

Bluetooth Technology Applied in Indoor Positioning

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Abstract

Nowadays, with the rapid development of wireless network and multimedia service, indoor wireless positioning technology is developing very fast. At this point, many new technology emerges. People's demand and requirement for positioning and navigation gradually improve a lot, particularly for complex indoor environment. Indoor positioning is often limited to time and position precision and complex indoor environment conditions. At this stage, we haven't found a sound way to solve this. So it is of great realistic significance to analyze bluetooth indoor wireless positioning technology to promote the domestic wireless system technology level. Firstly, this paper introduces indoor positioning technology; then explains bluetooth indoor wireless positioning; and lastly analyzes technology implementation of bluetooth indoor wireless positioning.

Keywords

Bluetooth technology, indoor positioning, positioning technology.

1. Introduction

At present, the main way of positioning all over the world is wireless positioning technology, mostly applied in navigation, transportation, and engineering. The technology of using satellites to get precise positioning has been mature, however, wireless communication system positioning is also developing rapidly. Because of its low price and flexibility, it is widely used in big occasions in recent years. Bluetooth is one of the wireless technology, which owns low power consumption and convenient applications. The emerging of bluetooth 4.0 protocol fully enhances the data transmission and power and bit error rate, etc.. This paper discusses bluetooth indoor wireless positioning, and puts forward practical technical implementation strategy. At first, indoor positioning technology is briefly introduced.

1.1 Indoor positioning technology

Indoor positioning which adopts wireless communication and base station positioning and navigation positioning is to achieve position location in the indoor environment. It combines a variety of technologies to achieve a set of indoor positioning system. The goal of indoor positioning is to closely monitor the position of people and objects in indoor space.

1.2 The principle of wireless positioning

Usually two and two or more lines and curves can determine the point in a two-dimensional plane, and meanwhile, can determine the space relationship between point coordinates and the known coordinates. According to this, there are four methods: the arrival time method, the arrival time difference method, the arrival angle method and the signal strength method. Firstly, the arrival time method is to measure the undetermined node and know the signal arrival time for no fewer than three beacon nodes, and the time multiplied by the speed of signal can attain the undetermined node and each beacon point distance. Then the beacon node is considered as the center of the circle, and the distance is seen as the radius of the circle. So the circle intersection is the beacon node coordinate. Secondly, due to the strict time

synchronization, this will increase the cost of hardware. So the arrival time difference method is used. This method is not strict with the time synchronization between the beacon node and the undetermined node. Because of its simple positioning system, it is widely used. Thirdly, the positioning principle of the arrival angle method is that the undetermined node transmits radio signals to beacon nodes, and uses the antenna of the beacon node to measure the signal arrival angle, and determines the undetermined node and the angle of the beacon node. Then the undetermined node is calculated using geometric principle, and no less than two signals and arrival angles should be measured in the two-dimensional space. And take the intersection at line direction, and at this moment, the undetermined node coordinate can be obtained. Lastly, the signal strength method is mainly that it uses signal receiver to measure the received power, and uses the propagation loss model to formulate the distance between nodes, and measures the undetermined node and the distance for no fewer than three beacon nodes. Then the beacon node coordinate can be calculated.

2. Bluetooth indoor wireless positioning

Bluetooth technology belongs to the short distance wireless communication technology, and it combines fixed and mobile information devices to achieve individual LAN, using the wireless connection. So that the wireless interconnection communication between devices can be implemented within low cost. Next, this paper analyzes indoor wireless positioning based on bluetooth technology, and designs to construct bluetooth indoor positioning system.

2.1 Bluetooth technology

As we all know, bluetooth technology belongs to the low power wireless technology, and bluetooth 4.0 protocol makes bluetooth data transmission rate and power consumption and bit error rate to get improved. Bluetooth technology can be applied to replace cable links in any place at any time, using the wireless interface. And it is mainly used in all kinds of communication scenarios. Bluetooth device which searches for another bluetooth device can immediately connect this device without any corresponding set. Usually the advantage of bluetooth technology is more significant in complex radio environment.

2.2 The technology analysis of bluetooth chip CC2540

Fig.1 shows the brief structure of Bluetooth chip CC2540. CC2540 is a SOC(system on chip) solution with high performance and low power dissipation, and it is suitable for bluetooth low power applications. It contains a RF transceiver with a great industrial standard 8051 kernel, programmable flash memory, 8KB RAM, other powerful features and peripherals.

