A Survey on localization in Wireless Sensor Network by Angle of Arrival

Shubhra Shubhankari Dash
Department of Information Technology
Veer Surendra Sai University of Technology Burla, Odisha, India

Tanmay Kumar Behera
Department of Information Technology
Veer Surendra Sai University of Technology Burla, Odisha, India

Abstract

Wireless sensor network is a type of sensor network which consist of a large number of sensor nodes, which are low cost small in size. When sensor nodes send the data to the user it must be localized itself. Here basically we focus on cooperative and distributed localization. Here we use cooperative positioning algorithm which is a hybrid positioning method used for the improvement of coverage network positioning and accuracy which is based on ultra-wide band technique, normally in harsh environment. In cooperative localization nodes are work together to make measurements and after that it form a map of network. There is a method for selection of neighbors for the distributed localization. Basically distributed algorithms are simple, have asynchronous operations that are there is no global coordination between nodes is required, and have the capability to operate in a disconnected network. Here also describe a Distributed algorithm in which whole network can be divided into cluster, after the initial cluster localized, by stitching together into other cluster whole network can be localized. The graph rigidity theory is define here for the new structure and their relationship. So the algorithm can provide relative location to maximum number of nodes. A hybrid scheme of AOA/TOA explained here. This hybrid scheme employ in multiple seeds in the line of sight scenario. Here we have to find the position of target sensor which not changes its moving direction.
Keywords: WSN, cooperative localization, AOA/TOA hybrid scheme, Distributed localization

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I. INTRODUCTION

A wireless sensor network consists of a large number of sensor nodes which can sense or monitor the environment. The node must be localized itself i.e. to find out the exact location, before sending the data to the neighbors, which is called as "localization". By localization estimation we can find the absolute position of a sensor node. This can be done by "anchor node", the node who knows its own position. Previously localization can be done through GPS. But due to some limitation i.e. by installing GPS its antenna increases the sensor node size factor, whereas sensor nodes are required to be small. It reduces the battery life of the sensor nodes due to high power consumption.

Sensor nodes can be used in Military applications, Battlefield Surveillance, target tracking, Nuclear, biological and chemical attack detection. The process of estimating unknown node position in the network is referred to node localization. We can apply localization algorithm not only 2D plane but also 3D. In 2d localization require less energy and time as compare to 3d plane. In 2D provides high accuracy on flat terrains but difficult to estimate in harsh terrains or hilly area. So by using 3D localization positioning error is improved in harsh terrain as well as in flat terrains.

For 3D localization we use some algorithms [1]:
1) New 3-dimensional DV-Hop localization Algorithm.
2) Novel Centroid Algorithm for 3D.
3) The 3-dimensional accurate positioning algorithm.
4) Unitary Matrix pencil Algorithm for ranged-Based 3D Localization.

In WSN localization we can locate the node by some techniques [2]:

A. Ranged Based Technique

this technique relay on the distance and angle measurement of nodes. This technique employ on point to point distance to identify the location among neighboring nodes. Ranged based techniques are Angle-Of-Arrival (AOA), TOA (Time-Of-Arrival), RSS (Receive Signal Strength).

1) Angle-of-Arrival (AOA)

Angle of arrival is the angle between a signal propagation direction and some reference direction. We can obtain AOA measurement by the phase differences in the arrival of the signals, commonly used in antenna array.

2) Time-of- Arrival (TOA)

By using TOA the node can be located by calculating the time of arrival of the signal from the node to more than one node. It sends a single packet from the one node to another node containing the time of transmission, with perfect clock synchronization between the nodes. The distance can be calculated as.

$$d=s*\Delta t$$

Where Δt is the difference in time of reception of two signals, d is the distance between the nodes and

$$s=(c_1 * c_2)/(c_1 - c_2)$$

Where c_1 and c_2 are the speed of RF and ultra sound signal.

3) Receive signal strength (RSS)

The received signal strength is the voltage measured by the receiver's received signal. This method is mainly used for RF signal. Due to the multipath propagation of radio signal, the performance is not good as compare to other ranging technique.

B. Ranged Free Technique

This technique doesn't require any measurements. This approach finds the position of non-anchor nodes by calculating their distance from the designated. The ranged free techniques are Binary proximity, APIT.

