IJCSE International Journal of Computer Sciences and Engineering Open Access
Survey Paper Vol.-7, Special Issue, 5, March 2019 E-ISSN: 2347-2693

Assessment of Localization Performances in Wireless Sensor Networks

Syed Jamalullah.R[1*], V. RajaLakshmi[2]

[1]Department of CSE, Sathyabama Institute of Science and Technology, Chennai, India
[2]Department of CSE, Sathyabama Institute of Science and Technology, Chennai, India

[*]*Corresponding Author: syedjamalullahr@gmail.com*

DOI: https://doi.org/10.26438/ijcse/v7si5.246250 | Available online at: www.ijcseonline.org

***Abstract*—** Wireless Sensor Networks (WSNs) has gained special deliberation among research groups with its assuming technology in wireless communication field. Wireless sensors are contiguously scattered and enthusiastic for recording and monitoring the environmental physical activity such as target tracking, defences, disaster relief and many more. The important function of sensor network is to collect and sends the data to its destination where the awareness of location (Viz. location of data) is a crucial challenge in (WSNs). This kind of information can be availed using localization techniques. For many wireless sensor networks applications, Localization has been regarded as one of the significant and aiding technology. It is also a way to govern the location of sensor nodes and also it is highly favourable to design low cost efficient localization mechanism for (WSNs). This study presented an overview of localization techniques, different classification methods, reviewed important localization algorithm, and summarized their advantages and disadvantages for Wireless Sensor Networks and few possible future research directions.

***Keywords*—** Localization techniques; sensor nodes; range-based localization; range-free localization; wireless sensor networks.

I. INTRODUCTION

The attraction of researchers towards wireless sensor networks (WSNs) has gone unprecedentedly and its applications are a great area of interest for researchers in the recent years. A wireless sensor network (WSNs) consists of spatially distributed autonomous sensors to cooperatively monitor physical or environmental conditions, such as temperatures, sounds, vibrations, pressure, motion or pollutants [1]. Whereas, sensors are small devices which has the capability to sense the physical characteristics of the surrounding environment and also it measures the physical quantity and converts it into a signal which can be verify by an observer or by an instruments or users, it stores the information and compute and sends the data to other devices[2]. However, for variety of users, sensing parameters of sensor can be changed depending upon the requirements. The application of wireless sensor networks includes military applications such as battle field surveillance, machine health monitoring, environment and habitat monitoring, healthcare applications, home automation, traffic control, transport and logistics, entertainment [3] and so on. Some of the (WSNs) applications rely completely on localization. Localization means to determine location of nodes in a network and to compute their positions in some fixed coordinate system [5]. It is the process of finding the positions of nodes as data and information are useless. In fact, without knowing the position of the sensor node, gathered information is valueless. Finally, whatever remains of this paper is sorted out as take after.

II. AN OVERVIEW OF LOCALIZATION TECHNIQUES

Localization is an identification of sensor nodes positions for any Wireless Sensor Networks. Localization is nothing but finding of locations [5]. The role of location is very important in Wireless Sensor Networks (WSNs). The issue of Localization is to locate the geometrical position of the sensor node in the network [3]. The role of Localization is to estimate the position of wireless sensor nodes [6] and also acts as a coordinator between the nodes. If there is any uncertainty occurs for any fixed or mobile devices, Localization process is used. The device whose network entity is known with its location is said to be localization base station [7]. There are different solutions and they are estimated according to size, cost and power consumption. There are considerable amount of research activities to improve Localization in Wireless Sensor Networks.

2.1 Localization Parameters

It is necessary to name parameters for estimating location information to overview the similarities and differences of different approaches [7]. Here, we represent some of typical parametric basements to classify different techniques.

2.1.1. Static Node

Static Nodes have unique sensing ability, computational ability, and the ability to communicate. Based on our

assumption, initial level battery powers of the nodes are identical.

2.1.2 Mobile Node
Mobile Nodes are homogeneous in nature. During the localization process, it has more battery power compared to the static nodes and do not drain out completely.

