, all nodes are randomly deployed. All anchor node podcast message in the form of packets which consist anchor node id, positions and hop count. The hop count initialize with 0. Each sensor node receives the min hop count and max hop-count would be rejected by each node then each and every sensor node increases the hop-count to one previous to sending to the nearby node. Later than each sensor node receives the minimum hop count from the each and every beacon sensor nodes.

Phase 2: In Distance estimation phase, to calculate the definite distance b/w unidentified motes and the beacon motes, the beacon node calculates the hopdistance from all other anchor node. Every beacon mote guesstimates the genuine avg hop-distance using formula which is shown in Eq.1. According to the hop count and location info of the other beacon nodes.

$$Hopsize_m = \frac{\sum_{m \neq n} \sqrt{(x_m - x_n)^2 + (y_m - y_n)^2}}{\sum_{m \neq n} h_{mn}} \qquad (2)$$

Where the position coordinates of the beacon node *m*, *n are* (x_m, y_m), (x_n, y_n) ; the hop account b/w beacon mote *m* and the beacon node n *(m ≠ n)* is h_{mn}. After that we calculate the mean of the hopdistance to reduce the estimated distance error.

$$Hopsize_{mean} = \frac{\sum Hopsize_m}{i} \qquad (3)$$

Where 'i' is the total no. of beacon nodes. Every Anchor nodes podcast the mean hopdistance to the entire unknown motes in the n/w which only save the first received slightest mean hopdistance. Then the unidentified motes compute the distance from each beacon mote, according to the account of hop-count.

$$d_m = Hopsize_{mean} \times Hops_m \qquad (4)$$

Phase 3: In Position estimation phase, we analyze the position or location of unidentified nodes. We are implementing Least Square Trilateration (LST) Method which get betters the predictable location or position accurateness.

Let us assumed that M beacon motes are used to guesstimate the position or location of unidentified node u. (x_m, y_m) are the co-ordinates of the beacon node *m* and (x_u, y_u) are the co-ordinates of unidentified mote *u*.

$$\begin{cases} (x_u - x_1)^2 + (y_u - y_1)^2 = d_{m1}^2 \\ (x_u - x_2)^2 + (y_u - y_2)^2 = d_{m2}^2 \\ \quad \vdots \\ (x_u - x_M)^2 + (y_u - y_M)^2 = d_{mM}^2 \end{cases} \qquad (5)$$

Where and (x_u, y_u) are the position co-ordinates of unidentified mote *u*.The equation (4) is non linear because of square term. To make the equation linear the (M-1) should be subtracted by last equation. The result can be written as PQ=R.

$$P = -2 \begin{bmatrix} x_1 - x_M & y_1 - y_M \\ & \vdots \\ x_{M-1} - x_M & y_{M-1} - y_M \end{bmatrix} \qquad (6)$$

$$R = \begin{bmatrix} d_{u1}^2 - d_{uM1}^2 - x_1^2 + x_M^2 - y_1^2 + y_M^2 \\ \vdots \\ d_{u(M-1)}^2 - d_{uM}^2 - x_{M-1}^2 + x_{M-1}^2 - y_{M-1}^2 + y_M^2 \end{bmatrix} \qquad (7)$$

$$Q = \begin{bmatrix} x_u \\ y_u \end{bmatrix} \qquad (8)$$

According to (6), Q can be obtained by using the least square Trilateration method

$$Q = (P^T.P)^{-1} P^T R \qquad (9)$$

The position coordinates of unidentified node u are given below

$$x_u = Q1$$
$$y_u = Q2$$

Phase 4: In Error estimation phase we estimate the average localization error for the network.

$$A.L.E = \frac{\sum_{i=1}^{N} \sqrt{(x_i' - x_i)^2 + (y_i' - y_i)^2}}{N_u \times R} \quad (10)$$

The "figure2" shows flow-diagram of planned work. In the planned research mainly the DV-hop algorithm is used. In this flow diagram proposed work done in many steps. First step is initialization; nodes are initializing for the network setup. A second step is distributed random topology. In third step Anchor Node Broadcast their Information such as location and hop. In next step condition is applied for received the beacon node packets and match up to previously received and Save the smaller hop count.. If this condition is satisfied then end of broadcast but this condition satisfied back to the upper step. After that next condition is applied for end of broadcast. If the condition is satisfied the procedure is reach next step. The next step is to compute nod hop and distance using shortest path algorithm then Calculate hop distance in unknown node. After this calculation it also calculates distance & hop between anchor node & unknown node. And then next stage is estimation using Least Square Trilateration method.

