Survey of node localization in Wireless Sensor Networks

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Abstract

Wireless Sensor Network (WSN) is a hot research field in the field of international attention, which involves multidisciplinary and highly intersecting and highly integrated knowledge. As a kind of brand-new information acquisition and processing technology, it can be widely used within the field of complex large scale monitoring and tracking tasks, and node localization is the foundation the wireless sensor network applications. Firstly, the related terms and evaluation criteria of wireless sensor network positioning technology and the classification method of positioning algorithm are introduced. Mainly from two aspects, ranging-based and ranging-free, the main positioning method of wireless sensor network is introduced and some new type of wireless sensor network localization method, which mainly includes the localization algorithm based on mobile anchor nodes, three-dimensional localization algorithm and intelligent localization algorithm are presented. Then, we summarize the existed problems of wireless sensor network positioning technology and some viable solutions are proposed from practical, application environment, hardware conditions, power and safety privacy. Finally, we look forward to the future prospect of research and application development trend.

Keywords

Wireless Sensor Networks;Anchor node;Positioning technology;Positioning algorithm.

1. Introduction

As a new information acquisition and processing technology, wireless sensor networks (WSN) have a wide range of applications in target tracking, intrusion detection and some localization related fields [1-4]. However, whether in military reconnaissance or geographic environmental monitoring or traffic monitoring and tracking the patients in healthcare, only monitoring information can show the location of the monitoring target, which makes sense. First, the sensor node must specify its location in order to specify "what events are arose in what position", and to realize the positioning and tracking of external targets. Secondly, it is helpful to know the location of the sensor nodes to improve the routing efficiency of the network, so as to realize the load balancing of the network and the automatic configuration of the network topology to improve the coverage quality of the whole network. Therefore, we must take a certain mechanism or algorithm to achieve the wireless sensor network nodes in the positioning.

Wireless Sensor Networks (WSN) is a special Ad-hoc network, which does not require fixed network support, with fast expansion, strong destruction and so on [5]. The typical work of wireless sensor networks is as follows: a large number of sensor nodes (from hundreds to thousands of) are scattered to the region of interest, and the nodes form a wireless network quickly through self-organization. Nodes are not only the collector and sender of information, but also the router of information. The collected data reaches the gateway via multi hop routing. Gateways (some documents, also known as sink node) are a special node that can communicate with the monitoring center through Internet, mobile communication networks, satellites and so on [6, 7].

The simplest way for the wireless sensor network positioning is to load the global positioning system (GPS) receiver for each node to determine the location of the nodes. However, due to economic factors, node energy constraints and GPS deployment environment has certain requirements and other restrictions, the feasibility of the program is poor [8]. As a result, only a small number of nodes obtain their coordinates by embedded GPS or by deploying them in a specific location. In addition, node localization in wireless sensor networks involves many aspects, including the positioning accuracy, network size, anchor node density, network fault tolerance, robustness and power, how to balance the relationship between them is a challenging problem for the wireless sensor network positioning. However, GPS positioning is adapted to the outdoor environment without occlusions. Owing to high energy consumption, large volume and high cost of the nodes, and needing for fixed infrastructure, which makes it not suitable for low-cost self-organized sensor network. Thus, we must adopt a mechanism and algorithms of sensor node self localization.

2. WSN node location related concepts

2.1 Basic Terminology

Anchor Node: Also known as beacon nodes, lighthouse nodes, etc., through other means to obtain their own location.

Normal Node: Also known as unknown nodes or nodes to be positioned, own position unknown in advance, needing to use the anchor node location information and a certain positioning algorithm to get the location of the estimated node.

Neighbor Node: Other nodes within the communication radius of the sensor node.

Hop Count: The total hops between the two nodes.

Hop Distance: The size of each hop between the two nodes.

Connectivity: This includes both node connectivity and network connectivity. Node connectivity refers to the number of neighbor nodes detected by the node. The network connectivity is the average of the number of neighbor nodes of all nodes, which reflects the density of the node configuration of the sensor network.

RSSI (received signal strength indication): The node receives the strength of the wireless signal.

AoA (angle of arrival): The signal received by the node is relative to the Angle of its axis.

LoS (line of sight): If there is no barrier between the two nodes of the sensor network, and direct communication can be achieved, the line of sight between these two nodes is called.

NLoS (none line of sight): There are obstacles between the two nodes of the sensor network, which affect their direct wireless communication.

Infrastructure: Fixed equipment that assists in locating and knowing its location, such as satellite base station, GPS, etc.

2.2 Positioning Performance Evaluation Index

In addition to general location accuracy indicators, there are other indicators for resource constrained sensor networks, including coverage, refresh rate and power consumption.

