

Distance Based Node localization Technique For Underwater Acoustic Networks

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Abstract- The wireless sensor networks are the decentralized type of network which can sensor environmental conditions and pass that to base station. The underwater acoustic network is the network in which sensors are deployed under the sea and pass sensed information to base station. Due to movement of the sensor nodes, to estimate exact location of the sensor node is the challenging task. In this research paper, technique of node localization is applied which is based on the distance based technique. The simulation of proposed technique is analzed in MATLAB and it has been analyzed that number of nodes localized increased with increase of coverage.

IndexTerms - WSN, Localization, angle of trajectory, distance, coverage area.

I. INRODUCTION

Wireless sensor networks (WSN) consists sensor nodes and base station. There are large numbers of small, low power, low cost sensor nodes with limited memory, computational, and communication resources, to monitor the physical aspects. WSN also consists of spatially distributed autonomous sensors and a Base Station to co-operatively pass their data through the network to a main node or central location.

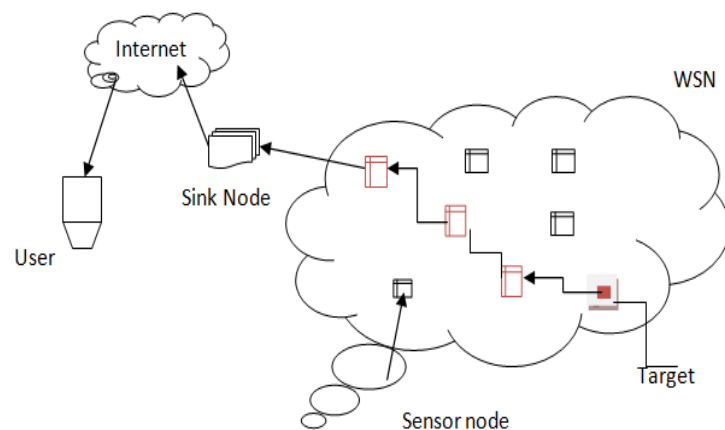


Figure 1: Traditional Wireless Sensor Network [1]

The environmental conditions are continuously monitored by the nodes of WSN to collect detailed information about the physical environment in which they are installed. Further the collected data is transmitted to base station (BS). The BS act as gateway between the sensor networks and the outside world [7]. The BS also has very large storage and large data processing capabilities. The main work of BS is to pass the data it receives from the sensor nodes to the server from where end user can access them. The sensors nodes are generally expand around the area of the Base Station and further as per the need of BS groups were formed. The Sensor nodes have short lifetime because it runs on batteries and once nodes are deployed their batteries cannot be recharged.

II. NODE LOCALIZATION

In WSN location awareness is one of the important, critical and challenging issues. Knowledge of location among the participating nodes is one of the crucial requirements in designing of solutions for various issues related to Wireless sensor networks. Wireless sensor networks are being used in environmental applications to perform the number of task such as environment monitoring, disaster relief, target tracking, defenses and many more. In many such tasks, node localization is inherently one of the system parameters. Node localization is also one of the problems in WSN [8]. It is the process of identifying the position coordinates of unknown nodes which can be achieved by using the distance information, and radius of wireless communications. Node localization is required to report the origin of events, assist group querying of sensors, routing and to answer questions on the network coverage. The measured distance between unknown node and anchor node is not the real value. So unknown node position estimation can be treated as a kind of optimization, which minimizes the target function of localization [9] error of anchor node to find out the position coordinate of unknown node. The major factor is a ranging error that affects the location error of the unknown node, and decrease the maximum error can meritoriously improve the accuracy of localization. So, node localization have become one of the fundamental challenges in wireless sensor network [10]. The mean square error of distance between anchor node and adjacent unknown node is defined as the fitness function of localization problem [11].

