IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 17, Issue 3, Ver. IV (May – Jun. 2015), PP 58-64
www.iosrjournals.org

A Novel Three-Dimensional Adaptive Localization (T-Dial) Algorithm for Wireless Sensor Networks

Harsimrankaur Dr. Rohit Bajaj
Post graduateStudent Chandigarh Engg College, Landran,India
Associate Professor Chandigarh Engg College,

Abstract: *Wireless Sensor Networks is one of the most important area of research. Over the time, WSN is expanding its reach from scientific research and monitoring to industrial as well as military operations. With its increasing applications in various areas of use it is becoming important to consider the location of deployment form where the sensors can generate the desired results The proposed algorithm for WSN localization is designed to connect the WSN nodes during the network initialization phase. The proposed algorithm works in three primary phases: Neighbor Formation, Group Formation and Localization Error Corrections. The proposed model maintains the neighbor tables on each table for the nodes within the transmission range. The group formation module connects the non-anchor nodes with the anchor nodes to divide the WSN network in the smaller manageable groups. The localization error correction is the process of recalling the missing nodes, which sent broadcast during the initial phase, but went disconnected after the final connectivity phase, called group formation. The proposed model results have been obtained in the form of localization rate, localization error and positioning rate. The experimental results have shown the significance improvement in the results obtained from the proposed model in comparison with the existing model.*
General Terms: *Localization Algorithms, Wireless sensor networks, WSN cluster initialization.*
Keywords: *DV-HOP, distance vector, survey, localization, neighbor formation, connectivity, WSN, edge nodes.*

I. Introduction

In the present era of Research and Technological trends , Wireless Sensor Network has now become one of the substantial area of research. The Wireless Sensor Network have fascinated the interest of Scientific society to be the forthcoming technology for sensing the surroundings wirelessly. The WSN technology is evolving rapidly and is being extensively used in several applications worldwide. The eminent applications of WSN encompasses Monitoring and Sensing environmental conditions, Technical applications,Therapeuticapplications, natural calamities Relief operations ,aids in Observing the activities of sensitive surface and so forth.

The wireless Sensor Network turn out into prominent Research Field by the virtue of recent gain in electronics and wireless communication which plays vital role in the development of devices termed as Sensors that are smart, microscopic,inexpensive ,consumes less power and have proficiency of performing various functions. These sensors are an integral component of WSN that sense and accomplishes computation. The most significant feature of Sensor is to gather sensory information ,process it and transfer it towards the destination .A Wireless Sensor Network can be defined as an adhoc network that comprises cluster of sensor devices that are deployed over some geographical region to monitor and record the physical conditions of atmosphere and further coordinate the assembled data at principal location known as Base Station.

The most essential aspect of wireless sensor network is Self localization. During the process of data transmission among the sensor nodes , it is desirable to know the location of sensor nodes in a network. For acquiring this kind of knowledge, Localization Techniques are applied in Wireless sensor network.The process of estimating geographical location of sensor node is known as Localization. An approach that discovers and creates spatial relationships between sensor nodes . Localization is becoming the centre of attraction for research in wireless sensor network as data recorded from sensor is only valuable when the location of sensor is known.

The subject of localization is very crucial and challenging in low –priced and low data rate network which utilizes large amount of sensor nodes because the aggregated data will be vague if the location of sensor nodes are not known so it becomes necessary to locate each and every node of the network with reference to related coordinate system. The localization is required for applications such as management of inventory ,monitoring environment ,checking road traffic, intrusion detection, precision farming ,medical management, surveillance of forest fire etc. For instance, in forest area,thousands of sensor nodes are deployed by aircraft for monitoring varied forest domain. Accordingly, adequate algorithm that need information from WSN nodes to locate specific nodes are highly desirable .A way for finding location of sensor nodes in a network is to equip nodes with built in GPS receiver. These methods provide high positioning accuracy but are avoided due to excessive consumption of energy and are expensive for estimation location.The localization assists in energy

efficient routing,arrangement of topology, clustering, distribution of sensor nodes, load balancing of network and for tracking objects.

