IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 6, Issue 9, September 2017

Localization Techniques in Wireless Sensor Networks: Review

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Abstract: Wireless sensor network is a distributed sensor network and it consists of a large number of tiny, portable devices called sensor nodes. Wireless sensor network has attracted many researchers because of its infrastructure less nature. It has emerged as promising technology in wireless communication field. Network sensor nodes are having limited energy and resources in wireless sensor network. Sensor node performs the function of collecting, processing and forwarding data to destination. Localization techniques are used to detect location or geographical placement of sensor nodes. Localization is a one of the problem in wireless sensor network. Without localization data collected in many applications is not accurate and even not useful also. In both networking and application domain of wireless sensor network localization play very significant role. In this paper various localization techniques are discussed with their requirements, area of applications and limitations

Keywords: Wireless sensor network, Practicle swarm optimization (PSO) and Binary practicle swarm optimization (BPSO), Localization.

I. INTRODUCTION

Wireless sensor network (WSN) is gaining interest of a many researchers and has become a significant technology. Wireless sensor networks are sometimes also called wireless sensor and actuator network (WSAN). Wireless sensor network consist of tiny devices called sensor nodes for monitoring and recording the physical conditions of the environment and organizing collected data at a central location. Sensor network nodes have many parts like a radio transceiver for transmitting and receiving data, battery (energy source), a microcontroller, and an electronic circuit. WSNs measures environmental conditions like sounds, pollution levels, humidity, wind speed , pressure, and temperature etc. The most interesting feature of wireless sensor networks is Self -localization. Applications of wireless sensor networks are area monitoring, health care monitoring, environmental sensing, forest fire determine industrial monitoring , road traffic monitoring, intrusion detection, water quality monitoring and inventory management etc. Localization is a method used to obtain information of location. Localization is a process to determine sensor nodes. Localization is not only important for location determination but also it is necessary for providing base of routing. Localization is very significant in many application such as position- aware data processing and geographic routing etc. Some localization technologies object carry communication-capable devices so that they can be detected and located by anchor nodes.

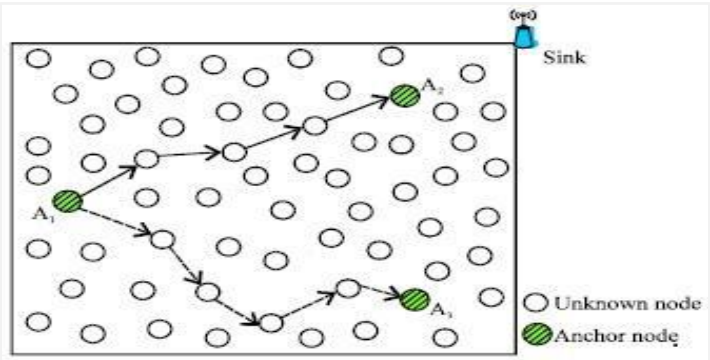

Fig 1.Architecture of WSN

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The one of method to know the position of sensor nodes is global positioning system (GPS) and second one is manually. But GPS system become very costly and consumes large energy. Line-of sight with satellite is also a problem of GPS. Therefore for large scale wireless sensor network GPS is not good solution and manual method also become impractical in large network. There are two types of nodes, anchor nodes and normal nodes. Anchor nodes have knowledge of their position and are equipped with GPS or are manually configured. Unknown nodes or normal nodes do not have position knowledge. For Localization energy efficient and cost –effective, robust and scalable localization algorithms are Fig 1.which shows the division of localization system consists of two phases that are ranging phase and estimation phase. Nodes estimate their distances from anchors using received signal strength of the signal, Angle of arrival or time based.

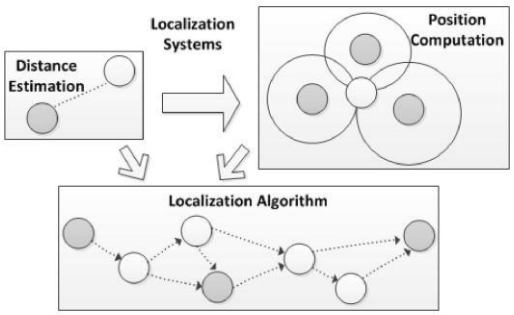

Fig 2. Division of Localization System

techniques. But in estimation phase, position of the node is calculated by using ranging information. There are two approaches such as geometric approach or an optimization approach. Localization in Wireless Sensor Network is a better and best choice for wireless sensor nodes because of their features like better accuracy, less power consumption, less localization time and reduced collision.