2.1.3 Accuracy
It is very important in Wireless Sensor Networks localization system. For the requirements in military surveillances, higher accuracy is deployed for detecting intrusion detection.

2.1.4 Cost
In localization Wireless Sensor Networks, cost is a challenging issue. There are very few algorithms which give low cost but those algorithms do not give high rate of accuracy.

2.1.5 Power
Power is the basement for computation. Powers are supplied from the source of battery and each sensor device has limited power. These are localization parameters discussed in order to obtain better results.

2.2 Localization Estimation
The communication between localized node and unlocalized node is estimated in prior for localization for getting the positions or geometrical placements [8]. The process of finding the location is specific by means of distance and angle between nodes. Distance/Angle estimation is most widely recognized as range estimation, to estimate distance or angle between two sensor nodes [9]. There are some other concepts used in localization [16][17] such as

2.2.1 Angulation occurs to measure the angle between nodes.

2.2.2 Triangulation In this process, at least two angles of an unlocalized node from two localized nodes is measured to estimate their positions.

2.2.3 Lateration occurs to measure the distance between nodes.

2.2.4 Trilateration In this concept, the location of nodes is calculated through distance measurements from three nodes. The intersection of three circles is calculated, which gives a single point and this point is considered as the unlocalized nodes position.

2.2.5 Multilateration In this concept, more than three nodes are used in location estimation

III. LOCALIZATION PROCESS FLOW

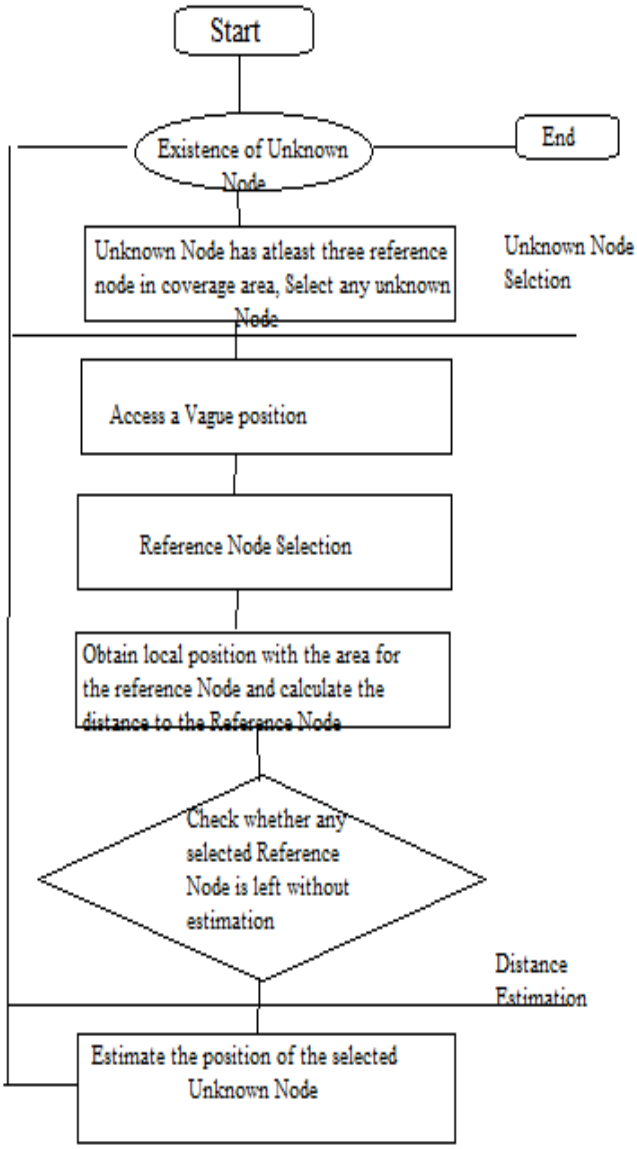

FIGURE 1: FLOW DIAGRAM OF LOCALIZATION

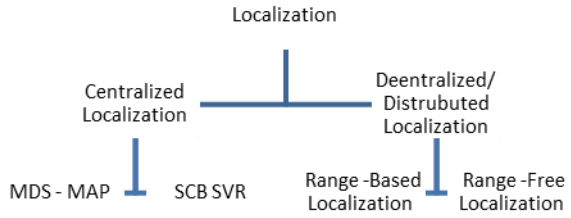

FIGURE 2: CLASSIFICATION OF LOCALIZATION PROCESS

IV. LOCALIZATION METHODS AND ITS CLASSIFICATION

Localization schemes are classified as centralized or distributed, anchor based or anchor free, GPS based or GPS free, fine grained or coarse grained, stationary or mobile sensor nodes, range based or range free [4]. In this scheme, we discuss broadly about centralized or distributed and its related range based or range free techniques to represent its features.

V. CENTRALIZED LOCALIZATION

If an algorithm collects localizations related data from one station and executes in the same station, then it is said to be centralized localization [12]. Centralized localization [13] transfers the data to a central node, In order to compute the location of each node.

It requires base station to gather network – wide environment information with huge amount of consumption energy. Base stations determine the location of every single node by collected data and sends back into network, while the number of nodes gets increased in network. By this, centralized localization becomes lower energy efficiency and longer network communication traffic and longer delay. However, this approach has fewer advantages. The techniques which relates on centralized localization model are explained below

5.1 MDS – Map