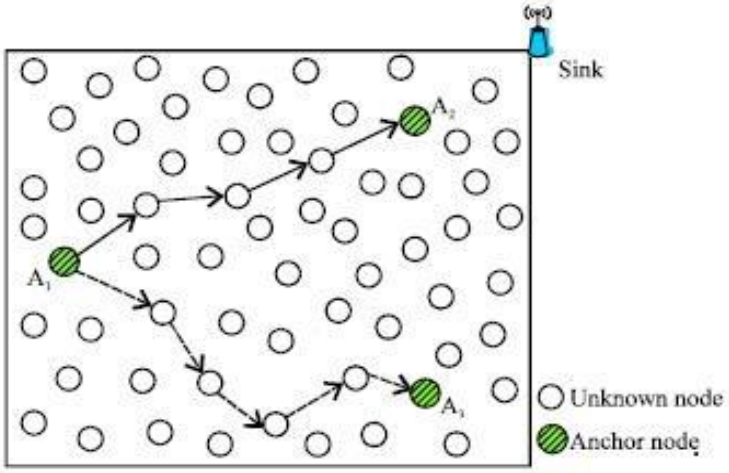

Fig 1: Localization Process In Wireless Sensor Network.

The primary weak-point of localization algorithm is Localization errors that results in low positioning accuracy . The difference between the exact location and the predicted location of sensor node is specified as Localization errors.The need of hour is to develop efficient localization algorithms that cope up with issue of localization errors and provides accurate information about the location of sensor nodes.

II. Literature Survey

A new 3-D localization algorithm based on DV-Hop algorithm was proposed by Chen.et.al.which enhanced the accurate location information of the sensor nodes.The algorithm overcomes the shortcomings of the traditional DV- Hop algorithm.

.Gayan.et.alrefined the DV-Hop algorithm through re-evaluation of anchor location which adopted the DV-hop algorithm for the computation of location of unknown anchors. The proposed algorithm improved position accuracy.Bal.et.al.launched a preliminary WSN localization testbed for an automation surroundings and examined various threats and necessities in this extent. The planned work consists of inspection of multiple wireless sensor networks concerning Zigbee ,Wifi RFID and RFID ,their unification and the 3-D localization.

Pei.et.al.proposed an anchor-free localization scheme for mobile targets in coal mine wireless sensor networks that depends on Multidimensional Scaling(MDS) and Rank Sequence. The scheme has improved the efficiency of localization and is more powerful in buried mines.

Kumar.et.al.designedHPSO(H-best Particle Swarm Optimization) algorithm which discovers the correct coordinate instantly and BBO(Biogeography Based Optimization) algorithm which determines the node coordinates more precisely.Tang.et.al. presented localization algorithm that depends upon mobile beacon node whose base stands upon the original DV-Hop algorithm. RCDV Hop localization algorithm was proposed by Wu, et.al.which decreases the distance estimation error between unknown node and the anchor nodes and reinforces the definite location information about the sensor nodes.

Raghavendra V. kulkarni, et.al.implemented Particle Swarm Optimization approach which focus on WSN problems such as localization of node,clustering,data gathering and optimal distribution of nodes.Shekofteh, et.al.appliedtabu search and Simulated Annealing for the development of localization algorithm.Qing Jiang Shi, et.al. presented Sequential Greedy Optimization algorithm that is too convenient for localization in distributed wireless sensor networks.

Li,Mo, et.al.projected Rendered Path Protocol that is a range-free technique for exploring sensors with fixed number of source in an Anisotropic network that contains holes in it.A Range free localization algorithm (LAEP) that implements expected hop progress which is used for the prediction of the sensor node position waspproposed by YunWang, et.al.

Author .Kulaib .et.al introduced an upgraded DV hop algorithm which widens the efficiency of DV hop algo without any notable growth in computational complexity.The first algo makes the use of k-means technique followed by the repositioning of node.The second algo also serves as the basis upon k-means technique which is followed by the division of cluster and Direction of Arrival (DoA) localization. RSSI based localization scheme in Wireless Sensor Network that diminishes the position errors and enhances accuracy with the help of distinct models and approaches was scheduled by Mistry.et.al.The authors spotlight on how to make an algorithm scalable and improve the energy efficiency in sensor network by providing key management and verification.

An improved localization algorithm that is based upon genetic algorithm was proposed by Peng.et.al.In this paper the writers linked the optimization mechanism to deal with the problem of localization in Wireless sensor network and suggested GADV- hop algo for finding unknown nodes. The GADV-Hop algo improves the accuracy of location.

Betta .et.al.recommended asimple calculation technique that is based on frequency diversity for the improvement of localization in wireless sensor network.The first measurement method that establishes on the linear optimizations of RSSI values were acquired on various frequencies.It is also used for the analysis of Zigbee case in outdoor and domestic scenario.

