Review on Localization Techniques in Wireless Sensor Networks

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ABSTRACT
The wireless sensor networks are prone to various connectivity, coverage and localization issues. All of these three terms are related to the neighbor formation, connectivity and convergence of the sensor networks. There are several existing solutions available against these problems. This paper proposes a survey on the techniques to overcome the issues of coverage, convergence and neighbor formation. The techniques surveyed under this survey are novel three-dimensional localization DV-Hop algorithm (NTLDV-HOP), distance vector hop (DV-HOP), Received Signal Strength Indicator (RSSI) and the correction value based DV-HOP (RCDV) and correction value based DV-HOP (CDV). Under this survey, we have evaluated all of these techniques for their effectiveness in various situations on the basis of theoretical analysis. This theoretical analysis is based upon the critical evaluation of the existing WSN localization techniques mentioned above. These are termed as the best available techniques for the WSN localization, but having different natures and adaptable and effective in scenarios of their adaptation environment.

General Terms
Localization Algorithms, Wireless sensor networks, WSN cluster initialization.

Keywords
DV-HOP, distance vector, survey, localization, neighbor formation, connectivity, WSN.

1. INTRODUCTION
The technological advancements and growth in micro-electro-mechanical systems have provoked the interest of Researchers in the research area of wireless Sensor Network. The term WSN came into light as contemporary class of network due to its reasonable up growth and dis-positioning of sensor nodes in mixture of distinct surroundings.

A Wireless Sensor Network is composed of bundle of sensor nodes that are deployed for sensing the environmental attributes of the world. The essential objective of WSN is to observe, assemble and process the knowledge of sensor nodes with in the network scope. The utmost fundamental element in WSN are Sensors. These sensors are microscopic and low cost devices that stack up some of the properties of the Real World, convert them into computerized form and transfers all the accumulated information through wireless medium to a focal point known as Base Station. The BaseStation acts as midway has abundant computing capacity and extensive storage space that stores, views and interprets the perceived input. BaseStation communicates with end-user by offering Graphical User Interface.

WSN provide the benefit of handling sensitive data in diverse fields. The well-known applications of WSN are Military Applications, Industrial Applications as well as Household, Disaster Relief operations, in Medical Applications and health care monitoring in the form of Body Area Network, Monitor activity of Sensitive area, Avalanche prediction and so on. For instance the sensor nodes are concealed under bed at various intensities for gathering climatic conditions, pressure and additional form of information for noticing the movement of Snow.

The Localization in WSN has captivated the interest of Research Workers over the few years. The Localization supports different activities in WSN such as Distribution of Sensor Nodes, Routing, Managing Network, Topology Formation, Event Report and Identification and Tracking of Objects. The WSN applications can't succeed if users are unable to collect the exact position information of sensor nodes. Therefore how to determine the topographical location of sensor nodes allocated in a network is often cited as Localization Problem. The data and information of sensor nodes is of no use if these nodes are not familiar with their geographical positions.

The central concept in Localization Techniques is that some unique class of sensor nodes that have knowledge about their coordinates are deployed to find the unknown nodes. Such nodes are known as Anchor Nodes/Landmarks. These nodes can be equipped with Global Positioning System(GPS) that send beacons with their coordinates in order to provide assistance to other nodes so they can perform Localization. The GPS is classical approach for localization of nodes but it turns out to be costly.

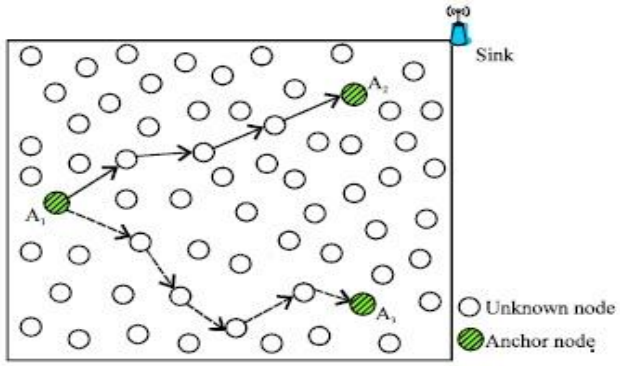

Figure 1: WSN Architecture

Several Algorithms have been projected to deal with Localization Problem. The Limelight of Localization in WSN is to design cost-effective, flexible and effective Localization Algorithms.

