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8 Indoor Real Time Location Systems

RTLS is a signal-based radio positioning method, which can be active or passive inductive. Among them, active type is divided into AOA (angle of arrival), TDOA (Time Difference of Arrival), TOA (time of arrival), TW-TOF (two-way time of flight), NFER (near-field electromagnetic ranging) and so on.

**1. Bluetooth indoor positioning technology**

Bluetooth indoor technology uses several Bluetooth LAN access points installed indoors to maintain the network as a multi-user-based basic network connection mode and ensures that the Bluetooth LAN access point is always the master device of this Micronet, and then measures the signal by Intensity triangulate the newly added blind nodes.

At present, there are two main methods for Bluetooth iBeacon positioning: RSSI (received signal strength indication) and positioning fingerprint, or a combination of the two.

The biggest problem based on distance is that the indoor environment is complicated, and Bluetooth, as a 2.4GHz high-frequency signal, will be greatly interfered with. Coupled with various indoor reflections, the RSSI value obtained by the mobile phone does not have much reference value; at the same time, in order to improve the positioning accuracy, it is necessary to obtain the RSSI value multiple times to smooth the result, which means that Increased delay. The biggest problem with location-based fingerprints is that the labor and time costs of obtaining fingerprint data in the early stage are very high, and database maintenance is difficult. And if the mall adds a new base station or makes other changes, the original fingerprint data may no longer be applicable. Therefore, how to balance and choose between positioning accuracy, delay, and cost has become the core issue of Bluetooth positioning.

The mainstream Bluetooth positioning accuracy in the market is that 70% of the lot is within 2 meters, and some companies can achieve 90% of the lot within 2 meters. At present, the mainstream Bluetooth positioning technologies on the market are based on the triangular positioning algorithm. The signal strength of the surrounding Bluetooth base stations is obtained through the mobile phone, and then other auxiliary methods such as weighted average algorithm, time-weighted algorithm, inertial navigation algorithm, kalman filter algorithm, etc. Gaussian filtering algorithm etc. to calculate the current position.

Advantages: small device size, short distance, low power consumption, easy to integrate in mobile devices such as mobile phones;

Disadvantages: Bluetooth transmission is not affected by line-of-sight, but for complex space environments, the stability of the Bluetooth system is slightly worse, subject to noise Signal interference is large and the price of Bluetooth devices and equipment is relatively expensive;

Application: Bluetooth indoor positioning is mainly used for small-scale positioning of people, such as single-story halls or shops.

**2 indoor WiFi positioning technology**

There are two types of Wi-Fi positioning technology. One is to use the difference between the wireless signal strengths of the mobile device and the three wireless network access points to accurately position people and vehicles in a triangulation. The other is to record the signal strength of a large number of determined location points in advance and determine the location by comparing the signal strength of the newly added device with a database with huge amounts of data. Advantages: high overall accuracy, low hardware cost, and high transmission rate; can be used to implement complex large-scale positioning, monitoring, and tracking tasks. Disadvantages: short transmission distance and high power consumption, generally star topology.

Application: Wi-Fi positioning is suitable for positioning and navigation of people or cars. It can be used in various places such as medical institutions, theme parks, factories, shopping malls and other places where navigation is required. Wi-Fi indoor positioning mode

**3 RFID indoor positioning technology**

Radiofrequency identification (RFID) indoor positioning technology uses the radiofrequency method. The fixed antenna adjusts the radio signal into an electromagnetic field. The tag attached to the object enters the magnetic field and the induced current is generated. Purpose of positioning.

Radiofrequency identification (English: Radio Frequency IDentification, abbreviation: RFID) is a wireless communication technology that can identify specific targets and read and write related data through radio signals without the need to establish mechanical or optical contact between the identification system and the specific targets.

The radio signal is transmitted through the electromagnetic field tuned to radiofrequency, and the data is transmitted from the tag attached to the article to automatically identify and track the article. “Some tags can get energy from the electromagnetic field emitted by the identifier when they are identified and do not need a battery; some tags have a power source and can actively emit radio waves (electromagnetic fields tuned to radiofrequency). The tag contains electronically stored information that can be identified within a few meters. Unlike barcodes, radio frequency tags do not need to be in the line of sight of the identifier, but can also be embedded in the tracked object.

Advantages: The indoor positioning technology of radio frequency identification is very close, but it can obtain the information of centimeter-level positioning accuracy within a few milliseconds; the size of the tag is relatively small, and the cost is relatively low.

Disadvantages: no communication capability, poor anti-interference ability, not easy to integrate into other systems, and user security and privacy protection and international standardization are not perfect.

Application: RFID indoor positioning has been widely used in warehouses, factories, and shopping malls for the positioning of goods and goods circulation.

**4 Zigbee indoor positioning technology**

ZigBee (low-power local area network protocol based on IEEE802.15.4 standard) indoor positioning technology forms a network between several nodes under test and reference nodes and a gateway. The nodes under test in the network send out broadcast information, and from each neighboring reference The nodes collect data and select the X and Y coordinates of the reference node with the strongest signal. Then, the coordinates of other nodes related to the reference node are calculated. Finally, the data in the positioning engine is processed, and the offset value from the nearest reference node is considered, so as to obtain the actual position of the node to be tested in the large network.