Rosales.et.al. assessed the performance of range-free, range-based and fuzzy based decision. Alteration of an algorithms were done by providing weights to equivalent matrix for better correctness.The performances metrices under consideration were accuracy, computational complexity and accuracy.The modified algorithm improved localization.

Lou .et.al.figures out the effects of wormhole attack on DV-Hop localization algo and presented a label based DV –Hop Secure localization algo that safeguards from the wormhole attack.Zhang.et.al.developed a novel hybrid that applies range-based feature RSSI and Range –free feature Hop-size for attaining economical 3-D localization.

III. Proposed Algorithms

Algorithm1- Neighbor Formation

The process of neighbor formation begins after initializing of sensor network and the sensor node form neighbor with the nodes that are present in direct transmission range.We assume that all the sensor nodes are deployed randomly in heterogeneous network. All the nodes broadcast data to their neighboring noes without any acknowledgement.

Algorithm

1. Initialize all the nodes N in the network and all the nodes will transmit their data in the cluster to the Sink, neighboring nodes or the nodes that are in direct transmission range.

Transmission Radius: R (=250 meters), denotes the direct range

2. Node i out of Node N will send neighbor formation message to all the other nodes and accept the j coordinate and the nodes that are in the range of neighbors.

$$\mathbf{Di}(i,j) = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2 + (z_i - z_j)^2} \qquad (1)$$

$$\int_0^N \mathbf{transmit}(\mathbf{x},\mathbf{y}) \rightarrow \mathbf{i} \quad , \ \mathbf{if\ Di} < R \qquad \mathbf{(2)}$$

3. Node I will frame up the coordinate array and estimate the distance between every other nodes.
4. Enable the mechanism of Neighbor Formation for all the nodes , neighbor table is formed which comprise of all the information about the neighbors in the respective neighbor table.

Algorithm 2-Localization Group Formation

Wireless sensor network Localization is the process of establishment of the inter-connections between the sensor nodes.The sensor node localization process connects the nodes with other nodes within the transmission range of each node. After the process of neighbor formation table completes,the neighboring nodes are further connected and are arranged in the groups to depict which nodes fall under the particular region. Thegroup formation facilitates the flexible and easy management of the nodes in near connections and permits other processes such as performing routing, clustering, etc

Algorithm

1. Select an Anchor node randomly.
2. Each Anchor node will compute the distance of all nodes from itself.
3. The Anchor node connects to the node with minimal hop-count and average distance.
4. Lastly, the anchor node will relay its function to other node with highest degree of connections on one-hop distance.

Algorithm 3- Edge Node Marking

The edge nodes are dead ends that exist on the edge in the network. These dead ends are to detected and marked effectively. If any node in the network forward data towards the dead ends consequently the data will not reach anywhere.

Algorithm

1. The Anchor nodes validate the location of client nodes linked with them.
2. Anchor node calculates the distance of all the nodes on the basis of angle information.
3. The extreme nodes in the network will be marked as Edge Nodes.

Algorithm 4- Localization Error Recovery

The nodes that are updated during the initial setup phase of localization, if found missing during the final setup phase, such nodes are listed as the localization error points. Such localization error points are updated and the search query will be sent from all of the anchor nodes to find the localization error points. If the reply is received from the error point, the node location is restored and marked as the normal node.

Algorithm

1. Anchor nodes load the current nodeand the initial learned node information table into the memory.
2. Anchor nodes check the locations of the existing nodes received during the initial phase and the final phase.

i = Linear $_0\int^N$

distance=$f_x(i,_0\int^N j)$ if missing point found

distance $= \infty$ if missing doesn't reply till wait period

$$f_x(i,j) = \sqrt{(x_i - x_i')^2 - (y_i - y_i')^2}$$

3. Anchor nodes query to lost nodes to the other anchor nodes and Non reported nodes would be marked as Localization error point and will transmit the message for the localization error points and if localization error points respond then their location will be compared against other Anchor nodes

a. Membership of the most suitable anchor node would be assigned.
Else

b. The localization error point will be marked as permanent localization error point.

4. If any localization error point sends request to anchor node

a. Anchor node will denotify the permanent tag from the reporting localization error point.

b. Review its location, calculate parameters and assign the membership of the most suitable anchor node.

IV. Simulation

The simulation scenario for this project is based upon the randomly deployed topology consisted of adequate number of nodes. The total 55 nodes have been taken in the simulation scenario. The nodes have been manually positioned with the random coordinates to simulate the near-to-real scenario. In the near-to-real scenarios, the nodes are being deployed by the pressure canons or through from the aerial vehicles in the case of hilly areas or other areas with dicey approaches. The standard node configuration has been selected from the nodes in the topology. The simulation scenario has been prepared using the NS2 simulator. The NS-2 simulation is known as the network simulator version 2, which has been written in C/C++ solely for the windows platform.