Positioning Accuracy

Positioning precision refers to the precise degree of location information provided, which is divided into relative precision and absolute precision. Absolute precision refers to the precision measured in length. Relative precision is usually defined as a percentage of the distance between nodes.

Coverage

Coverage and positioning accuracy are contradictory indicators. In general, the greater the coverage, the lower the accuracy provided. Providing a wide range of high precision is often difficult to implement.

Update Rate

Update Rate is the frequency of providing location information.

Power Consumption

Power consumption is an important index of sensor network design, and it is necessary to calculate the energy consumed for this locating service function.

Cost

The cost of locating systems or algorithms can be evaluated in several different ways. The time cost includes a system installation time, configuration time, location time required. The space cost includes a positioning system or an algorithm required infrastructure, network nodes, hardware dimensions, and so on. The cost of the funds includes the total cost of implementing a base system or algorithm for a positioning system or algorithm.

Anchor Node Density

Anchor node positioning usually depends on manual deployment or using GPS implementation. The method of manually deploying anchor nodes is not only restricted by the network deployment environment, but also severely restricts the scalability of network and application. With GPS positioning, the cost of the anchor node is two orders of magnitude higher than the average node, which means that even if only 10% of the nodes are anchor nodes, the price of the entire network will increase by 10 times. In addition, the range of positioning precision increases with the increase of anchor node density, which will not improve when it reaches a certain degree [9].

The wireless sensor network positioning system needs the ideal wireless communication environment and reliable network node equipment. There is usually a lot of interference in the actual application environment. The above indexes of the positioning system are related to each other. In order to ensure the implementation of the above indicators, in addition to the necessary hardware facilities, different positioning calculations must be adopted according to the specific application environment [10].

3. WSN Main Location Method

WSN has many positioning methods, which can be classified according to different data collection and data processing methods. In the data acquisition, different algorithms need to be partial the information collected, such as distance, angle, time or around the anchor node information. Therefor, the purpose is to collect the relevant data for positioning and make it the basis for positioning calculation [11]. In the way of information processing, whether it is processed by itself or uploaded to other processors, its purpose is to transform data into coordinate and complete positioning function. There are three common classification methods:

The distance measurement can be divided into two categories:

Range-based and Range-free. The distance measurement method is to directly measure of distance, the distance measurement method on network connectivity to achieve localization, ranging accuracy is generally higher than the range of methods, but distance measurement method for node itself higher hardware requirements. In certain occasions, such as on a larger scale and anchor node sparse network, pending a node cannot direct communication with enough anchor node distance, normal distance measurement method is difficult to locate, need to be considered at this time with a range of ways to estimate the distance between nodes, two algorithms has its own limitations.

According to node connectivity and topological classification can be divided into:

Single hop algorithm and multi-hop algorithm. One hop algorithm more jump algorithm is more simple, but there are some problems which is measuring range is too small, multiple jump algorithm applies more widely, when has a wide measuring range leads to the situation of the two nodes cannot direct communication is large, need more communication to solve.

The implementation of information processing can be divided into:

Distributed algorithm and centralized algorithm. In order to monitor and control the target algorithm, the data center is collected and processed in the data center, and the centralized algorithm is mostly used in the data center, which has a high precision but a large amount of traffic. Distributed algorithm is sensor node around the acquisition of information, in its own background localization algorithm, this method can reduce network traffic, but the node energy, computing power and storage capacity is limited, complex algorithm is difficult to implement in the actual platform.

Range-based Algorithm

The range-based method is the algorithm that the distance (Angle) between the nodes is measured by the way of physical measurement, and its positioning precision depends on the accuracy of these physical measurements itself to a certain extent. Several common measurement techniques include Time of Arrival (ToA), Time Diference of Arrival (TDoA), Angle of Arrival (AoA), Receiving Signal Strength Indication (RSSI), etc.

Distance Measurement Method

Receiving Signal Strength Indication (RSSI)

Based on the RSSI positioning algorithm, the propagation loss is calculated by measuring the transmit power and receive power. Then, using the theory and empirical model, the propagation loss is transformed into the distance between the transmitter and the receiver.

Advantage: Low cost. Each wireless sensor node has a communication module and it is easy to get RSSI values without additional hardware.

Disadvantage: ①The number of anchors is high. As the RSSI value in the practical application of the law is poor, so that the algorithm of locating with RSSI information is flawed in positioning accuracy and practicability. Therefore, in order to achieve high positioning accuracy, the algorithm using RSSI information usually requires more number of anchor nodes.②Multi-path reflection and non-visual problems can affect the precision of distance measurement.