1) Binary Proximity

this method involves whether two nodes are within the reception range of each other or not [15].Here the reference nodes periodically emits beacons, or the unknown node transmits beacons, this include their location IDs. Then the unknown node must determine which node is closest to it.

2) Approximate Point in Triangulation (APIT)

This APIT [16] method requires a heterogeneous network of sensing devices, where a small percentage of these devices are equipped with high power transmitters and location information. APIT involves area-based approach to perform location estimation by isolating the location into triangular regions between beacon nodes. Which node presence inside or outside of these triangular regions allows a node to narrow down the area in which it can potentially reside.

II. LITERATURE REVIEW

A. Cooperative AOA positioning Localization

By using cooperative localization the unknown-nodes can improve network positioning coverage and localization accuracy in the poor electronic condition. Here cooperative positioning algorithm is implemented to determine the location of unknown nodes and also describe the method to select neighbors for the distributed localization to improve the localization performance. Cooperative localization is a hybrid positioning method which combines the measurement from more than one ranging technique. Which takes the advantage of the high connectivity of the wireless networks as well as the fine time resolution of the UWB technique [3].Here the blind nodes have the ability to determine the AOA from neighbors that may be reference nodes and the blind nodes.

In the network each node has one main axis against which angles are estimated and has the capability to identify the direction from which a neighbors sending data. Here we use "orientation" is the clockwise direction from north. When the orientation is 0^0 or towards north, then the position is absolute otherwise relative. The orientation of node I and node k are w_i and $w_k$respectively.$\psi_{k,i}$Is the angle at node I measured w.r.t. k, it can be estimated by the antenna array. It is a relative angle, but we have to find out the absolute angle [4]. So the absolute angles at node I and k can be obtained as

$$\theta_{k,i}=\psi_{k,i}+\omega_i \text{ and } \theta_{k,i}=\psi_{i,k}+\omega_k \quad (1.1)$$

1) Algorithm Description

AOA cooperative positioning algorithm [4] can be broken down into three step (1) AOA ranging characterization.(2)Error aggregation compared by measured AOA and the estimated AOA.(3)Minimization of error aggregation.

a) AOA Ranging Characterization

The measured AOA $\theta_{k,i}$from node k to node I can be expressed as

$$\theta_{k,i}=\alpha_{k,i}+n_{k,i} \quad (1.2)$$

Where $\alpha_{k,i}$the actual AOA at node I is from node k.$n_{k,i}$is the noise. All the Angle measurement from different blind nodes and reference nodes, the equations have

$$\theta = \alpha + n \quad (1.3)$$

Where matrix θ represents all the AOA measurements, α represents the actual AOA, and n is the matrix showing the noise of the AOA measurements with variance of σ^2.

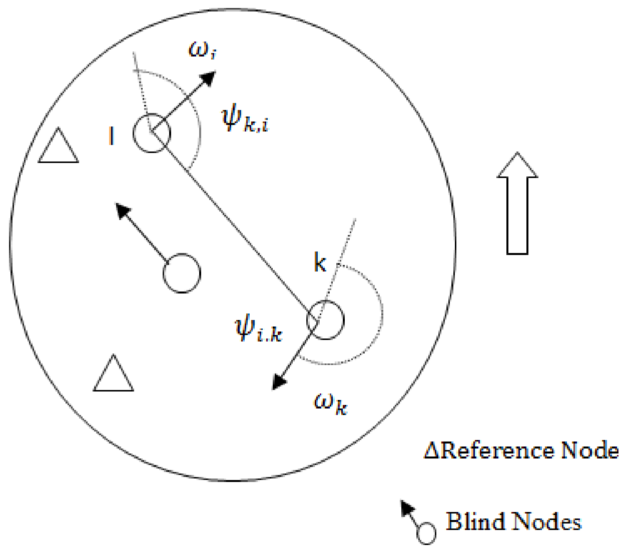

Fig. 1: Radio range of all nodes including reference and blind nodes cover the whole area.

b) Error Aggregation

The equation (3) can be rearranged into n=θ-α. θ should be equal to α, where noise doesn't exist. θ can be obtained directly from measurement campaign, and α can be calculated from the coordinates of reference nodes and the blind nodes. So by minimizing the θ-α we can estimate the coordinates of the blind nodes. So the objective function is the combination of information of the reference nodes and the cooperative nodes which shown below.

$$P= (\sum_{i=R+1}^{R}(\sum_{k=1}^{R} \omega_{k,i}(\theta_{k,i}-\alpha_{k,i})^2 + \sum_{k\epsilon CN} \omega_{k,i}(\theta_{k,i}-\alpha_{k,i})^2) \quad (1.4)$$

This function is a measure of errors of the AOA data since n is zero when all the nodes can correctly estimate their angles $\omega_{k,i}$Is the weighting factor which is the inverse of the variance of the AOA measurements?