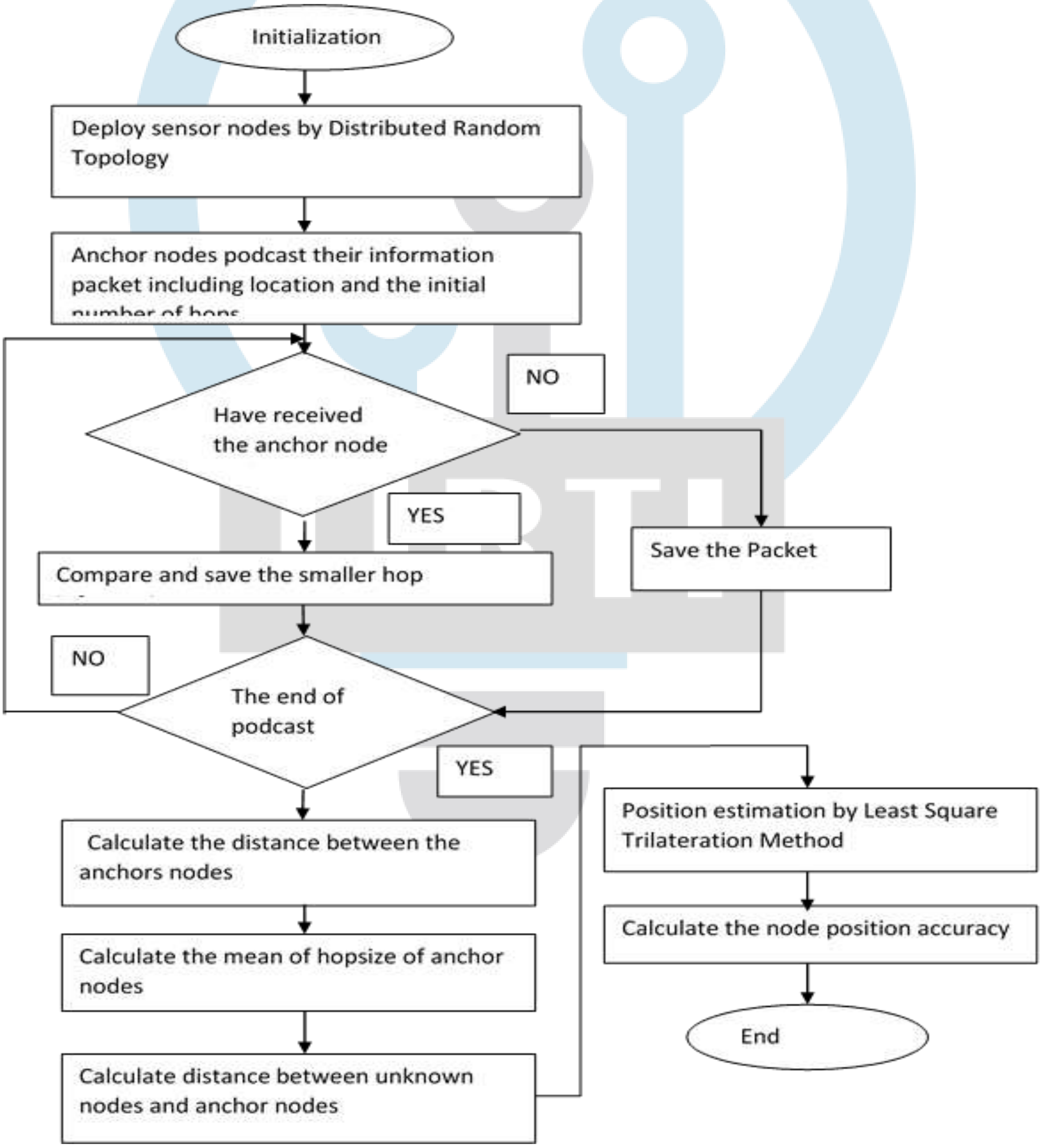

Figure 2:- Flow-chart diagram of proposed algorithm

V. Performance Analysis

In this part we are showing the result and it will be compare with previous research work.