The theoretical model commonly used in wireless signal transmission is the gradient model:

$$[P(d)]_{dBm} = [P(d_0)]_{dBm} - 10nlg\left(\frac{d}{d_0}\right) + X_{dBm} \quad (1)$$

In the formula, $P(d)$ represents the signal intensity received by the receiver when the transmitter is d, the RSSI value; $P(d_0)$ represents the signal power received by the receiving end when the transmitter is d_0; d_0 is the reference distance; n is path Loss (Pass Loss) index, usually by actual measurements, an obstacle, the more the greater the value of n, thus received the decrease of the average energy will be increased with the increase of the distance is becoming more and more fast; X is a Gaussian random variable with an average value of 0 in dBm, which reflects the change of energy received when the distance is certain.

In practice, a simplified gradient model is generally adopted:

$$[P(d)]_{dBm} = [P(d_0)]_{dBm} - 10nlg\left(\frac{d}{d_0}\right) \quad (2)$$

For ease of expression and calculation, the usual number of d_0 is 1m, so it is available.

$$[P(d)]_{dBm} = A - 10nlg(d) \quad (3)$$

It is possible to write $[P(d)]_{dBm}$ in the form of RSSI

$$RSSI = A - 10nlg(d) \quad (4)$$

Where, A is the RSSI value of the wireless signal strength received by the receiving node when the wireless transceiver node is 1m. The above model is the classical range model of RSSI, and the function relation between RSSI and d is given.

$$\text{So}d = 10^{(A-RSSI)/(10n)} \quad (5)$$

Time of Arrival (ToA)

Such methods estimate the distance between two nodes by measuring the transmission time. The accuracy is better. However, due to the fast transmission speed of the wireless signal, the small error in time measurement can lead to a large error value, so the sensor node is required to have a strong computing power. These two time-based ranging methods are applicable to multiple signals, such as Radio frequency, acoustic, infrared, and ultrasonic signals.

ToA mechanism is based on the signal propagation speed, the signal propagation time to calculate the distance between nodes. As shown in fig.3-1 below, a simple implementation process example of a ToA range is presented, and the pseudo-noise sequence signal is adopted as the acoustic signal. The distance between the nodes is measured according to the propagation time of the sound wave.

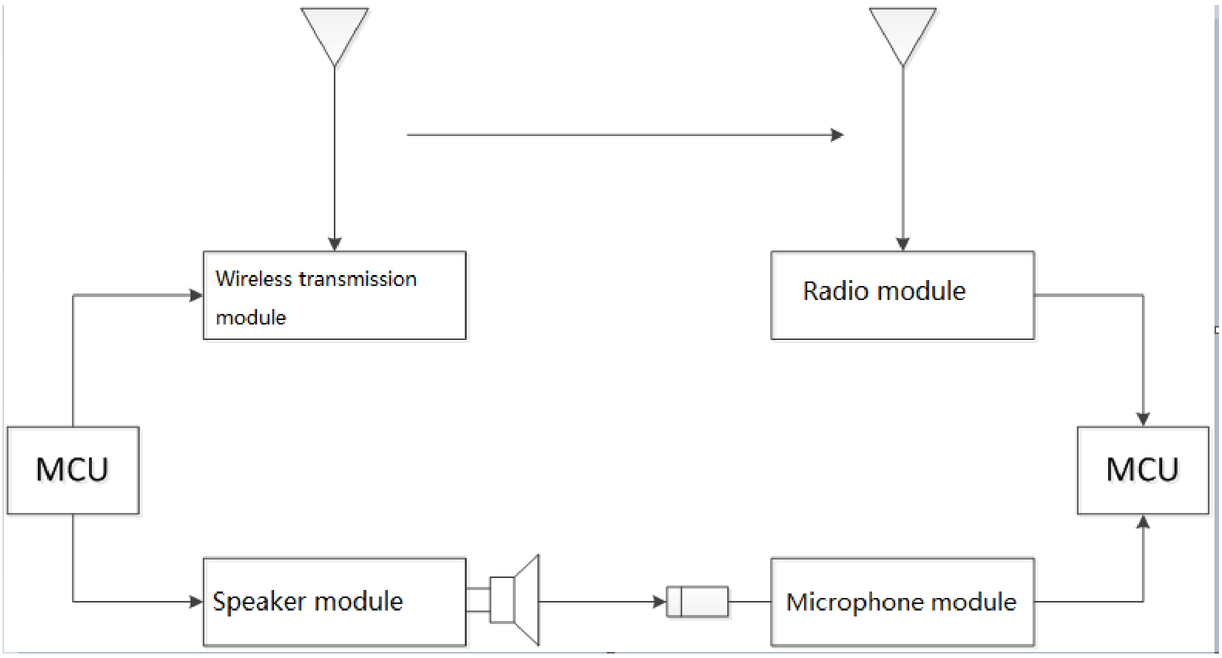

Figure .1 Toad range example

TOA technology by measuring the propagation time of the signal to calculate the distance, the technology can be divided into one-way range and two-way distance measurement. One-way distance measurement signal is only transmitted once and two-way distance measurement immediately after the arrival of the signal back. The former requires strict time synchronization between the two communication nodes, while the latter does not need time synchronization. The error of the local clock also causes a large distance deviation. The most typical application is the GPS positioning system.