MDS (Multidimensional Scaling) Map [13][14] is a classic customs of centralized localization methods. It gets the information of node location by using a technique from data - analysis in statistics. The advantages of this scheme is that if does not require anchor or beacon nodes to initiate with, However, it creates a relative map of the nodes even without anchor nodes. Then the relative map is transformed into absolute coordinates. These types of methods suits well in the situations where the anchor nodes have less amount of ratios. Although, the disadvantage is, it requires global information of the network and centralized computation.

5.2 SCBSVR

Another scheme for centralized localization is SCBSVR [14] (Semi Centralized localization Algorithm based on Support Vector Regression). It is used to estimate position based on connectivity constraints which has known position. The advantage of this scheme is that, it is a practical, self-organizing that allows addressing any outdoor environments. The drawback is, it is power consuming and requires extensive generations and has to forward more information to the central unit.

VI. DECENTRALIZED / DISTRIBUTED LOCALIZATION

Localization algorithm is said to be distributed when each node collects partial data and executes the algorithm [4][11][15]. Now, we discuss the process of range based and range free localization in brief.

6.1 Range Based Localization

Range measurement [2][3] for localization calculation is the common process for localization system. It depends on distance/Angle between the nodes to pertain unknown node relocation. This scheme belongs to distance estimation and angle estimation technique. Some of the techniques include Received Signal Strength Indicator (RSSI), Time of Arrival (TOA), Angle of Arrival (AOA), and Time Difference of Arrival (TDOA) which is used to measure the distance between the nodes.

6.1.1 Time of Arrival (TOA)

This technique evaluates time and distance between unlocalized node and anchor node to estimate the location of unlocalized node.

6.1.2 Time Difference of Arrival (TDOA)

This technique evaluates the distance by translating the propagation time between two nodes with known signal propagation speed.

6.1.3 Angle of Arrival (AOA)

Angle of Arrival (AOA) is also called as Direction of Arrival (DOA) used to measure the position by geometric relationship with the angle where signals are received.

6.1.4 Receive Signal Strength Indicator (RSSI)

In this technique, distance between transmitter and receiver is estimated by measuring signal strength at the receiver. Sensor node uses received Signal Strength (RSS) for the measurement of distance from anchor nodes and then it estimates their locations. In fact, when the distance between transmitter and receiver is increased, power of signal strength is decreased.

6.2 Range Free Localization

Range free techniques [4][5][6] acts as connectivity between neighbouring nodes to estimate the nodes location. Range free methods are Distance Vector (DV) hop, Hop Terrain, Centroid System, APIT (Approximate Point in Triangulation) and Gradient Algorithm. In this technique, Distance Measurements, Angle of Arrival (AOA) or any additional hardware is not required.