We have used MATLAB 2013 as the simulator tool for implementing our planned algorithm and comparing its efficiency with traditional localization algorithm. In the simulation all sensor nodes casually installed in an area of 100m X 100m. The simulation specifications are set as given below:

- All Sensor nodes are stable.
- All sensors are same in capacity of memory and energy.
- Communication channels are duplex in nature. Each node can transmit and receive.
- Every node has one neighbor node at least.
- GPS is set to be 0 in term of location error for each anchor node.

To obtain a better result simulation has been frequently executed. We have performed 50 experiments to get the average node localization error.

The accuracy for the node localization algorithm is inversely proportional to "node localization error".

The "Average node localization error" is calculated by

$$A.L.E = \frac{\sum_{i=1}^{N} \sqrt{(x_i' - x_i)^2 + (y_i' - y_i)^2}}{N_u \times R} \quad (11)$$

Where Nu is the no. of unidentified nodes whose position to be estimated. "R" is the "Communication Radius" of sensor node (xi'-yi'): predictable position coordinates of unidentified nodes. (xi-yi): actual position coordinates of the unidentified sensor nodes.

For the objective of simulation the following parameters are enlisted in "Table1"

Parameter	Value
Area	100 X 100
Total No. of sensor Nodes	200
No. of Beacon Nodes	20% of total no. of nodes
Communication Radius	30m
Localization Algorithm	Enhanced DV-Hop Algorithm
Observation Parameter	Localization Error and Accuracy

Table 1:- Parameter used in the simulations

To examine and compare the results we have evaluated the proposed algorithm which is based on the no. of Beacon nodes, no. of Unidentified nodes and the radius of communication which are shown below:

1. Comparison result based on no. of Beacon (anchor) nodes

In that case we calculate the "node localization error" on the basis of different no. of beacon nodes, the no. of total nodes is 200, the no. of beacon node is vary by 10-40 and communication radius is 30.
The comparison result on basis of anchor nodes are enlisted in "Table 2"

No. of Anchor node	Base Paper(IDV-Hop Algorithm)	Proposed Work (EDV-Hop algorithm)
10	.225	0.0120
15	.106	0.0116
20	.103	0.0112
25	.102	0.0111
30	.082	0.0108
35	.076	0.0105
40	.072	0.0096

Table 2:- Comparison table based on number of Beacon nodes

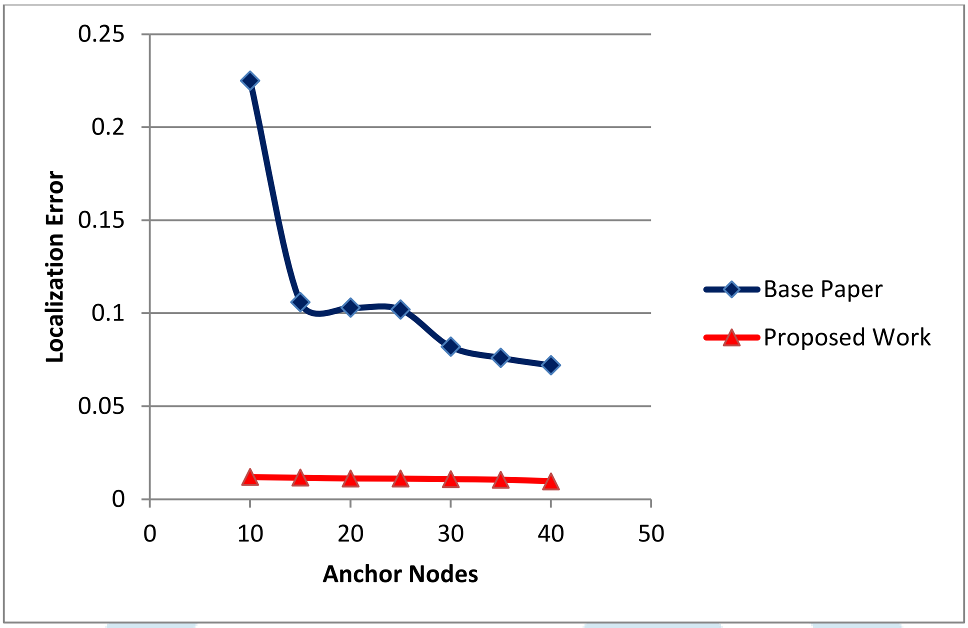

Figure 3:- Evaluation graphs which is established on no. of Beacon nodes

In the "figure 3" comparison graph is shown which is based on no. of Beacon nodes. In this figure we observed that the average Localization error for different no. of anchors node is varying.