The Localization Algorithms are mainly divided in to two types:-

- Range –Based Localization Schemes
- Range-Free Localization Schemes

Range-Based Schemes focus on distance and angle estimation between sensor nodes to determine the location of unlocalized node. The Range-Based schemes accomplish the correct information about the location of sensor nodes but is a high-priced way. Range-Based Schemes include Time of Arrival(TOA),Angle of Arrival (AOA),Time Difference Of Arrival(TDOA)and the Received Signal Strength Indication(RSSI).Range-Free schemes makes the use of connectivity information between unknown nodes and anchor nodes. These schemes are more efficient as no information is needed for distance, angle or range of nodes. Range-Free Schemes have become Centre Of attraction so as to acquire accurate location information.

2. LOCALIZATION ALGORITHM

2.1 DV-Hop Algorithm

DV-hop is standardized range-free localization algorithm which was proposed by D.Niculescu and B.Nath. The key concept of DV-Hop algo is that node transfer information with its neighboring nodes. The distance between unknown node and anchor node are depicted by the product of average per-hop distance and the shortest way among the nodes. Then trilateral method is used to retrieve the location information of node.

The three-dimensional DV-Hop algorithm serves as foundation of original DV-Hop algorithm and adopts 3-D coordinates. The 3-D DV-Hop algo is as follows:-

1. Anchor node broadcast the own location packets to the neighbor nodes.
2. The neighbor nodes forward the hop count information to reach the anchor node after adding 1 to the existing hop count metric to reach the anchor node.
3. The step 1 and step 2 gives the distance in form of hop count between the unknown nodes and every anchor node.
4. Anchor node performs the distance formula and divides the result with number of hops in order to get the actual distance between the anchor node and unknown nodes.
5. Anchor node calculates the maximum likelihood estimation value using edge measurement.

Improved DV-Hop Using Anchor Position Re-Estimation
The working of this algorithm is:-

1. Hop Size and Hop Count of the anchor nodes are found using Step 1 and Step 2 of the DV-Hop algorithm.
2. Known positions of the anchor nodes are recalculated using Step 3 of the DV-Hop algorithm.
3. Step 2 is iterated by modifying the Hop Size to minimize the average of anchor position errors. Through this, the optimum Hop Size Correction is obtained.
4. Locations of unknown nodes are estimated with Step 3 of the DV-Hop algorithm using the modified hop-size after applying the Hop-Size Correction.

2.2 APIT Localization Algorithm

APIT, a range-free localization scheme that needs a composite network where limited percent of these devices are supplied with high-powered transmitters and position information is acquired through the medium of GPS or other techniques. Utilizing Beacons from these anchors, APIT applies a new area based mechanism that accomplish the location estimation by separating the area into trilateral parts between the beacon nodes.

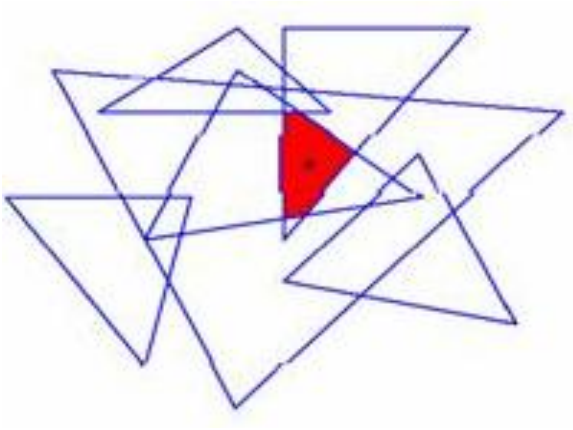

Figure 2: APIT

The existence of node internally or externally in triangular neighborhood grants the node to restrict the space in which it exists. By employing the connections of anchor locations, the width of the predicted space can be decreased to cater exceptional location prediction.

2.3 Amorphous Localization Algorithm

Amorphous algorithm is analogous to DV-Hop algo and the objective is to compute the hop-distance between anchor and unknown nodes rather than calculating linear distance between them. It consists of three steps:-

In the beginning, minimal hop from unknown to beacon node is determined. Then distance is estimated from unknown node to beacon node. Finally, use least square method for location information.