As shown below: $f_k(a^-, b^-) = d_k - \sqrt{(a_k - a^-)^2 + (b_k - b^-)^2}$ (1)

In above eqn.1 the a_k, b_k ($k=1,2,\dots,M$) is the actual coordinate of the i th anchor node, a, b is the evaluated coordinate of unknown node, the distance between the k^{th} unknown node and anchor node is defined by $\sqrt{(a_k - a^-)^2 + (b_k - b^-)^2}$. $f_k(a^-, b^-)$ is the error value between estimated and measured distance of the k^{th} unknown node and that anchor node, and measured distance d_k is the distance between the k^{th} anchor node and that unknown node. In reality the distance measured between two nodes is not the real distance; therefore the combined form of Gaussian error and real distance must be used for computing the real distance [12], i.e. $d_k = d_{kj}(1 + \text{randn} \times n)$ (2)

Where in d_{kj} is the measured distance, accuracy between error factor connected to real value between two distance [13]

$d_{kj} = \sqrt{(a_k - a^-)^2 + (b_k - b^-)^2}, n$ (3)

In the equations given above the randn is the random variable subject to standard normal distribution, where the average value is „0“ and square variance is „1“ [14].

III. Literature Review

Rnjit Kaur, et.al, (2017), have recommended Wireless sensor network (WNS) as one of the most important highly desirable factors is Localization. Localization can be stated as the estimation of the location of the sensor nodes in sensor network. In the applications of WSN, without localization information of the nodes, the gathered data at sink node will be meaningless. In [2], the author have used the nature inspired algorithms and analyzed it for an optimal estimation of the location of sensor nodes. The performance of the nature inspired algorithms viz.

Flower pollination algorithm (FPA), Firefly algorithm (FA), Grey Wolf Optimization (GWO) and Particle Swarm Optimization (PSO) for localization in WSN is analyzed in terms of localization accuracy, number of localized nodes and computing time. The comparative analysis has shown that FPA is more proficient in determining the coordinates of nodes by minimizing the localization error as compared to FA, PSO and GWO.

S.R.Sujatha, et.al, (2017), have proposed a hybrid optimized method using Dynamic weight partial swarm optimization, Linearization method and Differential Evolution algorithms. In [3] the author proposed DE algorithm which is used along with DWPSO to obtain the better localization accuracy. Simulation results indicate that this method provides smaller localization error, higher localization accuracy and better stability performance in DWPSO compared to LM.

Meng Joo Er, et.al, (2016), recommended that the node localization have become one of the most important research issues in wireless sensor networks (WSNs). Traditionally, the hop-count-based localization methods only work on integer value and in case of all node's one-hop neighbours it have a same distance estimation. In [4] the author proposed a new novel approach hop-count-based expectation of distance (HCED) algorithm.. It also show that the HCED algorithm requires fewer anchors and provides better performance compared to other localization algorithms. The amount of improvement is also proportional to the node density.

Eva Tuba, et.al, (2016), represented a class of ad hoc networks for which the localization problem is emphasized. Since, without the location information the collected data are usually not usable. In case of. In [5] the authors have proposed localization algorithm based on recent fireworks swarm intelligence metaheuristic. This is the enhanced fireworks algorithm for solving wireless sensor network localization problem. Further from the test of this proposed localization algorithm by using standard benchmark data have proved to be superior by considering most performance indicators that included average localization error.

Chin-Shiuh Shieh, et.al, (2016), have recommended the localization of sensor nodes as an important problem in many applications. Normally in localization problem, the unknown position nodes will determined their location through information of three or more anchors. In [6] paper the author have compared some popular heuristic optimization methods. The simulation results show that even when the population size is small the convergence of PSO, GA and GWO give good results. But the GA method is inaccurate in case of having large max iteration. FA and BSO are recent heuristic optimizations but the performance of these methods in node localization is not really impressed. An improvement in localization error function also has been proposed to enhance the number of nodes that can be localized, but it still keeps the efficiency in execution time as shown in the simulation results.

Suman Bhowmik, et.al, (2016) have considered that there are many applications for which location information plays a crucial role. The problem of finding the information of location by a sensor node is called the localization problem. The major challenge is to determine the location of unknown nodes based on the known location of other nodes. In [7] the author proposed a range-free localization scheme based on fuzzy-logic approach.. The reason of proposing a new Fuzzy based algorithm which use RSS information is to localize sensor node. So that nodes does not need any extra complicated hardware to obtain distances like Angle Of Arrival, Time Of Arrival, or Time Difference Of Arrival. Extensive simulation result confirms an improvement of localization performance over existing algorithms. For performance evaluation we have simulated the proposed algorithm using the well known WSN simulator Castalia V3.2 which is based on Omnet++ V4.4.1. At the radio layer CC2420 specifications have been used.