Advantage: The measurement method is simple and can obtain high positioning accuracy.

Disadvantage: ①Accurate timing difficulty. Communication between sensor nodes usually use radio signals, as a result of the radio transmission speed is very fast and the distance between the sensor nodes is small, which makes the calculation transmission time between send and receive signals of the nodes is very difficult.②High precision synchronization is difficult. Some algorithms also need to have strict time synchronization between the receiving node and the sending node. The problem of time synchronization is also a hotspot in the wireless sensor network and is not completely solved. This also limits the practicability of the algorithm.③Vulnerable to noise. The signal transmitted in space is affected by various noises, so even if the same signal transmission time is obtained in different measurements, it can not be concluded that the distance between the transmitting node and the receiving node in the two measurements is the same.

Time Diference of Arrival (TDoA)

In the TDoA-based positioning mechanism, the transmitting node simultaneously transmits two different transmission speed wireless signals. The receiving node calculates the distance between the two nodes according to the time difference and the propagation speed between the two signals.

As shown in fig.3-2, launch node transmitting radio frequency signal and the ultrasonic signal at the same time, the receiving node to record the arrival time of these two kinds of signal T_1, T_2, known radio frequency signal and the ultrasonic transmission speed of c_1, c_2, so the distance between two points is $(T_2 - T_1)$S, which S $= c_1 c_2/(c_2 - c_1)$.

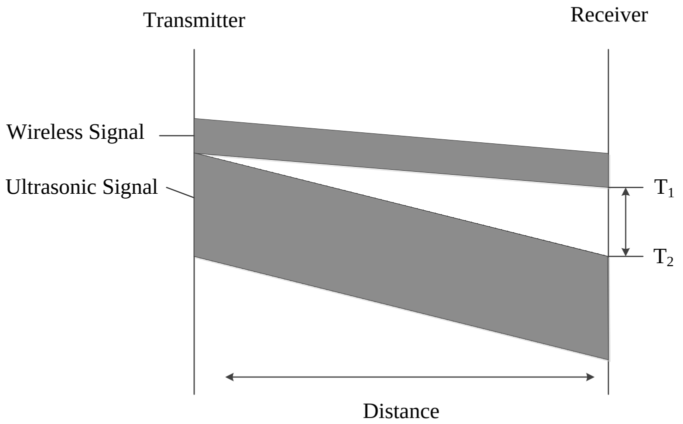

Figure .2 TDoA ranging principle

TDOA ranging technology is widely used in the positioning scheme of wireless sensor networks. Usually the node ultrasonic transceiver and radio frequency transceiver installed on, anchor node sends ultrasonic and electromagnetic wave at the same time when measuring distance. The receiving node calculates the distance between two points by the arrival time difference of the two signals.

Advantages: High positioning accuracy can be obtained in the case of LOS.

Disadvantages: ①High demand for hardware. Special hardware or ultrasonic transceivers must be attached to the sensor node, which increases the cost of sensing nodes.②Transmission signals are susceptible to environmental impacts. The transmission characteristics of sound waves or ultrasonic waves in the air are different from the general radio waves. The temperature, humidity or wind speed of the air will have a great influence on the transmission speed of the sound waves, which makes the estimation of the distance may be deviated. RF arrival time difference ranging range of 5 ~ 7 m, practicality is not strong, and the direction of ultrasonic propagation is single, not suitable for multi-point propagation.③Small scope of application. The premise of distance measurement is that there is no obstacle barrier between the sending node and the receiving node. In the case of an obstacle, the reflection, refraction and diffraction of the acoustic wave will occur. The actual transmission time will be increased at this time.

Angle of Arrival (AoA)

The AoA distance technology relies on the antenna array installed on the node to obtain the Angle information. Since most of the antennas are omnidirectional, there is no way to tell which direction the signal is coming from. Therefore, the technology requires special hardware devices such as antenna arrays or antennas to support them.

Advantages: Achieving good accuracy.

Disadvantage: Because the most energy-consuming part of the sensor node is the communication module, the energy consumption, size and price of the node with the antenna array should exceed the ordinary sensor node, contrary to the low cost and low energy consumption of the wireless sensor network. So the practicality is poor.

Node Location Method

I In the process of locating the sensor nodes, the unknown nodes use the following methods to calculate their own coordinates after obtaining the distance and angle for the adjacent beacon nodes.

