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Review on Localization in Wireless Sensor Network

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Abstract: ***Wireless sensor network is a type of wireless network which consist of a collection of a tiny device called sensor nodes. WSN is one of the rapidly developing areas. Localization is one of the problem in WSN. In most applications, the data collected by the network without location information is not useful. Localization has an important role in both networking and application domains of Wireless Sensor Network. This paper review and analyse various localization techniques.***

Keywords: ***Wireless sensor network, Particle swarm optimization (PSO), Binary particle swarm optimization (BPSO), Localization***

I. INTRODUCTION

Wireless Sensor Network (WSN) has a large number of sensor nodes that are deployed in some areas. They can be used in many applications, i.e. battlefields, fire endangered, security areas, monitoring environment conditions, tracking purposes, event detection and others [1][2][3]. Among most of these applications, location information of sensor nodes is essential. Thus, it is necessary to obtain the location information, which is called as localization. Location identification or localization in Wireless Sensor Network refers to estimating the position or spatial co-ordinates of Wireless Sensor Nodes [3]. Localization could be done either manually or by using GPS. In general the localization process equip each node with a global positioning system (GPS), which is not effective due to size, cost and power consumption constraints. The limitation of GPS is that it cannot be implemented in dense forests, mountains that block the line of sight from satellites. Therefore, many localization algorithms introduced to solve the localization problem. Localization algorithm in WSN use special nodes called landmarks or anchors to estimate the location of other nodes using a priori knowledge of the special node co-ordinates. Somespecial nodes called anchors being aware of their position and other nodes called unknown nodes measures the distance from special nodes to estimate their positions. [1]

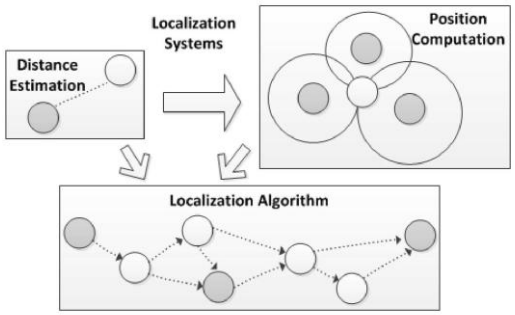

Fig. 1 Division of localization systems [1]

Fig 1 shows the division of localization system in WSN consist of two phases which are ranging phase and estimation phase. In ranging phase, nodes estimate their distances from anchors using the received strength of the signal, Angle of Arrival or time based techniques. In estimation phase, position estimation of the node is calculated using the ranging information. It could be done either by geometric approach or by using an optimization approach. Localization in Wireless Sensor Network is

best choice for wireless sensor node because of characteristics like better accuracy, reduced collisions, less power consumption and less localization time. Localization face some challenges that arises from communication link failures, memory and computational constraints. Localization algorithm mostly works on 2D planes i.e. x and y plane.

II. Related Work

Ifa et al. [1] proposed approach to reduce the localization error using BPSO algorithm for distributed node localization in WSN. Each unknown node performs localization under the measurement of distances from three or more neighbouring anchors. The node that get localized using iteration would be used as a reference for another remaining unknown nodes. Comparison of the localization techniques i.ePSO, basic BPSO and modified BPSO in terms of localization error was presented.

Jialing Lv et al. [4], propose the localization problem in WSN and to solve this problem PSO was used. To improve the algorithm efficiency and localization precision, author presented an objective function based on the normally distribution of ranging error, and a method of obtaining the search space of particles.

Nair. A et al. [3], was proposed the comparison of localization using centralized, distributed and PSO techniques. To reduce error during localization, used new means to approximate the distance between unknown nodes and anchor nodes when it was larger than node's communication radius. Moreover, the particle swarm optimization calculate the similar position of nodes, it makes the localization error much lower than the common method.

P. Sangeethaet al. [6], was proposed that in WSN the localization was an essential issue because many applications require sensor nodes to know their locations with a high degree of precision. An optimal path planning method for the mobile anchors based on localization. The proposed path planning method determined the location of the individual sensor nodes with the help of mobile anchor nodes. It ensured that the trajectory of the mobile anchor nodes minimized the localization error and guaranteedthat all of the sensor nodes could determine their locations. Then, the PSO algorithm determined the trajectory of the mobile anchor nodes. The path planning strategy method performed in both smaller localization error and a high percentage of localized sensor nodes by PSO.

Leelavathy S.R et al. [5], was proposed the applications of sensor networks which were developed require the location of wireless devices, and localization technique had been developed to meet this requirement. The Wireless sensor networks had been proved useful in many applications, like environment monitoring, military surveillance and many more. Triangulation was one such method that would be examined for localization.