IV. Proposed Methodology

Node localization is the process of identifying the position coordinates of unknown nodes which can be achieved by using the distance information, and radius of wireless communications. Node localization is required to report the origin of events, assist group querying of sensors, routing and to answer questions on the network coverage. The measured distance between unknown node and anchor node is not the real value. So unknown node position estimation can be treated as a kind of optimization, which minimizes the target function of localization error of anchor node to find out the position coordinate of unknown node. The major factor is a ranging error that affects the location error of the unknown node, and decrease the maximum error can meritoriously improve the accuracy of localization. So, node localization have become one of the fundamental challenges in wireless sensor network. The technique is proposed in this research work, which is based on the distance threshold technique. In the proposed technique, the beacon's are inserted in the network. These beacons are flood the beacons signals in the network and range of the beacon signals are defined. The nodes which come into the defined range will respond back to beacons. When any of the beacon receive the respond message from the two nodes then that node is considered as the localized node. In the research work, it has been analyzed that when the threshold distance is increased then the node localization is increased at steady rate. In the technique of base paper, the angle of trajectory is also checked with the distance. Any of the beacon when flooded into the network and nodes which are on the defined angle and on the given range that nodes get localized. The proposed technique is more simple with reduce the time for the node location in under water acoustic networks

Proposed Algorithm

Input : Number of nodes, Number of beacons

Output : Localized Nodes

1. Deploy wireless network with finite number of sensor nodes
2. N=number of beacons in the networks
3. R=Range of beacon
4. Calculate Distance ()
 - 4.1 For i=1 to n
 - 4.2 For j= i+1 to n
 - 4.3.Distance(i)= $\sqrt{((X1 - X)^2) - ((Y1 - Y)^2)}$
5. For i=1 to n

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5.1 If (Distance (i)> R)
5.2 Localization (i)=Node (i)
5.3 else
5.4 Node(i)=Node(i)
6. If (Localized(i)== for two beacons)
6.1 Node localized =Node localized+1;
6.2 else
6.3 Node localized=Node Localized
7. end
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Parameters for Localization

In this section we present the most typical parameters to classify different techniques.

i) Accuracy: Accuracy is very important in the localization of wireless sensor network. In military applications higher accuracy is typically required, such as sensor network deployed for intrusion detection. However, the required accuracy may not be lower for commercial networks which may use localization to send advertisements from neighbouring shops.

ii) Cost: Cost is a very challenging issue in the localization of wireless sensor network. There are very few algorithms which give low cost but those algorithms don't give the high rate of accuracy.

iii) Power: Power is necessary for computation purpose. Power play a major role in wireless sensor network as each sensor device has limited power. Power supplied by battery.

iv) Static Nodes: All static sensor nodes are homogeneous in nature. This means that, all the nodes have identical sensing ability, computational ability, and the ability to communicate. This is also assumed that, the initial battery powers of the nodes are identical at deployment.

v) Mobile Nodes: It is assumed that a few number of GPS enabled mobile nodes are part of the sensor network. These nodes are homogeneous in nature. But, are assumed to have more battery power as compared to the static nodes and do not drain out completely during the localization process.