Trilateration

Trilateration as shown in fig.3-3, the coordinates of three nodes A, B and C are known as (x_a, x_a), (x_b, x_b), (x_c, x_c), respectively. The distances from them to the unknown node D are d_a, d_b, d_c, respectively, assuming that the coordinates of node D are (x, y). Then there are the following formulas:

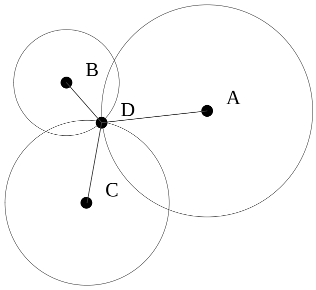

Figure .3 Schematic Diagram of the Trilateration

$$\begin{cases} \sqrt{(x - x_a)^2 + (y - y_a)^2} = d_a \\ \sqrt{(x - x_b)^2 + (y - y_b)^2} = d_b \\ \sqrt{(x - x_c)^2 + (y - y_c)^2} = d_c \end{cases} \tag{6}$$

You can get the coordinates of node D:

$$\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 2(x_a - x_c) & 2(y_a - y_c) \\ 2(x_b - x_c) & 2(y_b - y_c) \end{bmatrix}^{-1} \begin{bmatrix} x_a^2 - x_c^2 + y_a^2 - y_c^2 + d_c^2 - d_a^2 \\ x_b^2 - x_c^2 + y_b^2 - y_c^2 + d_c^2 - d_b^2 \end{bmatrix} \tag{7}$$

Triangulation

The principle of triangulation method as shown in fig.3-4, known to the coordinates of A, B, C three nodes respectively (x_a, x_a), (x_b, x_b), (x_c, x_c). The angle of node D relative to nodes A, B and C are ∠ADB, ∠ADC, ∠BDC, respectively. Assuming the coordinates of the node D are (x, y). For nodes A, C, and ∠ ADC, if the arc AC is within ∆ ABC, then a circle can be uniquely determined. Set the center of the circle to $O_1(x_{o1}, y_{o1})$ with a radius of r_1, then the angle $\alpha = \angle AO_1C = 2\pi - 2\angle ADC$, and the following formula exists:

$$\begin{cases} \sqrt{(x_{01} - x_a)^2 + (y_{01} - y_a)^2} = r_1 \\ \sqrt{(x_{01} - x_b)^2 + (y_{01} - y_b)^2} = r_1 \\ (x_a - x_c)^2 + (y_a - y_c)^2 = 2r_1^2 - 2r_1^2 \cos\alpha \end{cases} \tag{8}$$

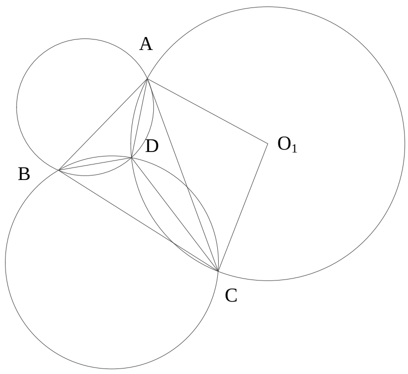

Figure .4 Schematic Diagram of the Triangulation

The coordinates and radius of the center point can be determined by (3-8). Similarly, A, B, ∠ ADB and B, C, ∠ BDC, respectively, to determine the corresponding center, radius. Finally, the coordinates of D are determined by three-edge measuring methods.

Maximum Likelihood Estimation

Maximum likelihood estimation is shown in fig.3-5. The coordinates of the nodes of 1, 2, 3 ... are respectively (x_1, y_1), (x_2, y_2), …, (x_n, y_n), and the distance between them are respectively d_1, d_2, …, d_n, assuming the coordinates of the unknown node are (x, y).

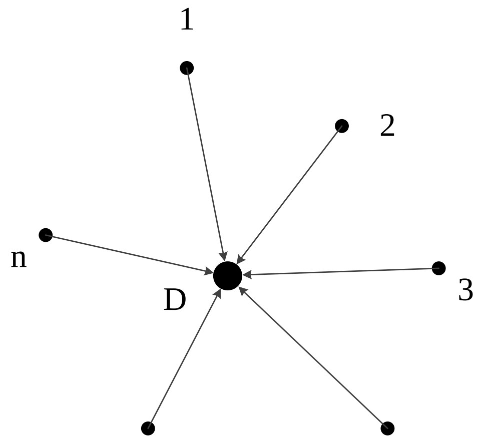

Figure.5 Maximum Likelihood Estimation Method

$$\begin{cases} (x_1 - x)^2 + (y_1 - y)^2 = d_1^2 \\ (x_2 - x)^2 + (y_2 - y)^2 = d_2^2 \\ \vdots \\ (x_n - x)^2 + (y_n - y)^2 = d_n^2 \end{cases} \tag{9}$$