If all the weighting factors are set to be 1, i.e. the accuracy of the AOA measurements is independent of the signal over noise ratio and the distance. So the objective function becomes

$$P= (\sum_{i=R+1}^{N}(\sum_{k=1}^{R}(\theta_{k,i}-\alpha_{k,i})^2 + \sum_{k\in CN} \theta_{k,i}-\alpha_{k,i})^2)) \quad (1.5)$$

c) Error Minimization using CGM

Conjugate gradient method is a nonlinear optimization method used to minimize the error [5].This method is often implemented as an iterative algorithm, applicable to sparse system that are too large to be handle by a direct implementation.

Neighbor selection:

In a Network if the blind node has 3 reference nodes within its communication range and its coordinate can be estimated as cooperative positioning algorithm. So the blind nodes are then upgraded as a virtual reference node to locate the other blind nodes. So the positioning errors propagate to the next iteration and this propagation substantially degrades the localization performance. To prevent the error coming from the propagation, it is necessary to select the neighbors. There is a method named "combined uncertainties" used to select neighbors. In this method each node sends a transmission packet which contains position estimation and the theoretical variance. After the blind nodes receives positioning information from its neighbors that may be virtual reference nodes or real reference nodes it perform cooperative localization itself. The reference node which estimates their AOA and position under certain threshold considered as selected.

In cooperative localization minimum number of nodes required to locate a blind node in a 2D positioning. It can be implemented without synchronization. It takes the advantage of UWB technique i.e. fine time resolution robustness against multipath, which gives more accurate AOA measurements.

B. Cooperative Positioning Localization Using AOA and TOA

This is a hybrid model of angle of arrival-time of arrival model for localization of wireless nodes; the model may be modified to remove the bias from the estimated positions and develop a linear least squares (LSS) scheme [17]. Localization can be classified as non-cooperative or cooperative [18, 19]. In non-cooperative only the anchor nodes are used to localize target nodes or in cooperative, all nodes are used to localization or it can be classified as

1) Centralized in which all the data is transferred and processed at a base station.

2) Distributed in which processing is done at node level. Localization that utilizes the angle of arrival of the incoming signal performs well in small networks but the accuracy degrades significantly as the TNs move away from the ANs. In order to measure the angle of arrival of incoming, the node must be equipped with antenna arrays, which adds to the cost and size of the nodes. As compare to non-cooperative localization cooperative localization show much better performance, however the target nodes used in these networks must have substantial processing power. There is a cooperative scheme using metric

multidimensional scaling (MDS) [19].One main problems in cooperative localization is noise propagation that means noise in one node will add to the noise in other node. Here we modify AOA-TOA localization model to make the system unbiased.

Let consider a network of M anchor nodes, where $(\overline{x_i}, \overline{y_i})$ are the coordinates of the i[th] anchor node. Let $\widehat{\theta_i}$ and $\widehat{d_i}$ be the measured angle and distance between ith anchor node and the target node which is given by

$$\widehat{d_i} = d_i + n_i$$

Where

$$d_i = \sqrt{(x - \overline{x_i})^2 + (y - \overline{y_i})^2}$$

$$\widehat{\theta_i} = \theta_i + m_i$$

Where

$$\theta_i = \text{arc tan}\left[\frac{y - \overline{y_i}}{x - \overline{x_i}}\right]$$

n_i and m_i Represents the zero mean Gaussian noise in the estimate of distance and angle with the i[th] anchor node.
Then the x and y coordinate of the target node can be estimated as

$$\hat{x} = \overline{x_i} + \widehat{d_i}\cos\widehat{\theta_i} \quad \text{for } i=1, 2\ldots M \qquad (2.1)$$

$$\hat{y} = \overline{y_i} + \widehat{d_i}\sin\widehat{\theta_i} \quad \text{for } i= 1, 2\ldots M \qquad (2.2)$$