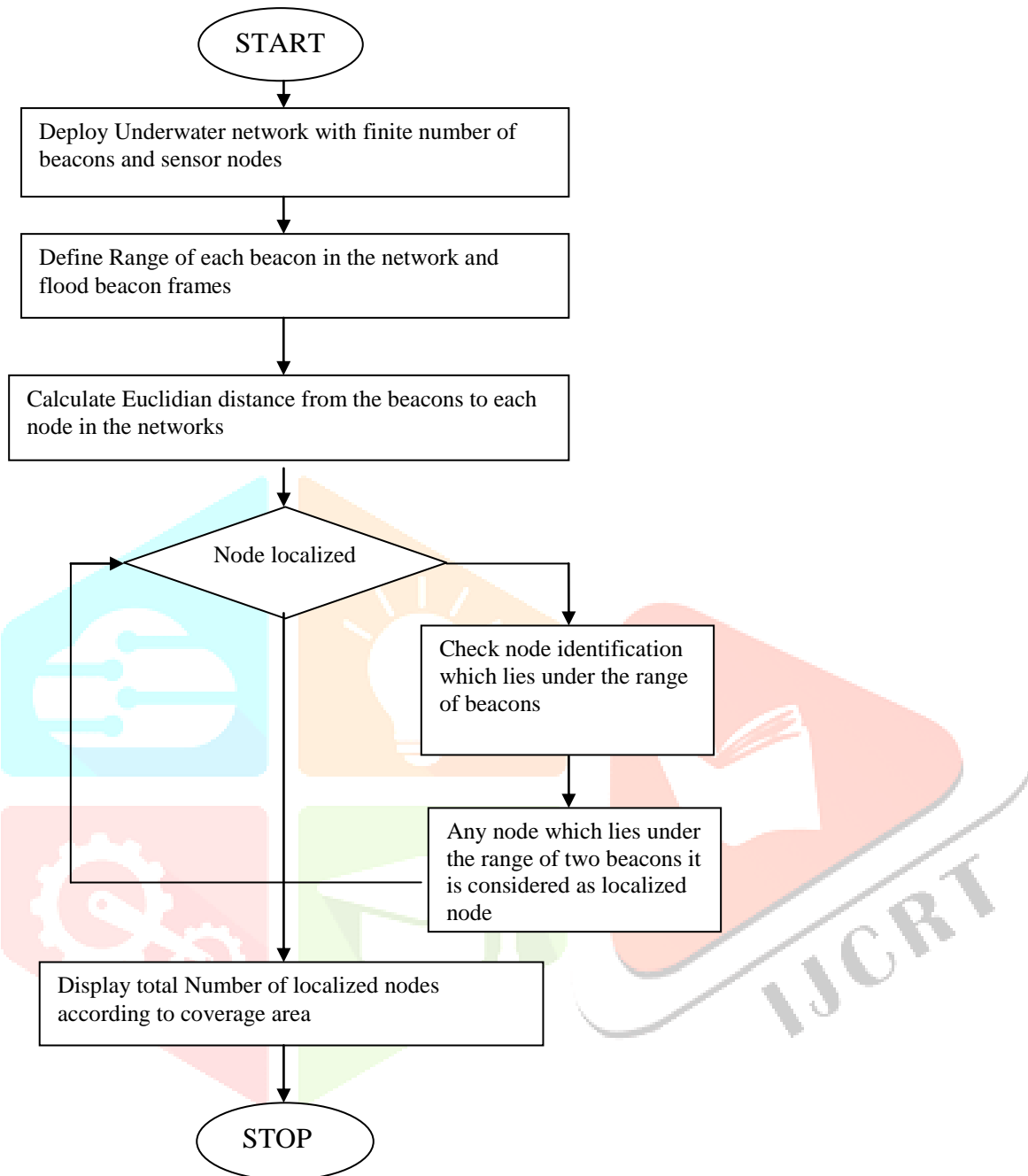


Figure 2:Proposed Flowchart

V. Results and Discussion

The proposed and existing algorithms are implemented in MATLAB by considering parameters given in table 1

A. Parameter	B. Value
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C. Number of nodes	D. 100
E. Frequency	F. 2.4 GHz
G. Antenna type	H. Omi-directional
I. Area	J. 800*800 meter
K. Number of beacons	L. 4
M. Data Link layer	N. LL
O. Queue	P. Priority queue
Q. Range of beacons	R. Variable