Equation to:

$$\hat{X} = (A^T A)^{-1} A^T b \tag{10}$$

Then:

$$A = \begin{bmatrix} 2(x_1 - x_n) & 2(y_1 - y_n) \\ \vdots & \vdots \\ 2(x_{n-1} - x_n) & 2(y_{n-1} - y_n) \end{bmatrix} \tag{11}$$

$$b = \begin{bmatrix} x_1^2 - x_n^2 + y_1^2 - y_n^2 + d_n^2 - d_1^2 \\ \\ x_{n-1}^2 - x_n^2 + y_{n-1}^2 - y_n^2 + d_n^2 - d_{n-1}^2 \end{bmatrix} \tag{12}$$

$$X = \begin{bmatrix} x \\ y \end{bmatrix} \tag{13}$$

Range-free Algorithm

Range-free algorithm don’t need to measure distance and Angle information directly. It is not by measuring the distance between nodes to locate, but only according to the network connectivity determine the hops between nodes in the network. At the same time, according to the location of the reference node coordinates, to estimate the approximate distance of each hop. Finally, the position of nodes in the network can be estimate.

Centroid Algorithm

The geometric center of the polygon is called the center of mass, and the mean of the vertex coordinates of the polygon is the coordinate of the center of the center of mass in computational geometry. Assuming the coordinate vector of the vertex position of the polygon is represented by $p_i = (x_i, y_i)^T$, the calculation method of the centroid coordinate of the polygon is as follows.

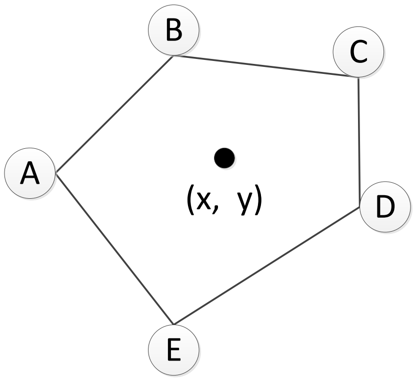

Figure .6 the Centroid Algorithm

$$(\bar{x}, \bar{y}) = \left(\frac{1}{n}\sum_{i=1}^{n} x_i, \frac{1}{n}\sum_{i=1}^{n} y_i \right) \tag{14}$$

Due to the different distance from the unknown node to different anchor nodes, the estimation of the location of unknown nodes is different from the anchor nodes of different distances. In order to further improve the positioning accuracy, a weighted centroid localization algorithm is presented:

$$(\bar{x}, \bar{y}) = \left(\frac{w_1x_1+w_2x_2+\cdots+w_nx_n}{\sum_{i=1}^{n} w_i}, \frac{w_1y_1+w_2y_2+\cdots+w_ny_n}{\sum_{i=1}^{n} w_i} \right) \tag{15}$$

In(3-14), w_i is the weight corresponding to the different anchor nodes.

DV-Hop Algorithm

The distance vector-hop (dv-hop) algorithm is very similar to the distance vector routing mechanism in traditional networks. In distance vector positioning mechanism, the unknown node firstly calculates the minimum hops of beacon nodes. Then, the average hop distance is calculated. And using the minimum hop multiplied by the average each hop distance, get the estimates of the distance between the unknown node and beacon node. Finally, the coordinates of unknown nodes are calculated by using the trilateration or maximum likelihood estimation. The localization process of dv-hop algorithm is divided into three stages:

Calculating the best hop from unknown node and beacon node.

The beacon node broadcasts the grouping of location information to the neighbor node, including the jump digital segment, which is initialized to 0. The receiving node records the minimum number of hops to each beacon node, ignoring the grouping of the maximum number of jumps from the same beacon node. The jump is then added to the neighbor node. In this way, all nodes in the network can record the minimum number of jumps to each beacon node.

Calculating the actual hop distance between unknown node and beacon node.

Each beacon node is based on the location information of other beacon nodes recorded in the first phase and the number of jumps, and the actual mean distance value of the average number of hops is calculated using the lower equation.

$$\mathrm{HopSize}_i = \frac{\sum_{j \neq i} \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}}{\sum_{j \neq i} h_j} \tag{16}$$

In(3-15), (x_i, y_i), $(x_j, y_j)$are the coordinates of the beacon node i, j, and h_{ij} is the hops between i and j.