2. Comparison result based on Communication Radius

In this Scenario, calculation for the node localization error is based on the no. of different radius of communication, total no. of nodes is 200, the no. of beacon node is 40 and communication radius is vary by 20m- 40m.
The comparison result on basis of Communication Radius are enlisted in "Table 3"

Communication Radius	Base Paper(IDV-Hop Algorithm)	Proposed Work (EDV-Hop algorithm)
20	.137	0.0188
25	.062	0.0122
30	.05	0.0094
35	.042	0.0091
40	.034	0.0088
50	.021	0.0083

Table 3:- Comparison table based on number of Communication Radius

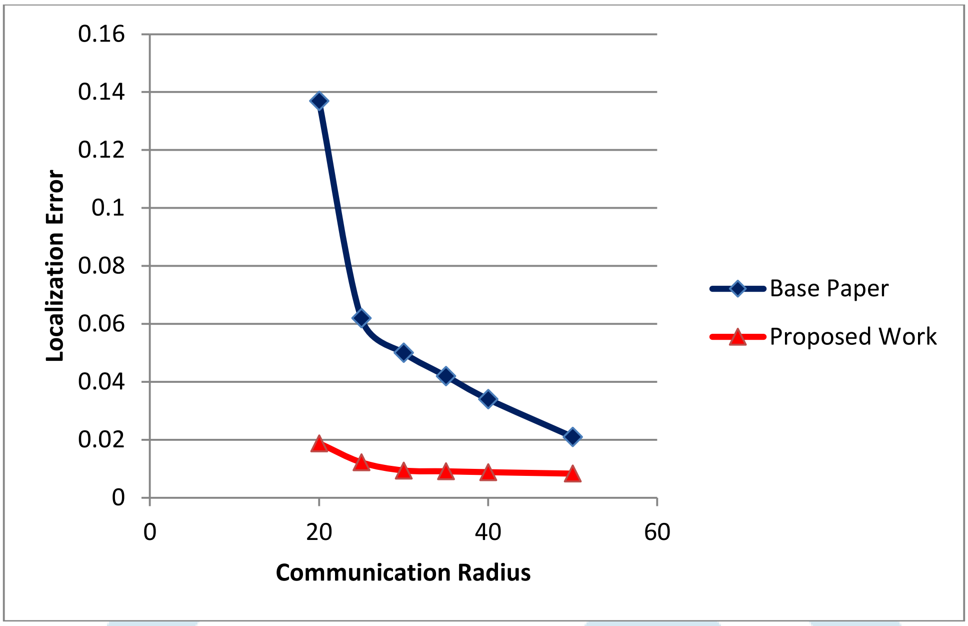

Figure 4:- Comparison chart based on no. of Communication radius

The "figure 4" shows the comparison chart based on communication radius. In this figure we observed that the average Localization error for different communication radius is varying.

3. Comparison result based on Total no. of Sensor Nodes

In this Scenario, calculation for the node localization error is depend on the different no. of nodes, the no. of total nodes is vary by 50 to 300, the no. of beacon node is 20% of total sensor nodes and the radius of communication is 30.
The comparison result on basis of total no. of sensor nodes are enlisted in "Table 4"

Nodes	Base Paper(IDV-Hop Algorithm)	Proposed Work (EDV-Hop algorithm)
50	.21	0.0183
100	.1	0.0157
150	.087	0.0144
200	.085	0.0089
250	.082	0.0078
300	.080	0.0058