Table 1: Simulation Table

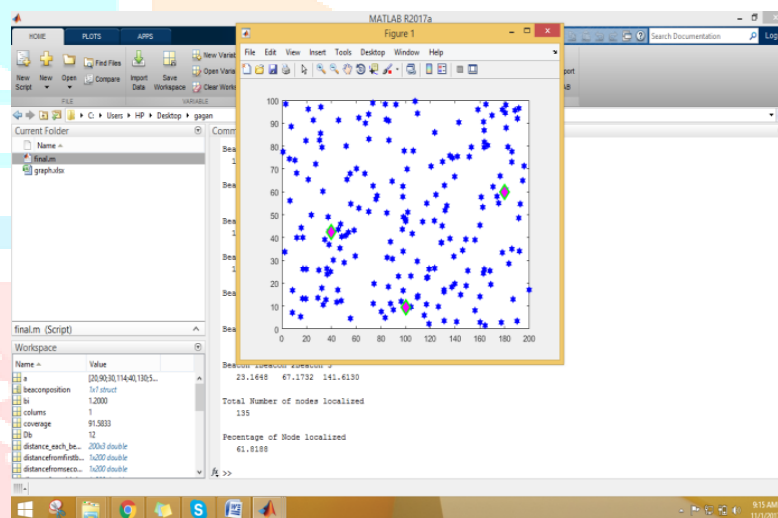


Figure 3. Network deployment

As shown in Figure 3, the network is deployed with the finite number of sensor nodes and in the network beacons are inserted and these beacons can change its location horizontally. The coverage area of the beacons are defined in the last figure which can localize the sensor nodes

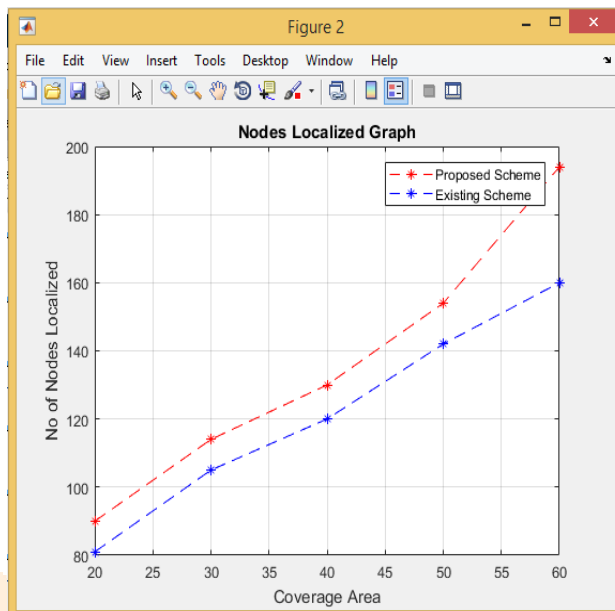


Figure 4. Performance Analysis of proposed technique

As shown in Figure 4, the performance of the proposed technique is analyzed and it is been analyzed that when the coverage area of the beacon get increased then the node localization is increased at steady rate.

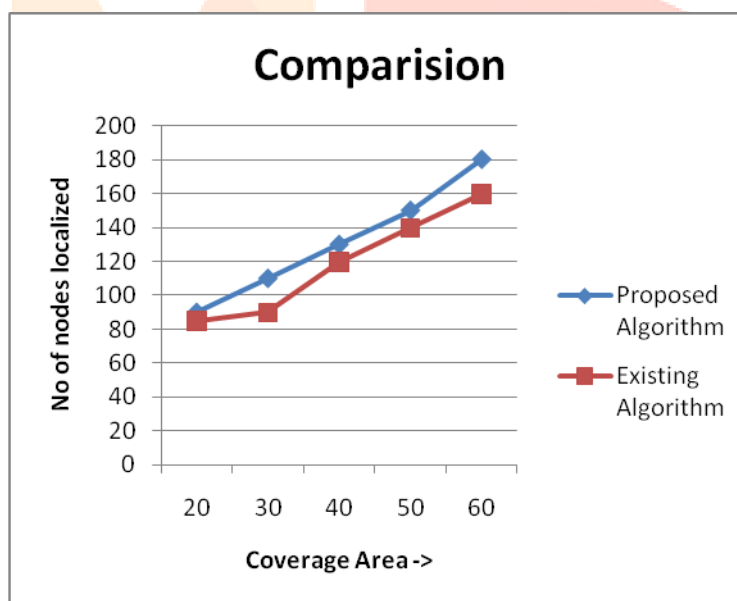


Figure 5. Comparison of Techniques

As shown in Figure 5, the proposed and existing techniques are compared and it has been analyzed that proposed technique performs well in terms of number of nodes get localized