V. Experimental Result

The results have been obtained from the proposed model in the form of various performance parameters. The performance parameters of localization coverage rate and the location error rate are the most deciding parameters in order to evaluate the quality of the proposed model. Positioning rate and positioning coverage are the parameters used for the evaluation of positioning accuracy of the nodes in the wireless sensor network.Positioning deviation is the variation between original location and estimated position for the unknown nodes. Positioning deviation rate is the average positioning deviation. It refers to the rate of the position deviation of all nodes to the communication radius.The positioning rate of the proposed model is quite effective in the proposed model, which shows the effectiveness of the proposed model in accurately connecting the sensor nodes during the initial setup phase.

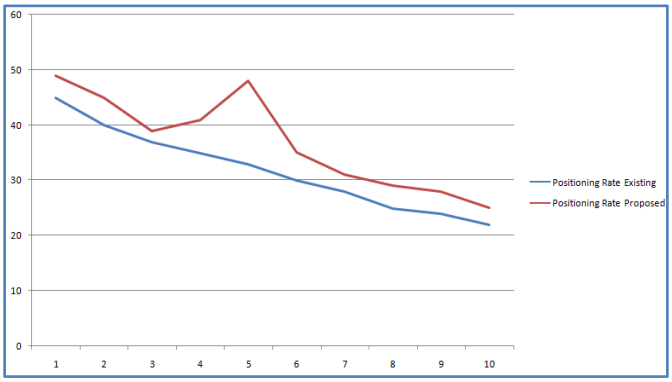

Fig 2: Positioning Rate

As shown in Fig.-2, the data was compared for localization accuracy in the case of various numbers of anchor nodes. With the increase in anchor nodes, localization accuracy is more correct.

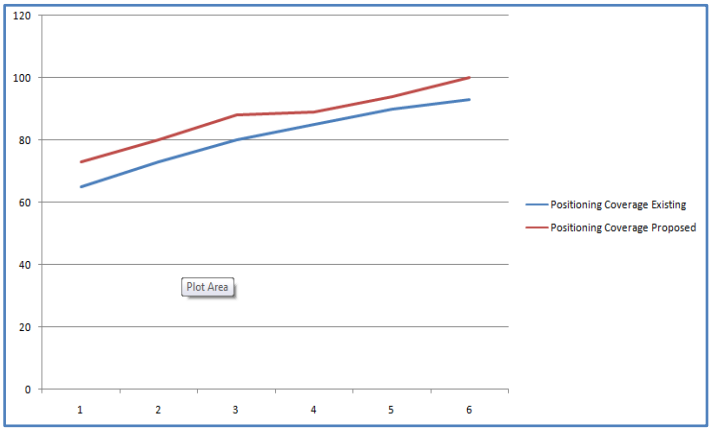

Fig 3: Positioning Coverage

The proposed algorithm reduces positioning error thus making positioning coverage better in Fig 3.If the communication radius increases, network node localization coverage more widely. The positioning coverage is the parameters which indicate the coverage accuracy across the given area where the WSNs are deployed.The higher positioning coverage indicates the effectiveness of the proposed model. The proposed model has shown the significant difference than the existing model in the case of positioning coverage.

Compared with the existing algorithm , the localization coverage rate also increases significantly as shown in Fig 4. The localization coverage is the process of connecting the sensor nodes within the neighbor group and further connecting them with the appropriate anchor node to divide the sensor network in the easy manageable groups. The localization coverage indicates the number of nodes correctly identified, connection and assigned to the anchor node groups. The localization coverage of the propsoed model is significantly better than the exsiting model, which again proves the effectivenss of the proposed model.