Beacon node will then calculate each jump average distance with survival in the field of packet radio to network, only record the received each unknown node average distance, and go to the neighbor nodes. This strategy ensures that most nodes receive the average distance value from the nearest beacon node. After the unknown node receives the average value per hop, the jump distance of each beacon node is calculated according to the number of jumps recorded.

$$D_i = \text{hops} \times \text{HopSize}_\text{i} \quad (17)$$

The method of trilateration or maximum likelihood estimation is used to calculate its position.

The unknown node takes advantage of the jump distance of each beacon node recorded in the second phase, and calculates its own coordinates by using the method of trilateration or maximum likelihood estimation.

Figure 3-7 shows an example of a DV-Hop algorithm. After the first and second stages, the actual distance and hops among the beacon node L_1, L_2, L_3 can be calculated. Therefor, Then the average hop distance calculated by the beacon node L_2 is d $= (40 + 75)/(2 + 5) = 16.42$m. Assuming that the unknown node A obtains the average hop distance from L_2, the distance between the node and the three beacon nodes is: 3d, 2d, 3d. Finally, the coordinates of the nodes are calculated by trilateral measurement method.

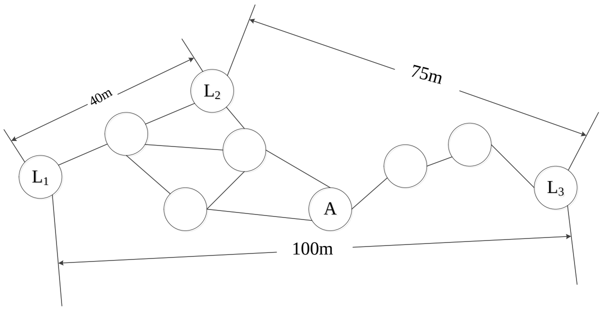

Figure .7 DV-Hop Algorithm Diagram

DV-Distance Algorithm

The DV-Distance algorithm is similar to the DV-Hop algorithm. The difference between them is that the DV-Hop algorithm calculates the distance between nodes by the average hop distance and hop count of the nodes. The DV-Distance algorithm is used by the radio Communication to measure the distance between nodes, that is, using RSSI to measure the distance between nodes, and then use the triangulation method to calculate the location of the node.

APIT Algorithm

The approximate point-in triangulation test (APIT) first defines a number of triangular regions containing unknown nodes. The intersection of these triangular regions is a polygon that determines a smaller region containing unknown nodes. Then the centroid of the polygon area is calculated and using the centroid as the location of the unknown node.

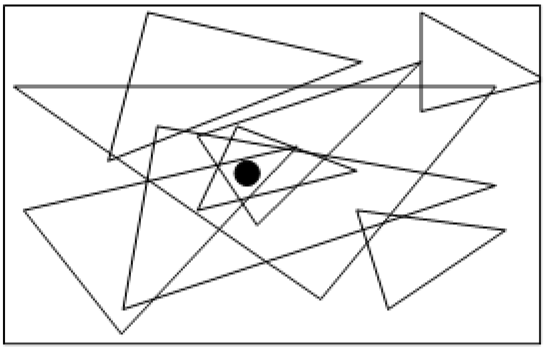

Figure .8 APIT Algorithm Diagram

APIT positioning specific steps:

Collect Information: The unknown node collects information about the neighboring beacon nodes, such as location, identification number, received signal strength, etc., and the neighbor nodes exchange information of the respective received beacon nodes.

APIT Test: Test whether the unknown nodes are within the triangle of the different beacon nodes.

Computing Overlap Region: Counting triangles that contain unknown nodes and computing overlapping areas of all triangles.

Calculating Unknown Node Location: Computes the center of mass of the overlapping region as an unknown node.

In the wireless signal propagation mode is irregular and under the condition of random deployment of sensor nodes, APIT algorithm is of high precision, stable performance, but APIT test for network connectivity is put forward higher requirements. Compared with the calculation of simple centroid localization algorithm, APIT algorithm has high accuracy and low distribution requirements for beacon nodes.

Positioning mechanism based on the distance between nodes through actual measurement of the distance or Angle, usually relatively high positioning accuracy, but also puts forward the high to the node hardware requirements, positioning in the process of the energy consumption is relatively more. The distance independent positioning mechanism does not need to measure the absolute distance or orientation between nodes, and the requirement of node hardware is lower, so that the node cost is more suitable for the large-scale sensor network. Distance irrelevant positioning mechanism positioning performance is affected by the external environment is small, corresponding larger positioning error, but the positioning precision can meet the requirements of most sensor network use, is the current focus on positioning mechanism.