1) Bias in the Hybrid Model

The bias of the LLS estimator is

$$\text{Bias} = A + p \qquad (2.3)$$

Where

$$P = \epsilon_i\left(\left(\exp\left(-\frac{\sigma_{m_i}^2}{2}\right) - 1\right)\right)$$

Where $\epsilon_i = d_i\cos\theta_i$ for the estimation of x coordinate of the TN and $\epsilon_i = d_i\sin\theta_i$ for the estimation of y coordinate of the TN.

2) Modified Hybrid Model

In order to reduce (2.3) to zero (2.1) and (2.2) are modified by introducing an un biasing constant So the eq. (2.1) and (2.2) are

$$\hat{x} = \overline{x_i} + \widehat{d_i}\cos\widehat{\theta_i}\delta_i \quad \text{for } i=1\ldots M$$

$$\hat{y} = \overline{y_i} + \widehat{d_i}\cos\widehat{\theta_i}\delta_i \text{for } i=1\ldots\ldots\ldots, M$$

Where δ_i is the unbiasing constant used in the ith observation and expressed as

$$\delta_i = \exp\left(\frac{\sigma_{m_i}^2}{2}\right)$$

The LLS solution for this system is

$$\widehat{U_H} = A_H{\dagger}\tilde{p}H.$$

a) Cooperative Localization and Topology

The localization consists of two phases, i.e. measurement phase and location estimation phase [20]. Most sensor network localization based on measurement between neighboring sensor nodes for location estimation. In this measurement phase packets are exchanged between neighboring nodes. The receiving node can collect information by estimating one or more signal from physical waveforms according to this packets. In the location estimation phase, measurements are aggregate and used as inputs to a localization algorithm.

b) Cooperative localization versus no cooperative localization

In cooperative localization the sensor nodes communicate with anchor nodes. Here internode communication removes the need for all nodes to be within communication range of multiple anchors [21]. So high anchor density or long-range anchor transmissions are no longer required. The cooperative localization problem is finding the coordinates of the ordinary nodes.

But in Non-cooperative localization approach, there is no communication between ordinary nodes, only communication between ordinary nodes and anchors. Ordinary nodes need to communicate with multiple anchors, requiring either a high density of anchors or long-range anchors transmissions.

Cooperative localization can be generally divided into “centralized algorithm”, which collect measurements at a central processor before calculation, and “distributed algorithms”, which require sensor to share information only with their neighbors. The detailed summary of these algorithms described in [20, 22, 23]. In centralize algorithms of cooperative localization, the positions of all nodes are determined by a central processor. The processor collects measurements from beacons as well as ordinary nodes and computes the positions of all ordinary nodes. Centralized algorithms are usually not scalable and thus impractical for large networks.

In distributed algorithms of cooperative localization, there is no central controller, and every node infer its own position relay on collected information. Distributed algorithms are scalable and thus attractive for large networks. Distributed algorithms for cooperative localization generally two types, “network multilateration” and “successive refinement” [22]. In network multilateration, every sensor node estimates its multi-hop range to the nearest anchors. When each ordinary node has multiple measurements estimation to know their positions, its coordinates are calculated locally by multilateration. Successive refinement algorithms try to find the optimum solution of global cost function. Each sensor estimates its location and then transmits that assertion to its neighbors. Then neighbors calculate their location and transmit again, until convergence.

Table - 1
Comparison of different cooperative localization

Serial number	1	2
approach	Cooperative localization by AOA	Cooperative positioning by AOA-TOA
Technique used	Weighted cooperative positioning localization	Linear least square (LLS)method
Localization	Absolute localization	Absolute localization
Robust	Robustness against multipath	More robust and accurate
Time	Fine time resolution	Fine time resolution
Accuracy	high	high

C. A Distributed AOA Based Localization for Wireless Sensor Network

Here distributed algorithm used for solving positioning problem in ad-hoc wireless networks [24]. Distributed algorithms are simple, and have the capacity to operate in disconnected networks. Ad-hoc networks are the collection of sensor an actuator nodes relay on monitoring and controlling environmental characteristics. The positioning algorithms have to satisfy the following requirements [25].