6.2.1 DV Hop

DV Hop estimates range between nodes using the process of hop count. The information sends across the network from neighbour to neighbour node. Hop counts increment to one

point when neighbour node receives such information. By this way, unlocalized node can find number of hops away from anchor node. Average hop distance is calculated by using the formula

$$\text{Average Hop} = \frac{\text{Distance between two nodes}}{\text{No. of hops}}$$

6.2.2 Hop Terrain

The process of Hop Terrain is similar to DV Hop method in which the distance between anchor node and unlocalized node is determined. There are two classifications in this method. First, unlocalized node estimates its position from anchor node by using average hop distance formula

$$\text{Average Hop} = \frac{\text{Distance between two nodes}}{\text{No. of hops}}$$

The next classification is, first estimated position is viewed to neighbouring nodes. This node receives the information with distance information. A node classifies its position until final position is met by using Least Square Method (LSM).

6.2.3 Centroid System

It uses proximity based grained localization algorithm which has multiple anchor nodes, which broadcast their locations with coordinate values.

6.2.4 APIT (Approximate Point in Triangulation)

In this scheme, the following four steps [12][13] were involved

- After receiving beacon messages from anchor nodes, unlocalized node maintain a table which contains information of anchor ID, location and signal strength.
- Unlocalized nodes pick any three anchor nodes from a particular area and check whether they are in triangle form. This test is called PIT (Point in Triangulation).
- Unless and until the accuracy of unlocalized node is found with the combination of any three anchor nodes, PIT test is continued.
- At the end, Center of Gravity (COG) is estimated, which is intersection of all triangles where an unlocalized node is placed to find its estimation.

6.2.5 Gradient Algorithm

By using Multilateration method, unlocalized node gets its location by estimating their positions from anchor nodes. Every node takes information of the shortest path from anchor nodes.

VII. CONCLUSION

Some localization scheme has fewer merits and greater demerits and some of them have less demerits and greater merits. These merits and demerits were the main source for proposing the idea of a unique approach. Localization is a mechanism in which nodes are located. There are many approaches for localization. However, such approaches are desirable and are capable to take care of limited resources. Localization in wireless sensor network is a hot area of research. In this paper, we explained different localization techniques in detail. Range free, range based techniques was discussed in detail. However, in future, the range estimation procedures between anchor nodes and sensor nodes can be assessed.

VII. ACKNOWLEDGEMENT

The author extends their gratitude to the research centers and the valuable information given by the empirical staffs and colleagues.

REFERENCES

[1] Nabil Ali Alrajeh, Maryam Basir, Bilal Shams " *Localization Techniques in Wireless Sensor Networks*", International Journal of Distributed Sensor Networks, Volume 20, pages 3-9,2013

[2] Aditi Shrivastava, Priya Bharti, "*Localization Techniques for Wireless Sensor Networks*", International Journal of Computer Application, Volume 116, Pages 1-6, 2015

[3] P.K Singh, Bharat Tripathi, Narendra pal Singh "*Node Localization in Wireless Sensor Networks*", International journal of Computer Science and Information Technologies, Volume 2, Pages 1-5, 2011

[4] Zhetao Li, Renfa Li, Yehua Wei and Tingrui Pei", *Survey of Localization Techniques inWireless Sensor Networks*", Information Technology Journal 9, Pages 1-4, 2010

[5] He, T., C. Huang, B.M. Blum, J.A Stankovic and T. Abdelzaher, 2003. "Proceedings of the 9th ACM International Conference on Mobile Computing and Networking, Sept 14-19, San Diego, CA, USA. Pages 81-95

[6] He, T., C. Huang, BM. Blum, J.A Stankovic and T.F Abdelzaher, 2005. "*Range free localization and its impact on large scale sensor networks"*. ACM Trans. Embedded Computer Syst., 4:877-906

[7] Li, Z.,R. Li and L. Liu, 2009b." *Range based clock synchronization protocol for wireless sensor networks*". Inform. Technol. J., 8: 776-780

[8] A. Srinivasan, J. Teitelbaum, J. Wu. DRBTS., "*Distributed Reputation – based beacon trust system*", 2nd IEEE International Symposium on Dependable, Autonomic and secure computing (DASC 06), Indianapolis, USA, pp. 277-283, 2006.