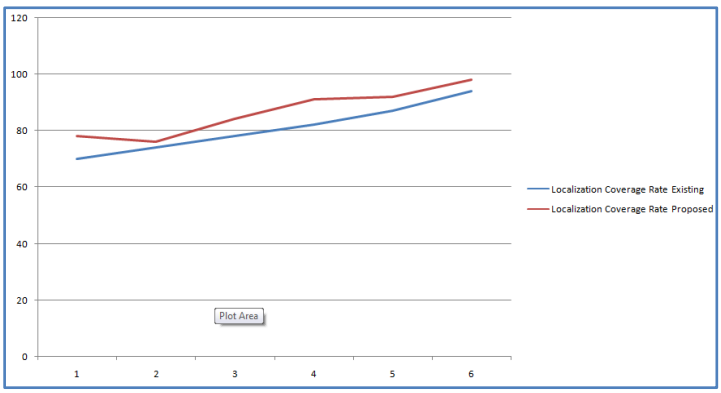

Fig 4: Localization Coverage

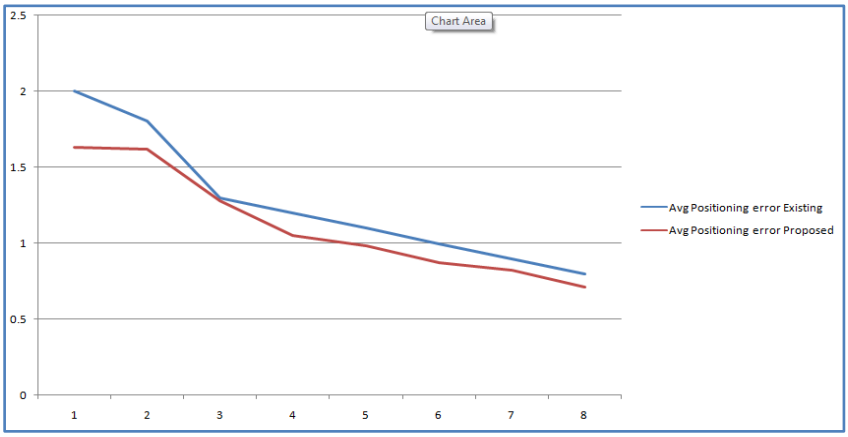

Fig 5: Localization Error

With the increase in the number of connected nodes with the anchor nodes, the average positioning error decreases, hence, localization accuracy also shows improvement. The proposed model is based upon the three dimensional coordinate model, which computes the distance of the nodes according to the height in the sensor positioning also.The proposed model has proved to be efficient in the case of localization error, which improvises the resulting accuracy of the proposed model in producing the errors during the localization phase.

VI. Conclusion

The wireless sensor network localization is the process of initial connectivity, which consists of the tasks like neighbor formation, topology building, anchor node selection, edge node marking, etc. The effective localization algorithm can connect the nodes with high accuracy hence with less localization errors. The localization errors are the errors produced due to falsely connected or not connected nodes in the wireless sensor network during the initial setup phase. These localization errors further become the reasons of connectivity holes, longer routing paths, less coverage and poor connectivity.The proposed algorithm is the three dimensional adaptive localization (T-DiaL) algorithm which carries various positive localization features. The proposed model has performed better than the existing DV-Hop algorithm for WSN localization. The proposed algorithm has performed better in terms of localization errors and coverage.

VII. Future Work

The proposed model is applicable on WSN with any topology or application. But the most suitable application for the proposed model is the random-way point topology. The largely deployed WSNs are deployed in the random topologies, hence the proposed algorithm is ready-to-fit solution for such situation. The proposed algorithm can be tested with static and geometrical topologies in the future. Also the proposed algorithm can be secured using some security protocols in order to improve the performance of the proposed model under attack situations.

References

[1]. Chen, Manju, Xiangqian Ding, Xiaodong Wang, and XiaoweiXu. "A novel three-dimensional localization algorithm based on DV-HOP." In Signal Processing, Communications and Computing (ICSPCC), 2014 IEEE International Conference on, pp. 70-73. IEEE, 2014.Ding, W. and Marchionini, G. 1997 A Study on Video Browsing Strategies. Technical Report.University of Maryland at College Park.

[2]. Gayan, Samiru, and Dileeka Dias. "Improved DV-Hop algorithm through anchor position re-estimation."In Wirelessand Mobile, 2014 IEEE Asia Pacific Conference on, pp. 126-131.IEEE, 2014.Tavel, P. 2007 Modeling and Simulation Design. AK Peters Ltd.

[3]. Lazos, Loukas, and RadhaPoovendran. "HiRLoc: high-resolution robust localization for wireless sensor networks." Selected Areas in Communications, IEEE Journal on 24, no. 2 (2006): 233-246.Forman, G. 2003.An extensive empirical study of feature selection metrics for text classification. J. Mach. Learn. Res. 3 (Mar. 2003), 1289-1305.