Table .4:- Comparison table based on no. of nodes

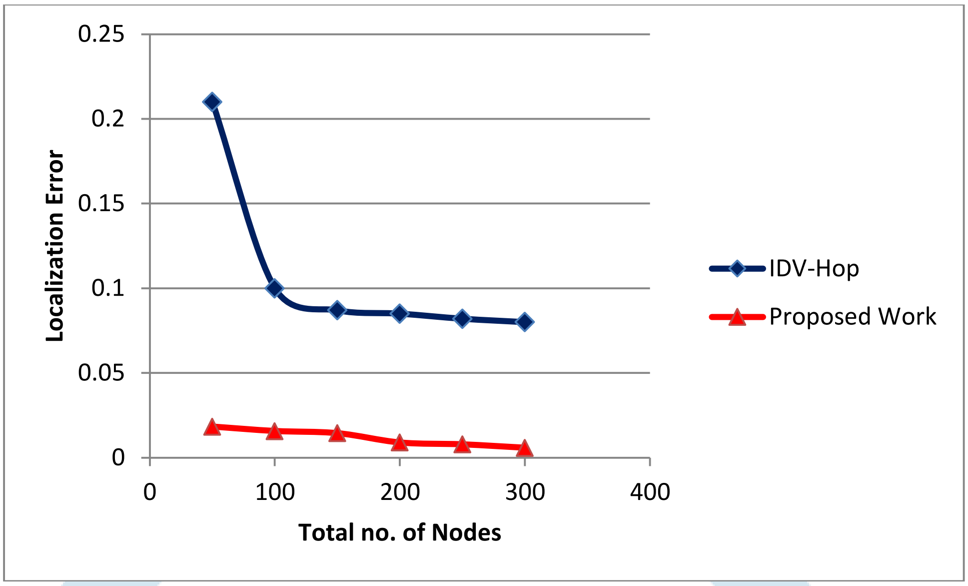

Figure 5:- Comparison chart based on no. of nodes

The "figure 5" shows the comparison chart based on the total no. of anchor nodes. In this figure we observed that the common Localization error for different no. of nodes is varying.

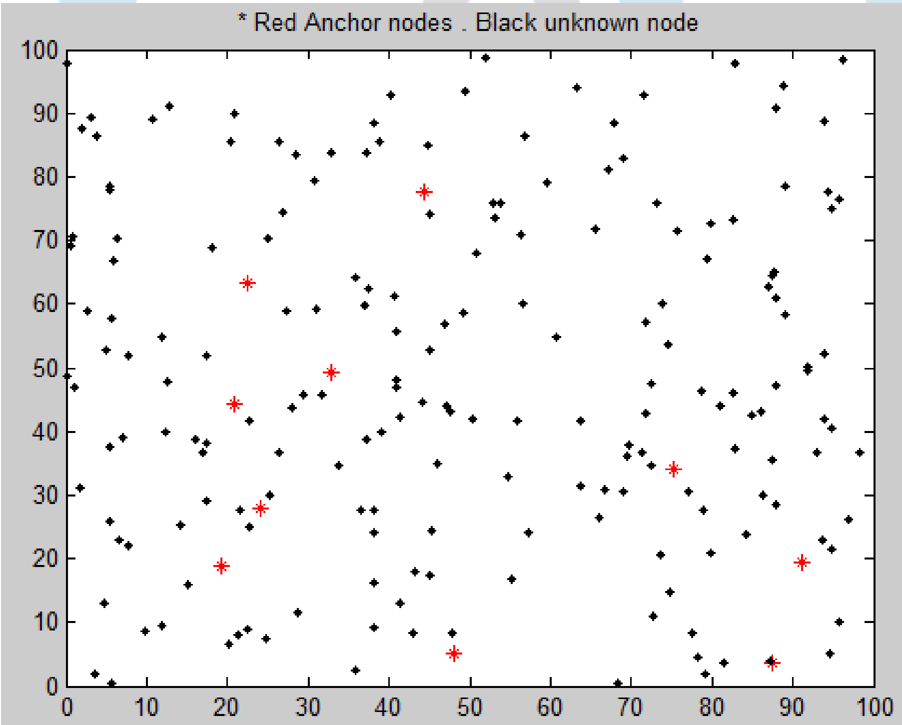

Figure 6:- Deployments of Nodes

The "Figure 6" displays the localization of node. In this anchor node are in Red color and are unidentified nodes are in black color. In proposed architecture we have used 200 nodes on 100 X 100 areas.