II. LOCALIZATION TECHNIQUES OF WSN

In 2D plane, the Anchor nodes are required whereas in 3D four anchor nodes are needed to determine the location of nodes. There are following types of node:-

- **Anchor nodes**: - Node in WSN who know their location is known as Anchor or Beacon node.
- **Base Station**: - It is a special type of anchor node that routs WSN information from network to a PC. With the help of PC information acquired by the network is given to rest of the AMI devices.

There are different types of localization techniques:-

1. Range free localization
2. Centralized localization
3. Distributed localization
4. Anchor Based Localization
5. Anchor Free Localization
6. Fine grained /coarse grained Localization
7. Stationary sensor nodes Localization
8. Mobile Sensor Localization
9. Practical swarm localization (PSO)

Many parameters are needed for implementing any localization techniques. To find the difference and similarities between different approaches these parameters are needed. These parameters are as follow –

- **Accuracy –**

It is one of the most important parameters for the localization. Applications like military installation for intrusion detection where accuracy is the main concern.

- **Cost-**

Another important parameter is cost and this is challenging issue for many localization techniques. Some applications are not expensive but fail in accuracy.

- **Power/ Energy -**

Sensor nodes contain limited power in terms of battery. Therefore it is main concern while selecting any localization algorithm.

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- **Range based localization-**

The distances between all the nodes are estimated using sensors such as ultrasound in this technique. Distance between sensor, anchors and a beacon is estimated by special hardware. It is very costly for large networks because of additional hardware required but it provide high accuracy. Range based localization technique contain two-step process:-

- **Ranging Step -**

In un-localized nodes tried to calculate their anchors with the help of signal propagation time or strength of the received signal. For this step many method are there like RSSI, TOA, TDOA, AND AOA etc.

- **Position step -**

In this ranging information is used. By solving a set of equations the ranging information can be evaluated. Unless all nodes are settled this localization procedure is iterated. Trilateration, Maximum likelihood (ML), Triangulation are involved in such techniques.

The concepts that can be used in this localization are:-

- **Lateration -**

It is a process for calculating distance between the sensors nodes.

Tri-Lateration - In UN -localized node location is determined by calculating the distance from three nodes through the intersection of three circles that gives a single point which will be the position of the un-localized node.

- **Multi-Lateration -**

More than three nodes are used for location estimation.

- **Angulation -**

Angle between the nodes is used for determining the location.

- **Triangulation -**

By measuring at least two angles of a un -localized nodes from two localized nodes the location can be determined.

Range Based Localization uses techniques such as (RSSI), Time of arrival, Angle of arrival (AOA) etc.

- **Received Signal Strength Indication (RSSI) -**

It is very easy to calculate distance with RSSI .It measure signal power in a received node and distance is calculated using received signal. Drawbacks are power decrease when node is at long distance and also power strength is fading in distance. Accuracy become low as distance increases.

- **Time of arrival (TOA) -**

Single packet is sends from one node to other node containing the times of its transmission and it also assume prefect clock synchronization between nodes. It is more accurate than RSSI and is not affected by channel fading. But because synchronization has to achieve between nodes therefore this method is not so popular.

- **Angle of arrival (AOA) -**

With the help of known reference axis angle is estimate and signal is sent to another nodes. AOA data can be gathered from optical communication methods and with array of RF antenna or microphones it is possible to discover angle of arrival of signal.

2. Range free localization -

By sending messages anchor nodes inform to other sensors about its position. Special hardware is not required. Only information about which nodes are within radio range and radio range of sensors are needed. The common ones are Hop count, DV Hop, and Centroid algorithm in 2D (CL).

- **Hop count -**

Distance between two nodes is analysed by hop count method. The number of hopes are taken from sensors nodes to receiver nodes by signal and then multiplied by maximum communication range of nodes. This method does not require any complex calculation and gives accuracy of 56%. When neighbour nodes are more than 15 then up to 20% errors of maximum range can be reduce.

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- **Centroid algorithm in 2D :-**

All anchors first send their positions to all sensors nodes within their transmission range. Every Unknown node collects all the beacon signals it receives from various reference points. Positions of unknown sensor nodes are calculated by a centroid determination from all n positions of anchors in range. This algorithm is very simple but it has drawback of high location error due to centroid formula.