III. Localization Techniques of WSN

Localization has been categorized into different techniques as

A. Range based- Range free

B. Centralized localization

C. Distributed localization

D. PSO

a) Range based –Range free

In range-based technique, special hardware is used for estimating the distance between anchors and sensors and beacons expensive for large networks.

In *range free* technique, the anchor informs other sensor about its own position by message passing[4][8]. They do not require any special hardware just have the information about which nodes are within radio range and the radio range of sensors.

b) Centralized algorithm [3]

In this algorithm a central processor is used which collects the information from each sensor nodes. In centralized model the problem is that if computing server fails due to some problem then entire processing goes down. Centralized algorithm reduce the problem of computation in each node but at the same time it is quite complex with respect to computation. It is very expensive due to limited power supply for transmission of data from sensor node to central device. The techniques which are based on centralized model are explained below.

1. *MDS-MAP:* Multidimensional scaling technique used the data analysis and information visualization to display distance. This technique calculate the shortest distance between all pair of nodes and then made a distance matrix and applied MDS to construct the relative location of nodes. It has ability that even without anchor nodes it reconstruct the relative map of the network. A drawback of MDS-MAP is that it requires global information of the network and having high computation and communication cost.[14]

2. *Localization based on simulated annealing:* It is a solution for optimization problem such as minimizing function of multiple variables. The simulated annealing method exploits an analogy between the manner in which the metal cools and fridges into the minimum energy crystalline structure. This technique transform a poor unordered solution into highly optimized, desirable solution.[9]

3. *A RSSI-based centralized localization technique:* RSSI (received signal strength indicator) is a technique which is used for distance estimation. This technique utilize small resources without the need of extra hardware. RSSI technique compute the power of received signal to measure the distance between two nodes which are in the transmission range of each other. [14]

c) Distributed localization

Distributed algorithm is proposed to guarantee the asymptotic localization of all localizable sensor nodes [7]. This technique gives better scalability. In decentralized or distributed localization techniques, each sensor node giveslimited communication with the closer sensor nodes to get the location information. All the required computations can be done on the sensor nodes themselves in these algorithms and the sensor nodes communicate between one another to get their exact position within the network. [3] [10]

1. *Beacon-based distributed algorithm:* The unknown node positions could be estimated from the beacon positions in this algorithm. All the required computation can be done on the sensor nodes themselves in these algorithm. It categorized into two parts [3] [10].

   Diffusion: In diffusion the most suitable position of the node is at the centroid of its neighbouring unknown nodes.It requires a high ratio of beacons andlonger range beacons to get a good position estimation. It is useful in the networks where nodes need to do less computation.

   Bounding Box: This approach is computationally simple method of localizing nodes which gives their ranges to several beacons. This algorithm is a method where nodes can be localized within the range of nodes and starts filter their right positions. Bounding box gives accurate results, when the node's position is closer to the centre of the beacon nodes.

d) Localization of sensor node using Particle Swarm Optimization (PSO) [3] [6] [11]

Computational intelligence ha an important role to solve technological problems and it is appropriate for uncertain and nonlinear formulation. In fact, Computational intelligence attempts to achieve tractability, robustness and low solution cost. The localization can be formulated as a multidimensional optimization problem, and tackled by using Particle Swarm Optimization

(PSO). PSO is a population based search algorithm based on the simulation of the social behaviour of birds, bees or a school of fishes [4]. It employs a set of feasible solutions called particle which explore the search place to find the global situation.

1. Localization scheme with PSO:

These steps presents the PSO-based localization scheme:

Step 1: Measure the distance between each pair of nodes.

Step 2: Obtain the search space S_U of unknown node U having three or more neighbouring anchors, and utilize PSO to solve to estimate its location.

Step 3: Localized the unknown nodes having not been localized in previous steps,if each of them has three or more neighbouring anchors and localized nodes.

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

Step 5: Localize the unknown nodes having not been localized in previous steps, if each of them has two neighbouring anchors and localized nodes.

Step 6: Repeat step 5 until no more unknown nodes can be localized. [4]

2. BPSO:

BPSOis an extended version of PSO, which was used in binary discrete research space. It can reduce the computation complexity and computation time compared to PSO, but decreasing some computational accuracy. In the PSO algorithm, there are two update functions: velocity and position update function. Position was update 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 [13]. The main advantage of BPSO is that it has a finite state of solutions which can greatly reduce computation time required for the particle to convergence compared to PSO.[1]

IV. CONCLUSION

In this paper we discuss localization in wireless sensor network. Different localization techniques has been explained to reduce the localization error. Localization can be used to localize the sensor node. In Wireless Sensor Network, the localization is an essential issue as many applications requires sensor nodes to know their locations. Many algorithms are used for localization of sensor nodes. This paper show some techniques for localization i.e centralized localization algorithm, distributed localization algorithm and PSO.

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