[9] A. Pal "*Wireless sensor networks current approaches and future challenges*" Network protocols and algorithms ISSN 1943-3581, Vol. 2, No. 1, 2010

[10] MohitSaxena, Puneet Gupta, BijendraNath Jain. " *Experimental Analysis of RSSI based location estimation in wireless sensor networks*", Communication systems software and middleware and workshops, 2008. COMSWARE 2008. 3rd International Conference on 6-10 Jan. 2008 Pages: 503 – 510.

[11] Guoqiang Mao, BarisFidan, Brian D.O. Anderson "*Wireless sensor network localization techniques*", Computer Networks 1 (2007) 2529-2553.

[12] RaduStoleru, Tian He and john A. Stankovic "*Range Free Localization*", secure localization and time Synchronization for Wireless Sensor and Ad Hoc Networks Advances in information Security Volume 30, 2007, pages: 3-31.

[13] AsmaMesmoudi, mohammed Feham, Nabila Labraoui "*Wireless sensor networks localization Algorithm : A Comprehensive Survey*", International journal of Computer Networks and Communication (IJCNC) Vol.5., No.6, November 2013

[14] A.Faheem, R. VirranKoski and M. Elmusrati "*Improving RSSI based distance estimation for 802.15.4 Wireless sensor networks*", Wireless Information Technology and systems (ICWITS), 2010 IEEE International Conference on Aug, 28 2010 – sep 32010 Pages: 1-4

[15] Hady S. AbdelSalam, Stephen Otariu "*Towards Enhanced RSSI – based Distance Measurements and localization in WSNs*", INFOMO Workshops 2009, IEEE 19-25 April 2009 Pages: 1-2

[16] EnyangXu, IEEE, Zhi Ding and SouraDasgupta "*Source Localization in Wireless Sensor Networks from Signal Time of Arrival Measurements*", IEEE Transactions on Signal processing, Vol. 59, No.6, June 2011

[17] Khalid K. Almuzaini, Aaron Gulliver "*Range Based Localization in Wireless Networks Using Density Based Outlier Detection*", Wireless sensor Networks, 2010, Pages: 807-814.

Authors Profile

Mr. C T Lin pursed Bachelor of Science from University of Taiwan, Taiwan in 2006 and Master of Science from Osmania University in year 2009. He is currently pursuing Ph.D. and currently working as Assistant Professor in Department of Computational Sciences, Department of Electronic and Communication, University of Taiwan, Taiwan since 2012. He is a member of IEEE & IEEE computer society since 2013, a life member of the ISROSET since 2013, ACM since 2011. He has published more than 20 research papers in reputed international journals including Thomson Reuters (SCI & Web of Science) and conferences including IEEE and it's also available online. His main research work focuses on Cryptography Algorithms, Network Security, Cloud Security and Privacy, Big Data Analytics, Data Mining, IoT and Computational Intelligence based education. He has 5 years of teaching experience and 4 years of Research Experience.

Mr C H Lin pursed Bachelor of Science and Master of Science from University of New York, USA in year 2009. He is currently pursuing Ph.D. and currently working as Assistant Professor in Department of Telecommunication, University of New York, USA since 2012. He is a member of IEEE & IEEE computer society since 2013, a life member of the ISROSET since 2013 and ACM since 2011. He has published more than 20 research papers in reputed international journals including Thomson Reuters (SCI & Web of Science) and conferences including IEEE and it's also available online. His main research work focuses on Cryptography Algorithms, Network Security, Cloud Security and Privacy, Big Data Analytics, Data Mining, IoT and Computational Intelligence based education. He has 5 years of teaching experience and 4 years of Research Experience.