1) It must be distributed.
2) The algorithm has to minimize the number of node-to-node communication and computation power as the processor are the main sources of battery life.
3) Even when the network becomes disconnected, the positioning localization system should work.
4) It is desirable to provide absolute positioning, and enables a unique name-space in the global coordinate system of GPS.

This algorithm is distributed, robust against disconnected network and give absolute position in global coordinate system. Different types of approaches are used to face the positioning problem. Ranged-free approaches use only connectivity between nodes. Ranged-based approaches measure the hop-count of anchors with known location.

There are different types of approach is based on the capability of the nodes to sense direction from which signal is coming, which is called as angle of arrival. There are two algorithms are developed to infer the node position, called DV-Bearing and DV-Radial [26]. AOA combined with ranging [27, 28]: the disadvantage of this scheme is in the technical difficulties to build nodes with both measurement capabilities. Here the algorithm requires AOA sensing capability and a antenna array or a small set of ultra sound receivers at each node. In WSN each node has a main axis [26] against which all angles are estimated from which neighbors is sending data. There is a term heading which indicates the angle form by its main axis with respect to north. The term bearing refers to an angle measurement with respect to another object.

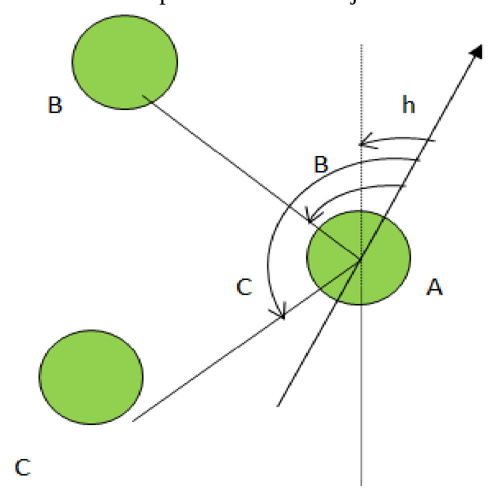

Fig. 2: Node A with heading and bearing to B & C

For the above figure for node A, bearing to B is b, bearing to C is c, and heading is h. When an node interact with its two neighbors, node can find the angle between its own axis and the direction where the signal is coming from. Node A cans inferring the inferring the angle α_ABC formed by the neighbors B and C as c-b. Here all angles are measured in trigonometric direction. There is also a distributed localization technique for wireless sensor networks, known as AT-angle, where sensors only estimate angles with their neighbors. AT-Angles locate a number of sensors with accuracy positions and manage accumulation of measure errors. Every node performs the localization technique which defines a restricted zone containing the node, with respect to information about beacon positions and angles. To be located, a node computes a measurement of its position which is the gravity center for this zone. AT-Angle has two important properties:

1) A node detects if its measured position is closed to its real position. Here this node becomes an estimated anchor and used by other nodes to obtain their position.
2) Some wrong localization information due to measure errors can be eliminated regarding to defined sensor zones.

These AT-Angle properties allow obtaining good results.

D. Distributed Algorithm for Anchor-Free Network Localization Using Angle of Arrival

Here the whole network is divided into cluster, then after the initialization of initial cluster by stitching them together the whole network can be localized. The optimal method by least square error metric for stitching cluster described in[6].By using graph rigidity theory[7] new structure and their relationship is define, by which algorithm can provide relative location to maximum number of nodes. The Distributed localization more robust, energy efficient and better response to network topology changes. The distributed algorithm uses ad-hoc positioning System (APS) [8].Direction information are reduced on utilizing bearing propagation from anchors to regular nodes in distributed algorithm.

For design, analysis and description of the localization the following structure have to be defined [6].

1) Cluster: is a set of nodes with their bearing constraints defined with respect to heading of the origin node. The node's location inside the cluster is not unique.
2) Sub clusters: are the largest subsets of a cluster. The nodes inside the sub cluster can be scaled, rotate or translated together with the other members of the same sub cluster.
3) Link sub cluster: is a special sub cluster that has only two nodes.
4) Initial sub clusters: are sub clusters made only of the origin node and its neighbors.
5) Global cluster: is a cluster consisting of all the nodes in the network.
6) Forests are sub clusters of the global sub cluster.

