Localization Techniques For Wireless Sensor Networks

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ABSTRACT
A wireless sensor network comprises of small sensor nodes each of which consists of a processing device, small amount of memory, battery and radio transceiver for communication. The sensor nodes are autonomous and spatially distributed in an area of investigation. Certain applications and protocols of wireless sensor networks require that the sensor nodes should be aware of their position relative to the sensor network. For it to be significant and to be of value, the data such as temperature, humidity and pressure, gathered by sensor nodes must be ascribed to the relative position from where it was collected. For this to happen, the sensor nodes must be aware of their relative positions. Traditional location finding solutions, such as Global Positioning System, are not feasible for wireless sensor nodes due to multiple reasons. Therefore, new methods, techniques and algorithms need to be developed to solve the problem of location and position estimation of wireless sensor nodes. A number of algorithms and techniques based upon different characteristics and properties of sensor nodes have already been proposed for this purpose.

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

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

1. INTRODUCTION
A Wireless Sensor Network is a network of tiny sensor nodes which communicate with each other through a wireless communication link. Each sensor node typically consists of a processing device, small amount of memory, battery and radio transceiver for communication. These sensor nodes obtain data, e.g. temperature, pressure and humidity, do some local processing, and transmit the data to a neighbor node or a beacon node, which, in turn, may be connected to a central computer where

major processing is performed. As is evident, this central computer may be part of a bigger 1 computer network so that the information can be communicated from this central computer to other

computers which are part of the bigger network.

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,

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

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.

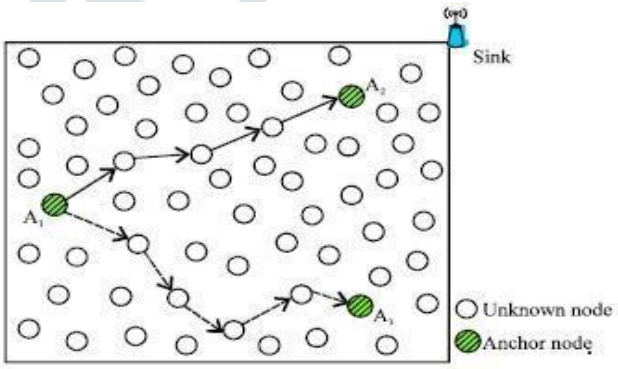

Figure 1: WSN Architecture

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 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.

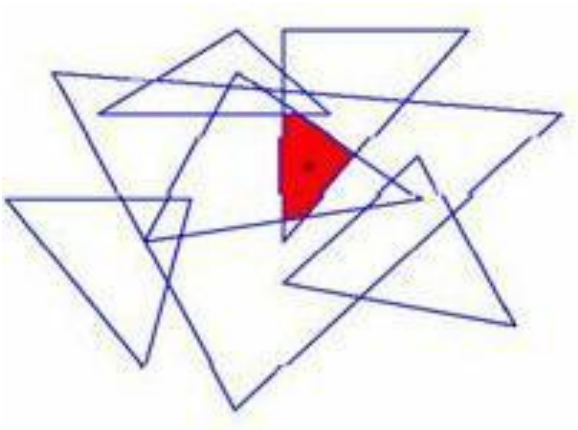

Figure 2: APIT

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.

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