4. WSN Application Research

Hu and Evans first introduced the monte carlo localization algorithm in robot positioning to mobile wireless sensor network in 2004 [12]. Baggio and Langendoen Monte Carlo localization in WSN is improved, puts forward the Monte Carlo localization algorithm MCB box (Monte Carlo localization boxed, MCB), through the construction of anchor box and anchor box of reducing sampling space to improve the efficiency of positioning and location accuracy [13]. Hartung proposed auxiliary sensors such as monte carlo localization algorithm SA - MCL (Sensor - Assisted - MCL, SA - MCL) algorithm, and Sensor for the auxiliary anchor node density is low or no cases of anchor node movement direction and speed, position precision is improved [14]. Yi et al. proposed the multi-hop Monte Carlo Localization algorithm, MMCL, to make full use of the relevant information of anchor nodes and have better positioning accuracy in the wireless sensor network with low anchor node density [15]. Niu proposed NMCT (will be Monte Carlo - -based Tracking algorithm, NMCT) algorithm, through the Monte Carlo localization algorithm to collect some samples, and then through the two attachment on both sides of the perpendicular bisector of anchor node, received two different received signal strength of anchor node size for sample points selection, the positioning precision is improved [16]. Tian Haosha etc. This paper proposes a Feedback Time sequence combined with Monte Carlo localization algorithm TSMCL (Feedback Time Series - -based Monte Carlo, TSMCL), which is Based on the target node 1 jump neighbor anchor nodes Feedback mechanism of sequential sampling, narrowed the sample space, improves the sampling efficiency and positioning accuracy [17].

F. aballero etc. Put forward the use of wireless sensor network system for auxiliary positioning technology, it without any previous location information of nodes can measure three-dimensional node location information [18]. Lai Xini etc for target nodes move quickly or in the case of an emergency based on wireless sensor network (WSN), a fast and accurate positioning model, through the simulation experiment has obtained the good effect [19]. Shi Shuo, etc in the study design a set of indoor positioning scheme based on WSN, in which wireless sensor module, using the independent innovation CC2510 chip, greatly improving the positioning accuracy [20]. On the basis of the positioning of various soft computing methods, Chakchai so-in has proposed and improved the Extreme Learning Machine (Extreme Learning Machine), which has been evaluated by simulation to further improve the positioning accuracy [21]. Yingbiao Yao, etc on the basis of two-dimensional logarithm search algorithm, the proposed distributed weighted search algorithm (WSLA) and on the basis of the algorithm is improved algorithm (WSRA), the ideal result is obtained by simulation analysis [22].

5. Conclusion

So far, the study on the orientation of wireless sensor network (WSN) has been widely carried out and obtained many research achievements, but there are still some issues not been resolved or was found, the most critical problems still WSN node energy consumption problems, all of the localization algorithm should be in precision and select one of the more obvious effect on energy consumption. The existing problems and possible solutions are described below.

a) Poor Practicability: Most of the positioning algorithm based on the distance is only stay in the theoretical research stage, and is mostly under the simulation environment, need to assume that a lot of uncertain factors, and these factors often cannot meet in practical application, these algorithms has lost its real meaning. Therefore, the design of positioning algorithm should be more practical and practical based on practical application.

b) Application Environment Single: Most of the algorithms are both designed for a specific application scenario, that is, each algorithm can only solve the problem of special or applied to specific scenes, once the environment changes, algorithm or the system measurement error will increase even no longer apply. Therefore, it is a new challenge to explore more general positioning algorithm or positioning system and apply it to more complex and changeable environment.

c) Constrained by Hardware: In actual location, some algorithms due to the limitation of sensor node hardware cost and performance, such as need some algorithm in GPS positioning nodes increases, ultrasonic transceiver, have to the antenna array devices, such as increasing the node hardware cost, hinders its application in the actual positioning system. Therefore, the algorithm design should consider the actual situation of WSN nodes, such as adding additional hardware to some nodes, or using other location algorithms based on the actual node resource constraints.

d) The Limited Energy: The problems of measurement accuracy, fault tolerance and energy consumption are also hot spots in the research of wireless sensor networks. Usually, high measurement accuracy and low energy consumption can not be combined, and it is often necessary to make effective tradeoffs in measuring accuracy and energy consumption. So, can improve the capacity of energy storage device, or use of possible external environment resources provide the energy for the node direction are studied, in addition, high efficiency, energy saving, in line with the actual situation of wireless sensor network localization algorithm will have realistic significance.

e) Security and Privacy Problems: Security and privacy issues are also a major research direction in a wide range of wireless sensor networks. On the one hand, some applications require node location information; on the other hand, disclosing location information to nodes that do not need to know the location will expose the network to security problems. In addition, in view of the nature of the wireless sensor network (WSN), the centralized algorithm in background processing locator makes the position of the node information is through layer upon layer transfer node knows too much, so the distributed algorithm is compared with the centralized algorithm can decrease The Times of information transfer and enhance network security. In addition, the use of information encryption in network communication can also improve network security.

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