VI. CONCLUSIONS

Node localization is also one of the problems in WSN. It is the process of identifying the position coordinates of unknown nodes which can be achieved by using the distance information, and radius of wireless communications. Node localization is required to report the origin of events, assist group querying of sensors, routing and to answer questions on the

network coverage. In the base paper, technique of distance and angle is proposed which estimate location of the sensor node. In this work, improvement in the existing technique is proposed which is based on threshold distance technique. The proposed technique can increase accuracy of node localization.

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REFERENCES

- [1] Sukhwinder Sharma, Rakesh Kumar Bansal, Savina Bansal, "Issues and Challenges in Wireless Sensor Networks", 2013, IEEE International Conference on Machine Intelligence Research and Advancement, vol 4, pp.58-62
- [2] Ranjit Kaur, Sankalp Arora, "Nature Inspired Range Based Wireless Sensor Node Localization Algorithms," 2017, Springer, vol.4, pp7-17
- [3] S.R.Sujatha, Dr.M.Siddappa, "Node Localization Method for Wireless Sensor Networks Based on Hybrid Optimization of Particle Swarm Optimization and Differential Evolution," 2017, IOSR-JCE, vol.19, pp.7-12
- [4] Meng Joo Er, Shi Zhang, Baihai Zhang, Chiang-Ju Chien, and Feifan Wang, "A novel localization approach towards anchor to node in wireless sensor networks," 2016, IEEE, vol.4, pp.143-148
- [5] Eva Tuba, Milan Tuba, Marko Beko, "Node Localization in Ad Hoc Wireless Sensor Networks Using Fireworks Algorithm," 2016, IEEE, vol.3, pp. 130-137
- [6] Suman Bhowmik, Rajib Kar, Chandan Giri, "Fuzzy Node Localization in Wireless Sensor Network," 2016, IEEE WiSPNET 2016 conference, vol.8, pp.1112-1116
- [7] A. Caiti, P. Felisberto, T. Husoy, S.M. JesusI. Karasalo R. Massimelli, T.A. Reinenk and A. Silva, "UAN - Underwater Acoustic Network", IEEE, vol.7, pp.46-53, 2011.
- [8] Manjula.R.B, Sunilkumar S. Manvi, "Issues in Underwater Acoustic Sensor Networks", International Journal of Computer and Electrical Engineering, vol.3, pp.101-110, 2011.
- [9] J.H. Cui, J. Kong, M. Gerla, and S. Zhou, Challenges: Building scalable mobile underwater wireless sensor networks for aquatic applications, IEEE Network, Special Issue on Wireless Sensor Networking, pp. 12-18, 2006.
- [10] X. Yang, K.G. Ong, W.R. Dreschel, K. Zeng, C.S. Mungle, and C.A. Grimes, "Design of a wireless sensor network for long-term, insitu monitoring of an aqueous environment", vol. 11, pp. 455-472, 2002.

- [11] Vasilescu.K.Kotay and D.Rus, Data Collection, Storage and Retrieval with an underwater Sensor Network, ACM SenSys, vol.5 pp.154-165, 2005.
- [12] I. F. Akyildiz, D. Pompili, and T. Melodia, Underwater acoustic sensor networks: Research challenges, Ad Hoc Networks, vol.7, pp. 257–279, 2005.
- [13] Q. Zhang , and M. Cheng, “A node localization algorithm for wireless sensor network based on improved particle swarm optimization”, Lecture Notes in Electrical Engineering, 2014, vol. 237, pp.135-144
- [14] S.R.Sujatha, Dr.M.Siddappa, “Node Localization Method for Wireless Sensor Networks Based on Hybrid Optimization of Particle Swarm Optimization and Differential Evolution,” 2017, IOSR-JCE, vol.19, pp.7-12