The basic function of this algorithm is stitching two clusters I. e. registering all nodes from source cluster to destination cluster.

1) Algorithm Description

The Algorithm is divided into three phases:

1) Phase1 Initial Sub Clusters Localization is also known as centralized localization method, which may be scaled down to other node and its neighborhood in which nodes are localized with respect to the local coordinate system.
2) Phase2 Minimum Spanning Tree Constructions in which a distributed protocol called mega merger [9] is used for the creation of minimum spanning tree, whose goal is to minimize localization error induced in the third phase.
3) Phase3 Sub Cluster Stitching is the phase where scaling, rotation, translation can be performed. It is performed along with the spanning tree created in phase 2.

a) Localization from Sub Clusters to Forest

There are two important operations are performed within the nodes. The first task is the initial sub clusters localization which is AOA measurements perform by base node. The second is the sub clusters stitching that stitch together as many sub clusters as possible from two neighboring clusters. In the network every node the initial sub cluster can be performed by Robust Angulations Using Subspace Techniques (RAST)[10].After completion of initial sub cluster localization, the set of overlapping localized sub clusters distributed in n clusters is defined. The task of this phase is to stitch all sub clusters into minimum number of forests inside the global cluster. In the distributed algorithm, using simple converge cast protocol, this task can be reduced to iterative stitching of sub clusters from two neighboring clusters c_iandc_j.

b) Method for Stitching Two Sub Clusters

1) Stitch nodes: In this method transformation parameter is calculated by using the nodes that are common in both sub clusters, we can uniquely resolve all three transformation parameters i.e. rotation, translation, scaling.
2) Stitch links: If there is only one sub cluster in common but there is a link sub cluster inside destination cluster with nodes in both sub clusters, It can also uniquely resolve all three parameters.
3) Simple addition: If there is only one common node we can resolve only rotation and translation, so from the source sub cluster all the nodes have to end up with new sub cluster with common node as its baseband.

So the position of the nodes in the destination sub cluster are computed using

$$p_d = \vec{t} + £Rp_s$$

Where $p_s$and p_d are the vector of two node positions in source and destination sub cluster, and R, £, $\vec{t}$ are the rotation matrix, translation vector and scaling factor.

E. AOA-Aided TOA Distributed Positioning for Mobile Wireless Sensor Networks

This approach used to localize a mobile sensor using a TOA/AOA hybrid positioning scheme which employing multiple seeds in the line-of-sight scenario.

For location estimation in propagation environments, some information such as AOA information and signal strength can be used together to achieve the location estimate. So the hybrid algorithm, AOA information aided with TOA positioning algorithm which may be employed in most propagation environments. Here an TOA/AOA hybrid positioning scheme, i.e. AOA-aided TOA positioning Algorithm (ATPA) [11], employ in multiple seeds in the line of sight scenario, which present positioning system that consider the relative movement between the seed and the mobile sensor .Here assume that the clock of seeds and mobile sensors with unknown positions are synchronized and the target sensor will not change its moving direction and seeds broadcast their position information periodically. Here we have to estimate the position of a target sensor with broadcasting time stamp of the seeds.

The positioning algorithm estimates the location in two phases:

1) AOA-Aided TOA measurement
2) Geometrical positioning with particle filtering.

Mobile location with TOA/AOA information at single base station is proposed in [12].and TOA/AOA location algorithm with multiple base stations explained in [13].

In Hybrid location methods the combination of time and angle measurements can reduce the number of receiving base stations and improve the coverage of location-based service.

1) Principles Of AOA-Aided TOA Positioning

a) AOA-Aided TOA Measurement

As the location of the seeds different, the time stamp of the received signals from the seeds is different. So measurement modification applied to coordinate the signals and information with multiple seeds.