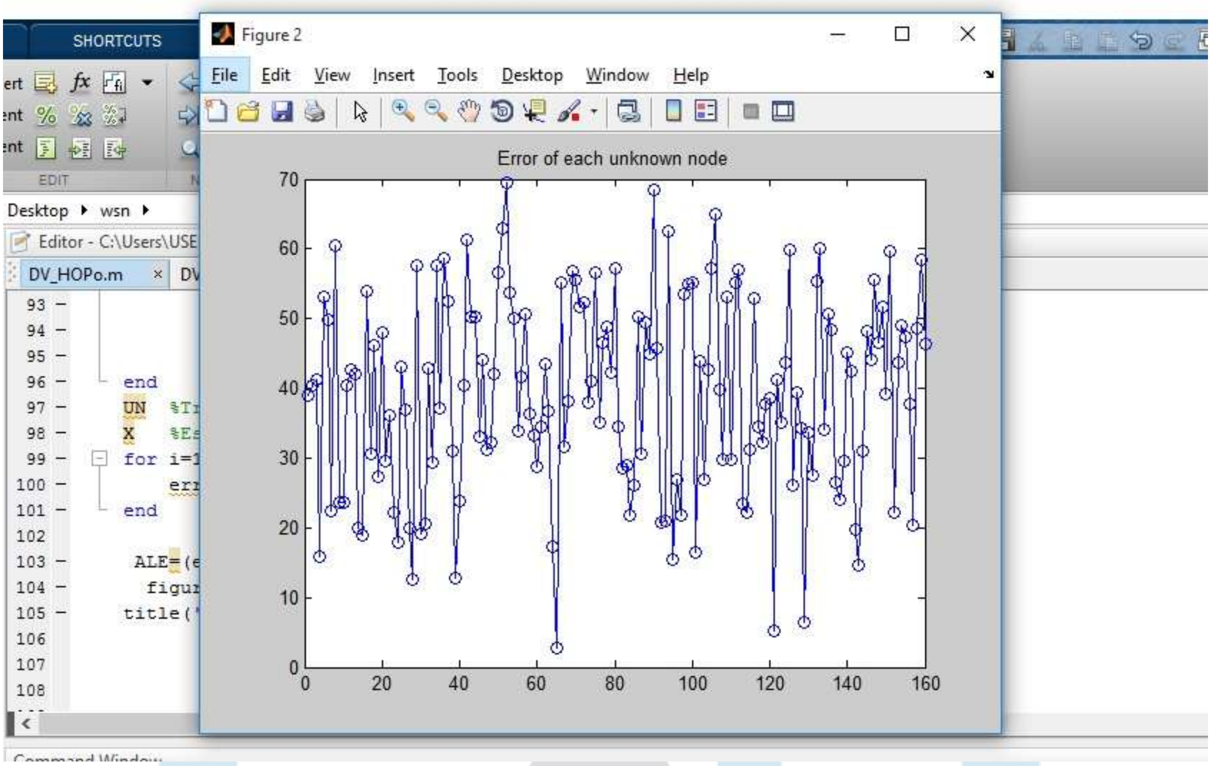

Figure 7:- Error of each unknown node

The "Figure 7" illustrates the error of localization for each node. In proposed architecture we have used 200 nodes on 100 X 100 areas.

CONCLUSION DRAWN FROM THIS RESEARCH

Wireless sensing element network could be a new technology regarding exploit and process info, it will self-organize configuration arrangement. The sensor nodes will observe and collect numerous ecological or observance object info through cooperative add actual time, and method the knowledge at constant time. In (Wi-Fi) wireless sensing element if the sensor nodes location is not known then the information collected by that nodes are pointless, that the "sensor node localization" downside is single in every of the vital shore up technologies within the wireless(Wi-Fi) sensing element networks and is much regarded. within the planned system we have a tendency to planned improved DV-HOP algorithmic program with least sq. error technique for analyze the localization error and improve the network period for 2-D. To boost the localization accuracy and improve energy potency of wireless sensing element network in planned work. Within the analysis work we have a tendency to compare to the previous work supported anchor node, node and vary. Basic analysis parameter is node readying and so distance between node and error estimation with anchor node. In this research we planned enhanced DV-Hop algorithm with least square Trilateration method to lessen the node localization error and increases localization accuracy so the new computation of mean hop size in distance estimation will be more precise than the previous approaches. Using this efficient approach the localization error reduced very effectively as compared to previous proposed algorithm. In the proposed research we estimate node location and analyze localization error at every node. In simulation experiments through MATLAB, localization error of proposed algorithm is compared to previously proposed algorithm based on full amount of beacon node, unknown nodes and communication range.

FUTURE SCOPE

In future work, we can give center of attention on the other range free techniques for "node localization". As there is constantly an opportunity in the enhancement of technique, the same will follow with this research-work too. The main objectives of this research work mentioned are effectively achieved but there is always a hope of improvement which is given below:

- Proposed algorithm will be implemented for 3-D space.
- In future, we will work on Computational complexity and time constraint of the proposed technique.
- The future objective will be to decrease the cost of the technique while improving the accuracy of the localization algorithm.

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