- **DV Hop** :-

The minimum hops between the node and anchors are calculated by unknown node and then the length of every hop is analysed to obtain the distance between unknown nodes and anchors by multiplying the minimum hopes. Therefore, the position of the unknown nodes can be obtained.

3. Centralized Localization -

In centralized localization, central base station is used for computation and central processor is used which collect information from all sensors. All information is transmitted to central node known as base station or sink node. There is one big problem that if computing processor fails due to some process whole processor goes down. It is quite complex with respect to computation. This process becomes costly because of limited power supply for transmission of data from sensor nodes to central device. Overhead is also one drawback in addition to cost. Techniques which are based on centralized algorithm are described below:-

- **MAP- MDS :-**

To determine distance, Multidimensional scaling techniques use data analysis and information visualization. Firstly, the shortest distance between all pairs of nodes is calculated and then a distance matrix is produced and lastly MDS is applied to construct the relative location of nodes. It can construct relative map of network without anchor nodes. Its major disadvantages is that it requires global information of the network and involve high computation and communication cost.

- **Localization based on simulated annealing** :-

Optimization problem such as minimizing function of multiple variables is solved by this method. A simulated annealing method can cause metal to cool down and fridges into the minimum energy crystalline structure. A poor unordered solution can also be transformed into highly optimized desirable solution.

- **A RSSI- Based centralized localization technique** :-

In this method there is no need of extra hardware. RSSI (received signal strength indicator) is a technique used for calculating distance and to locate nodes. It is used to compute the power of received signal to measure the distance between two nodes in transmission range.

4. Distributed localization -

In distributed scheme every sensor node is responsible for estimating and calculating their position individually. Each communication node communicates directly with anchor nodes because there is no clustering. By using mobiles nodes and acoustic energy for distance approximation the errors can be reduced by distribution algorithm. The authors have used kalman filter based distributed localization algorithm for determining the location of nodes. Its classification is as follow:-

- **Beacon- Based distribution algorithm**:-

From the beacons positions the unknown nodes position can be determined in this algorithm. Computation is done on sensor nodes themselves in these algorithms. It consists of two parts such as diffusion and bounding box that are given below:-

➢ **Diffusion**: The most suitable position of the node is at the centroid of its neighbouring unknown nodes in diffusion. For more accurate position estimation a high ratio of beacons and longer range beacons are required.

➢ **Bounding box:-** This is very simple method of localizing nodes. Here nodes can be localized within the range of nodes and starts filtering their right positions. When the node's position is closer to the centre of the beacon nodes bounding box gives more accuracy.

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5. Anchor Based Localization -

In this scheme the position of some few nodes are known which are called anchor nodes. The location of other un-localized nodes is determined with help of anchor nodes. Higher the number of anchor nodes, higher the location accuracy.

6. Anchor Free Localization -

Here anchor nodes are absent. As there are no anchor nodes therefore instead of calculating absolute position of node, algorithms calculate relative position of the nodes.

7. Fine Grained /Coarse Grained Localization -

In fine grained schemes the received signal strength features of nodes are used . Where as in coarse grained localization received signal strength is not used.

8. Stationary Sensor Nodes localization -

There are two types of sensor nodes stationary (static) and mobile nodes. Algorithms are designed based on the deployment of sensor nodes. All nodes are static and fixed at one place in stationary sensors nodes but in mobile nodes are moving.

9. Mobile Sensor Nodes Localization -

In this sensor nodes are mobile which means they are moving. Mobile sensor nodes are used in many applications.

10. Localization of sensor node using Particle swarm Optimization -

To solve technological problem computational intelligence plays a significant role and it is needed for uncertain and nonlinear formulation. Tractability, robustness and low cost can be achieved with the help of computational intelligence. The multidimensional optimization problems are tackled by using Particle Swarm Optimization (PSO). It is a population based algorithm which depends on the simulation of social behaviour of birds, bees or a school of a fishes. It uses particle and feasible solutions that explore the search place to find the global situation.

- ***Localization Scheme with PSO:-***

This include following steps:

Step 1: To measure the distance between each pair of nodes.

Step 2: Using three or more neighbouring nodes obtain the search space of unknown nodes U and utilize PSO to estimate its location.