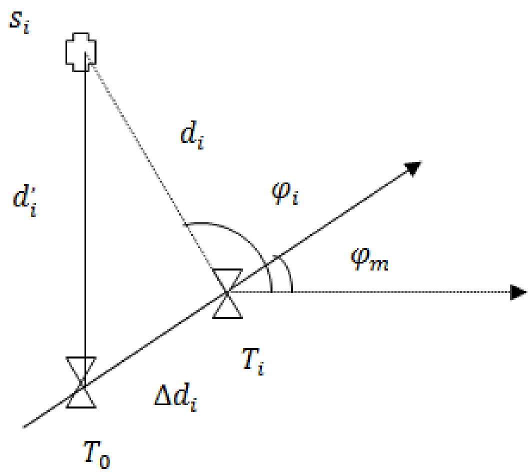

Fig. 3: Measurement modification

Here unknown sensors know their orientation before estimation. The above figure shows the concept of measurement modification. Let T_0 is the broadcasting time of the seed. T_i is the time stamp of the received signal from seed S_i. Δd_i is the movement of the target sensor from time stamp T_0 to time stamp T_i. φ_i is the direction of the received signal from seed S_i with respect to the orientation. φ_m is the moving direction of the target sensor with respect to the orientation.

So based on the AOA information and the information mobility the distance measurement can be written as

$$d_i'^2 = d_i^2 + \Delta d_i^2 - 2 d_i \Delta d_i \cos(\theta_i)$$

Because of the location of the seeds and the target sensor, the angle yields,

$$\theta_i = \{\pi - \left| |\varphi_m| - |\varphi_i| \right|, \text{ if } \varphi_m >= 0 \text{ and } \varphi_i >= 0$$
$$\{\pi - \left| |\varphi_m| - |\varphi_i| \right|, \text{ if } \varphi_m <= \text{ and } \varphi_i < 0$$
$$\{\pi - \left| |\varphi_m| - |\varphi_i| \right|, \text{ otherwise}$$

2) Geometrical Positioning With Particle Filtering

Whenever mobile sensor doesn't know its position but able to receive information from neighboring seeds that is assume to be accurate position information. Here this problem can be solving by Bayesian particle filter method because it is robust to noisy measurements. It allows flexible information transmission, and it can be robust to loss data.

a) Distance Measurements

Here target sensor m obtains new measurements from neighboring seeds and estimates its own position using the particle filter. So the target sensor position is estimated by discrete-time state equation:

$$x_k = \varphi x_{k-1} + \Gamma \omega_k \quad (3.1)$$

Where x_k is the position of the mobile sensor and is the uncorrelated Gaussian diffusion term.

b) Geometrical Positioning

Particle filter[14] is used to estimate the unknown sensor position from the above state equation. Here we have to find feasible position to make the error of state vector minimum. The state vector is the set of random samples updated and propagated with algorithm. it takes the advantages of mobile sensor that carries along a complete distribution of estimates of its position.

Table – 2
Comparision of different distribted techniques

Serial number	*1*	*2*	*3*
Approach	*Distributed AOA localization*	*Distributed algorithm for anchor- free network*	*AOA-Aided TOA distributed positioning localization*
Techniques	*Distributed algorithm*	*Graph rigidity theory*	*AOA-Aided TOA positioning algorithm, particle filtering approach*
accuracy	*Satisfactory accuracy*	*Low accuracy*	*Highest accuracy*
Cost	*Low cost*	*High hardware cost*	*Low cost*
Synchronization	*No synchronization*	*No coordination between nodes*	*No need of synchronization*

III. Conclusion

The flexibility, low cost, small size characteristics of sensor network create an attractive research in WSN. This paper contains a brief description about various Cooperative and distributed localization schemes using AOA. As the AOA techniques involve the presence of a transmitter and an antenna array, which automatically leads to the advantages like fine time resolution, robust against multipath, more accurate AOA measurements. These concepts are described briefly in this paper. Also tables describing different approaches, techniques and parameters of localization are given in this paper in a tabular format. Since cost and power consumption are two main factors in localization of WSN, AOA techniques always gives its best result considering to the above factors. The cooperative localization can be used in a scalable, when the information propagated through the network to locate new nodes. Cooperative localization shows much better performance when compared to the non-cooperative scheme. But one main problem in cooperative localization is noise propagation that is noise in one node will propagate to the noise in other node. By using cooperative localization, it can improve the positioning performance. And the distributed algorithm is very simple and it also can work. Even if when the network is disconnected that is no global coordination is needed among nodes and this type of algorithm gives satisfactory accuracy. In the future work we are interested to generate a proper algorithm using different AOA based algorithm discussed in the above paper.

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