[4]. Wu, Jiawei, Jinming Yu, AijunOu, Yiming Wu, and WujunXu. "RCDV-Hop Localization Algorithm for WSN." In Wireless Communications, Networking and Mobile Computing (WiCOM), 2012 8th International Conference on, pp. 1-4. IEEE, 2012.Y.T. Yu, M.F. Lau, "A comparison of MC/DC, MUMCUT and several other coverage criteria for logical decisions", Journal of Systems and Software, 2005, in press.

[5]. Li, Mo, and Yunhao Liu. "Rendered path: range-free localization in anisotropic sensor networks with holes."In Proceedings of the 13th annual ACM international conference on Mobile computing and networking, pp. 51-62.ACM, 2007.

[6]. Kulkarni, Raghavendra V., and Ganesh Kumar Venayagamoorthy. "Bio-inspired algorithms for autonomous deployment and localization of sensor nodes."Systems, Man, and Cybernetics, Part C: Applications and Reviews, IEEE Transactions on 40, no. 6 (2010): 663-675.

[7]. Liu, Yong, Yu Hen Hu, and Quan Pan. "Distributed, robust acoustic source localization in a wireless sensor network." Signal Processing, IEEE Transactions on 60, no. 8 (2012): 4350-4359.

[8]. Jiang, Joe-Air, Xiang-Yao Zheng, Yu-Fan Chen, Chien-Hao Wang, Po-Tang Chen, Cheng-Long Chuang, and Chia-Pang Chen. "A distributed RSS-based localization using a dynamic circle expanding mechanism." Sensors Journal, IEEE 13, no. 10 (2013): 3754-3766.

[9]. Bal, Mert, Henry Xue, WeimingShen, and Hamada Ghenniwa. "A Test-Bed for Localization and Tracking in Wireless Sensor Networks."In SMC, pp. 3581-3586. 2009.

[10]. Shekofteh, S. Kazem, M. B. Khalkhali, M. H. Yaghmaee, and HosseinDeldari. "Localization inwireless sensor networks using tabu search and simulated annealing." In Computer and Automation Engineering (ICCAE), 2010 The 2nd International Conference on, vol. 2, pp. 752-757. IEEE, 2010.

[11]. Pei, Zhongmin, Zhidong Deng, ShuoXu, and Xiao Xu. "Anchor-free localization method for mobiletargets in coal mine wireless sensor networks." Sensors 9, no. 4 (2009): 2836-2850.

[12]. Kumar, Anil, ArunKhosla, Jasbir Singh Saini, and Satvir Singh. "Meta-heuristic range based node localization algorithm for Wireless Sensor Networks." InLocalization and GNSS (ICL-GNSS), 2012 International Conference on, pp. 1-7. IEEE, 2012.

[13]. Tang, Liping, Wanfang Chai, Xuanguang Chen, and Jianbin Tang. "Research of WSN Localization Algorithm Based on Moving Beacon Node."In Circuits, Communications and System (PACCS), 2011 Third Pacific-Asia Conference on, pp. 1-5.IEEE, 2011.

[14]. Salman, Naveed, MounirGhogho, and A. Kemp. "Optimized low complexity sensor node positioning in wireless sensor networks." (2014): 1-1.

[15]. A. R. Kulaib, M. Shubair, M. A. Al-Qutayri, "Improved DV-hop Localization Using Node Repositioning and Clustering."(2015),IEEE.

[16]. Hetal P. Mistry, Nital H. Mistry," RSSI based Localization Scheme in Wireless Sensor Networks: A Survey."in 2015 Fifth International Conference on Advanced Computing & Communication Technologies.

[17]. G. Betta, D. Capriglione, D. Casinelli, L.Ferrigno," Experimental Analysis of the Frequency Diversity to Improve Localization in WSNs." In 2015 XVIII AISEM Annual Conference.

[18]. Bo Peng ,Lei Li," An improved localization algorithm based on genetic algorithm in wireless sensor networks." In Springer (2015).

[19]. Bahuoi Zhang, Jin Fan, Goujan Dai ,"A hybrid Localization Approach in 3d WSN.", Hindawi Publishing Coroporation,2015.

[20]. Vargas Rosales, Mass-Schanez, Ruiz Ibarra ,."Performance evaluation of Localization Algorithms for WSN."In International Journal of Distributed Sensor Networks, 2015.

[21]. Maoheng Sun, AzhiTen ," A mobile Localization algorithm based on SPSO Algorithm." In Springer 2015 , pp-65-72.

[22]. Betta G, Casinelli ,Ferrigno L." Experimental Analysis of frequency diversity to improve localization In WSN." In AISEM Annual conference 2015.