Step 3: Unknown nodes not localized in previous step is localized in third step.

Step 4: Until no more unknown nodes can be localized by three or more neighbouring anchors or localized nodes repeat step 3.

Step 5: Locate the unknown nodes having not been localized if each of them have two neighbouring anchors and localized notes.

Step 6: Until no more unknown nodes left for localization repeat step 5.

- **BPSO:-**

BPSO is a latest version of PSO that was used in binary discrete research space. The computational complexity and computation time is reduced as compared to PSO. In PSO position was updated by combining its current position and velocity but in BPSO, the position is updated by reflecting only the current velocity, which is mostly updated by sigmoid function. The main merit of BPSO is that it has a finite state of solution to reduce computation time required for particle to convergence compared to PSO.

III. ISSUES IN WSN LOCALIZATION

There are many issues in all localization techniques in WSN such as low positioning efficiency that is inaccurate location information of nodes that are placed in network coverage. Another point of concern is localization Errors .These localization errors also can cause inaccurate positioning. There are many issues in localization in WSN which need attention which are discussed below:-

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- **Network security:-**

Accuracy in the output of localization algorithm i.e. correct estimation is really important. Some localization algorithms have high accuracy but after implementation they lag in security as they can easy subject to attack. Therefore, it becomes necessary to consider the security and privacy of nodes locations. Some work in this field is still going but the problem is not solved adequately yet.

- **3D Area:-**

Most of the proposed localization algorithms are only applicable or useful in 2D Area; they are not applicable to 3D plane. Therefore it is necessary to design algorithm which can also be applicable to 3D Area because there are many applications which need 3D Localization algorithm**.**

- **Low Cost, Anchor Based Localization Approach :-**

There are many applications especially in industry fields which are anchor based and it is not appropriate to decrease number of anchors, it is required to decrease another cost of localization methods.

- **Large Scale Mobile Learning Approach:-**

For mobile networks learning concepts are used because of their have good efficiency in the performance of localization. But more works are done for mobile indoors. Most of the large scale localization algorithms only can work on the fixed networks.

IV. CONCLUSION

In this paper we study Localization in Wireless Sensor Network. Different localization techniques are proposed to reduce the localization error. Localization is used to localize or locate the sensor node. In Wireless Sensor Network, the localization plays significant part in many applications which requires sensor nodes to know their locations. There are so many algorithms present that are used for localization of sensor nodes. This paper show some techniques for localization like centralized localization algorithm, distributed localization algorithm and PSO.

The performance of any localization algorithm depends on a number of factors, such as accuracy, cost, computational and communication cost, node density and anchor density etc. All algorithms have their own advantages and disadvantage which make them suitable for different applications. Centralized algorithms give more accurate positions and are applicable to applications where accuracy is important factor. On the other hand distributed algorithms do not depend on large centralized system and have better scalability. Factors like battery life, communication cost are very important for sensor networks. Range Based RSSI provide less accurate distance estimate but it is still favored by many researchers because of its low cost compared to other technique, mainly for 3D area. Localization faces some challenges which are mainly cause due to communication link failures, memory and computational constraints.

REFERENCES

[1] 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.

[2] M. Patil, U.Shaha , U.B. Desai and S. N. Mercahant , " Localization in Wireless Sensor Networks using Three masters", IEEE, pp 384-388, 2005.

[3] Stefano, G.D. and A. Petricola, 2008. A distributed AOA based localization algorithm for wireless sensor networks: Journal of Computers, (3): 1.

[4] 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, 20

[5] Pal, A. 2010. Localization algorithms in wsn Current approaches and future challenges: Network Protocols and Algorithms, (2): 45–73.

[6] 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.

[7] Zhuang, W. and G. Song, J. Tan, and A. Song, 2008. Localization for hybrid sensor networks in unknown environments using received signal strength indicator: Information and Automation, 2008. ICIA 2008. International Conference on: 567–572.

[8] 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.

[9] Le, T.N., Chong, P.H.J., Xue Jun Li, Wai Yie Leong, 2010. A simple Grid-based Localization Technique in Wireless Sensor Networks for Forest Fire Detection: Second International Conference on Communication Software and Networks, ICCSN'10: 93–98.

[10] 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.

[11] Chen, J. C and K. Yao, and R.E. Hudson, 2002 . Source localization and beamforming: Signal ProcessingMagazine, IEEE, (19): 30–39.