Positioning and Ranging Process of RSSI Algorithm Based on ZigBee Technology

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Abstract: Communication and positioning systems in wireless network are merging and promoting each other. Using wireless communication and parameter measurement to determine the location of mobile nodes, node location information can be used to support location services and optimize network management, improve the location service quality and network performance. In various wireless networks, the location algorithm, location technology and location system to obtain the location information of mobile nodes quickly, accurately and in real time have become the current research hotspot. Based on ZigBee technology, RSSI algorithm is used to complete the positioning and ranging from anchor point to label point, and the positioning and ranging method is applied to practical engineering.

1. Introduction
With the development of wireless communication technology and the improvement of data processing capability, location-based service has become one of the most potential mobile Internet services. Whether in the indoor or outdoor environment, the demand of quickly and accurately obtaining mobile location information and providing location services becomes the main research object.

The performance of positioning system is not only the standard to evaluate the positioning system and algorithm of wireless sensor network, but also the goal to design and implement the positioning system. In order to achieve the optimization of these objectives, a lot of research work needs to be completed. At the same time, these performance indicators are interrelated, so we must make trade-offs according to the specific needs of the application, in order to design appropriate positioning methods and technologies.

ZigBee technology is used in short distance and low rate wireless communication technology. ZigBee technology is mainly used for data transmission between various electronic devices with short distance, low power consumption and low transmission rate, as well as the application of periodic data, intermittent data and low response time data transmission.

ZigBee is a highly reliable wireless data transmission network. ZigBee data transmission module is similar to mobile network base station.

ZigBee module is a wireless data terminal of Internet of things, which uses ZigBee network to provide users with wireless data transmission function. ZigBee interface can be used to realize the function of digital input and output, and ZigBee interface can realize the function of direct input and output.

In many cases, sensor nodes are randomly deployed in a certain area, the nodes can not know their own location in advance, so they need to obtain their own location information through positioning technology after deployment.
2. Location method based on distance measurement
Firstly, the distance (R1, R2, R3) between the reference point (a, B, c) of known position and the object to be measured should be measured, and the position of the object to be measured should be calculated by triangle knowledge.

There are three methods of distance measurement

2.1 direct measurement
The distance between the reference point and the measured object is measured by physical action and movement. The robot moves its probe until it touches the obstacle, and takes the distance of the probe as a distance parameter between itself and the obstacle.

2.2 transmission time
When the propagation speed is known, the distance of radio wave propagation is proportional to its propagation time. The following problems should be paid attention to in the measurement method:
- The propagation characteristics of radio wave;
- Clock accuracy;
- Clock synchronization.

2.3 radio wave energy attenuation
Given the strength of the transmitted radio wave, the received radio wave strength is measured at the receiver to estimate the distance between the transmitter and the receiver. In the ideal propagation environment, the attenuation of radio wave is proportional to $1 / R^2$, and R is the propagation distance. The energy attenuation of radio wave in space is affected by many factors, which has no advantage over the propagation time measurement method.

3. Composition of wireless positioning system
The basic idea of node positioning is to calculate the position of the object to be measured by using the geometric triangle relationship according to the measured data. It is the most important and widely used positioning technology.

Location method based on distance measurement. Assuming that the location information of some nodes in the wireless network is known, the location information of other nodes is estimated by some means. There are usually two steps: ranging and position estimation.

In order to get the location information of the unknown node, the distance between the beacon node and the unknown node must be determined first.

3.1 wireless positioning system node
The node of wireless positioning system consists of MCU, ram, display device, receiver and transmitter. The receiver receives data information, which is processed by MCU. The data information is stored in RAM, and the display outputs information system. The transmitter sends data to other nodes.

The node of wireless positioning system is shown in the figure.
3.2 Node structure layout of wireless positioning system

In the node layout of wireless positioning system, M1, M2 and M3 are used as anchor nodes. W as the node to be tested, unknown node. The positioning process of M2, M2 and M3 is completed.

3.3 Mathematical model of RSSI for wireless signal strength

$$\text{RSSI} = f(A,N,d)$$

$$\text{RSSI} = A - 10 \times \text{log}(d)$$

Where, $a$ is the RSSI value of the wireless signal strength received by the receiving node when the distance between the wireless transceiver nodes is 1 m. The function relationship between RSSI and $D$ is given. According to the mathematical model, the distance between the receiver and the transmitter can be calculated when the RSSI received by the receiver is known. $A$ is the empirical value of the specific hardware node; $n$ is the empirical value closely related to the environment of line signal propagation. In different environments, the parameters of $a$ and $N$ are different, and their ranging models are different.

3.4 Estimation of ranging

Set 3 anchor points M1, M2 and M3, 1 label point W, and give 4 sampling signal strength values. As shown in the table, the calculation and estimation of which anchor station is closest to point w indicates the positioning process of using ZigBee technology and RSSI algorithm.
Zigbe technology is a bionic bee flapping wireless communication technology. RSSI is a signal strength positioning algorithm. RSSI estimation method estimates the distance between anchor point and label point by measuring the signal strength between anchor point and label point. Complete the estimation and location of the distance between two points. According to the calculation data in Table 1, the distance of W point is estimated.  
Calculation M1 -- W  
Then: rssi1 = 0.006525  
Calculation M2 -- W  
Then: rssi2 = 0.008600  
Calculation m3 -- W  
Then: rssi1 = 0.007075  
It is estimated that the tag point W is closest to the M2 base station.

4. conclusion
In this paper, the system engineering method is used to analyze the node positioning technology in wireless network system. This paper explains that wireless network positioning involves the knowledge and basic concepts of mobile wireless communication, mathematics, geographic information, computer science and other disciplines; discusses the positioning method based on RSSI algorithm; evaluates the standard of wireless sensor network node positioning system and algorithm, and puts forward the goal of wireless network node positioning design and implementation.

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