3. RELATED WORK

Chen, et.al. [1] Developed a unique 3-D localization algorithm that depends on typical DV-Hop algorithm which reforms per hop distance for computing the distance between unknown and anchor nodes and adopts Total Least Square procedure for modification of anchor node position variation. Gayan, et.al. [2] enhanced DV-hop algorithm through re-estimation of anchor point in which DV-Hop algo is used for estimation of unknown anchor locations. Lazos, et.al. [3] addressed the issue in which location of deployed nodes is evaluated when security threats exist . To solve this problem a range-free localization algo was proposed that is known as High-Resolution Range-Free Localization(HiRLoc) that permit sensors to decide their position with high resolution without growth in reference marks.The algorithm achieved improvement in location accuracy. Li,Mo, et.al.[4] proposed Rendered Path Protocol which is a range-free approach for finding sensors with stable number of source in Anisotropic Network that consist of holes. Wu, et.al. [5] presented RCDV-Hop localization algorithm for WSN which consist of two components:-RDV and CDV Hop algorithm. RCDV algo reduces the location error between unknown and anchor nodes and contributes in improved location knowledge of sensor nodes by using MATLAB Simulator. YunWang, et.al.[6] projected a range-free localization algo that apply expected hop progress(LAEP) for forecasting the location of any sensor in WSN. QingJiang Shi, et.al.[7] presented Sequential Greedy Optimization algo which is more appropriate for localization in distributed WSN . Raghavendra V. kulkarni, et.al. [8] implemented Particle Swarm Optimization technique in WSN

that address the problem of optimum positioning, clustering, node localization and aggregation of data. Yong liu, et.al. [9] presented a mechanism for distributed source location assessment by adopting acoustic indication in WSN. Joe-Air-Jiang, et.al. [10] improved the localization precision by establishing a different distributed algo with a dynamic-circle expanding structure which creates mathematical connection between unknown node and associating nodes. Bal, et.al. [11] planned a test bed for tracking and localization in WSN which spotlights the emphasis on implementation of WSN and WSN localization in automation surroundings. Shekofteh, et.al. [12] used tabu search and Simulated Annealing to develop a localization algo in which localization concludes in 2 steps:-In the first step Tabu Search is used to estimate the exact location of node .The second step covers Simulated Annealing Algorithm(SAA) that measures the position estimates of nodes that retains flip ambiguity flaw. Pei, et.al. [13]proposed approach for mobile targets in WSN which is anchor-free and established upon Multidimensional Scaling(MDS) and Rank Sequence. Kumar, et.al. [14] illustared an error model for interpretation of perfect position of nodes by reducing the positioning inaccuracy with the support of HPSO and BBO algorithms. Tang, et.al. [15] worked on localization algorithm for mobile beacon node that stands upon popular DV-Hop algorithm. MounirGhogho, et.al. [16] enhanced the performance of Linear Least Square Method by first applying a Weight Least Square algo that advances the efficient position estimation. Secondly, it improves the performance of LLS and WLS by decreasing hypothetical Mean Square Error.

4. ISSUES IN WSN LOCALIZATION

The matter of concern in all localization techniques in WSN is low positioning efficiency that is inaccurate location information of nodes that are placed in network coverage. Another point at issue is Localization Errors .These localization errors also results in inaccurate positioning. These errors occur when nodes are unable to determine the route or pathway that is more optimal. To deal with localization error is vital as it will improve the lifetime of cluster in WSN hierarchy.

5. CONCLUSION AND FUTURE WORK

This survey was conducted on various algorithms like DV-HOP, RCDV, NTLDV-HOP, CDV etc. All of the considered algorithms have been analyzed in depth on the basis of the given parameters and workflow. The proposed system and its possible applications have been studied. Also the merits and demerits has been marked out of the literature survey.

The survey has been performed in order to evaluate the effectiveness of the popular localization techniques. The localization techniques have been undergone in-depth theoretical evaluation under this literature survey. This survey gives the new research gaps and possibilities for the future research to overcome the problems listed in the above studies. The theoretical literature survey has been shaped to provide the fundamental information about the research gaps in the existing WSN localization algorithms. The proposed algorithms have been evaluated on the basis of the connectivity and coverage issues required to be resolved for the effective WSN localization. The NTLDV-Hop seems most appropriate for the solution of maximum of connectivity and coverage issues in the WSNs. The CDV, DV-Hop and RCDV are good for the 2-D localization but not appropriate for 3-D situations, where the sensors are deployed on the slopes.

In the future this survey can be enhanced by implementing the surveyed algorithm in the form of simulation in the uniform sensor network topologies. The algorithm can be tested under various conditions of WSN connectivity. Also these localization techniques can be evaluated on the basis of network performance parameters which are directly affected by the localization method like network load, delay, path selection accuracy in the WSN clusters.

6. 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 in

wireless 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.