From the bottom to the top of the ZigBee protocol layer are the physical layer (PHY), media access layer (MAC), network layer (NWK), and application layer (APL). The roles of network devices can be divided into three types: ZigBee Coordinator, ZigBee Router, and ZigBee End Device. There are three types of network topology: star, tree, and network.

Advantages: low power consumption, low cost, short delay, high capacity and high security, long transmission distance; can support mesh topology, tree topology and star topology, flexible networking, and multi-hop transmission.

Disadvantages: The transmission rate is low, and the positioning accuracy requires higher algorithms.

Application: Zigbee system positioning has been widely used in indoor positioning, industrial control, environmental monitoring, smart home control and other fields.

**5 UWB positioning technology**

Ultra-wide band (UWB) positioning technology is a new technology that is very different from traditional communication positioning technology. It uses the anchor nodes and bridge nodes of known locations that are arranged in advance to communicate with newly added blind nodes, and uses triangular positioning or "fingerprint" positioning to determine the location.

Ultra-wide band wireless (UWB) technology is an indoor high-precision wireless positioning technology that has been proposed in recent years. It has a time resolution capability of up to nanosecond level. In combination with a time-of-arrival-based ranging algorithm, it can theoretically reach centimeter-level positioning accuracy and can meet Positioning needs for industrial applications.

The entire system is divided into three layers: management layer, service layer, and field layer. The system hierarchy is clear and the architecture is clear.

The field layer consists of positioning anchors / Anchor and positioning tags / Tags:

Anchor

The positioning anchor calculates the distance between the tag and itself, and returns the packet to the location calculation engine through wired or WLAN.

Positioning tags

The tag is associated with the person or item being located, communicates with Anchor and broadcasts its location.

Advantages: With a bandwidth of the order of GHz, high positioning accuracy; strong penetration, good anti-multi-path effect, and high security. Disadvantages: However, since newly added blind nodes also need to actively communicate, power consumption is high, and the system cost is high;

Application: Ultra-wide band technology can be used for radar detection, as well as indoor precise positioning and navigation in various fields.

**6 Infrared indoor positioning**

There are two types of indoor infrared positioning. The first is to use the infrared IR mark as a moving point for the target. The modulated infrared radiation is emitted and received by the indoor optical sensor for positioning. The second is to use multiple pairs of transmitters and receivers. The woven infrared net covers the space to be measured and directly locates the moving target. Advantages: high indoor positioning accuracy and strong anti-interference ability;

Disadvantages: Infrared rays can only be transmitted through the line of sight, and the penetration performance is extremely poor. When the logo is blocked, it cannot work normally, and it is also very susceptible to environmental factors such as light and smoke.

The transmission distance is not long, which makes it in the layout. No matter which way, the receiving end needs to be installed behind each occlusion or even the corner. The layout is complicated and the cost is high.

Applicable: It is suitable for the precise positioning record of simple objects' trajectories in the laboratory and the positioning of indoor self-propelled robots.

**7 Ultrasonic positioning system**

The ultrasonic positioning technology is developed based on the ultrasonic ranging system. It consists of several transponders and a main rangefinder: the main rangefinder is placed on the object to be measured, and the same radio signal is transmitted to the fixed transponder, and the transponder is receiving After arriving at the signal, an ultrasonic signal is transmitted to the main rangefinder, and the position of the object is determined by using algorithms such as reflection ranging and triangulation. Advantages: The overall positioning accuracy is very high, reaching the centimeter level; the structure is relatively simple, has a certain penetration and the ultrasonic itself has a strong anti-interference ability.

Disadvantages: The attenuation in the air is large, and it is not suitable for large-scale occasions; reflection ranging is greatly affected by multi-path effects and non-line-of-sight propagation, resulting in investment in the underlying hardware facilities that require accurate analysis and calculation, which is too costly.

Application: Ultrasonic positioning technology has been widely used in digital pens, and such technology is also used in offshore prospecting. Indoor positioning technology is also mainly used for object positioning in unmanned workshops.

**8 iBeacon positioning**

iBeacon is a new type of precise indoor micro-location technology based on Bluetooth 4.0. Currently, iOS, Android, Windows and BlackBerry system devices are equipped with Bluetooth Low Energy Technology (BLE). When your handheld device is near an iBeacon base station, the device can sense the iBeacon signals (UUID and RSSI), which can range from a few millimeters to 50 meters. The accurate position can be obtained through a weighted three-loop positioning algorithm, which can generally reach 2m the accuracy.

iBeacon is a set of protocols that can be used in indoor positioning systems by Apple, which is a "new low-power, low-cost signal transmitter that can be detected by nearby handheld electronic devices." This technology enables a smart phone or other device to execute corresponding commands within the sensing range of an iBeacon base station.

This is an application that helps smartphones determine their approximate location or environment. With the help of an iBeacon base station, the software of the smartphone can roughly find its relative position with this iBeacon base station. iBeacon allows mobile phones to receive notifications of goods sold nearby, and also allows consumers to complete payment at a point of sale POS machine without taking out a wallet or credit card. iBeacon technology is implemented through Bluetooth Low Energy (BLE), also known as Smart Bluetooth.