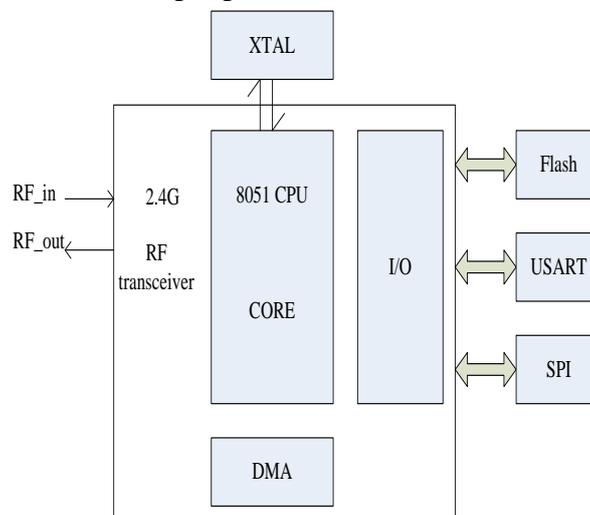


Fig.1 The brief structure of Bluetooth chip CC2540

CC2540 is suitable for low power system, and its low power sleep mode and low power consumption and transformation of running mode further achieve the low power consumption. CC2540 combines TI low power bluetooth protocol stack, and becomes the most flexible and most cost-effective single mode bluetooth BLE solution on the market. It owns many important features, such as SOC solution of low power, integrated RF module, few peripherals, low power consumption, and inner micro controller. Its receiving sensitivity is -93dBm. As we know, a problem of indoor positioning is how to measure the distance between communication nodes. At this moment, an easy way to complete the measurement of the distance is to measure the value of RSSI(Received Signal Strength Indication) to calculate the distance. The relationship of power and distance in wireless communication is as follows: $P_R(dBm) = A - 10 * n * \lg r$, A is considered as the power of the received signal when the signal transmits one meter, and n is the propagation factor(it is influenced by obstacles, temperature and humidity), and r is the distance between nodes. When A and n are confirmed, r can be calculated according to $P_R(dBm)$.

Another question is how to obtain the value of RSSI of bluetooth nodes. For different devices, there are different ways to get the value of RSSI. Take the iphone for example, iOS provides the API function to obtain the value of RSSI, and for CC2540 in the BLE protocol stack, first put the value of RSSI into the function and then establish connection, and the main device uses the GAP function to read the value of received RSSI. After this, an experiment is completed to read the value of RSSI. Then we set up the experimental environment as follows, the host is fixed, and sends the signal to the slave, and the slave adopts LED and Buzzer to indicate the success of receiving the signal, and then move the slave gradually, and obtain the relationship between the value of RSSI and the physical distance. According to this, the communication nodes can be mostly estimated. In order to get more accurate results, take more experiments and adopt better sampling algorithm.

3. Technology implementation of bluetooth indoor wireless positioning

3.1 The application characteristics of the bluetooth serial port

When the bluetooth serial port is used, it is free to choose the use of authentication and encryption. And these are the supports of safety features, and authentication and encryption for key support. In the connection establishment phase of application security, bluetooth device can match another device with bluetooth serial port, and establishes analog serial cable connection. In this period, it should perform the service discovery process. And then adopt RFCOMM to transport data, and use modem to control signal modulation, and meanwhile, allocate various aspects of command efficiently.

3.2 The program implementation of access point

The steps of program implementation of access point are as follows: firstly, initialize the bluetooth device, and complete the initialization of PIO(parallel input output), and configure the task function of controlling PIO; the second step is to configure application task processing function of bluetooth serial port, and initialize application devices of bluetooth serial port, and meanwhile, initialize the channel number of RFCOMM, and set up the priority and the state of the application of serial port, and then initialize the storage space, and set up the task to return to the end of the service; and next, handle connection tasks configuration, and initialize the management of the multipoint transmission; and then, register the safe mode of the device, and record the properties of the device, and change the state of the device to enter the query mode; and then establish connection, and search the device, and then obtain the address of another bluetooth, and at the same time, the bluetooth address of each device is unique; and at last, read the value of RSSI, and after establishing connection, use function to read the value of RSSI, and meanwhile estimate the distance between the transmitting device and the receiving device, and usually the return value is a value of 8 bit integer between -128 and 127. Fig.2 depicts the brief implementation of access point program.

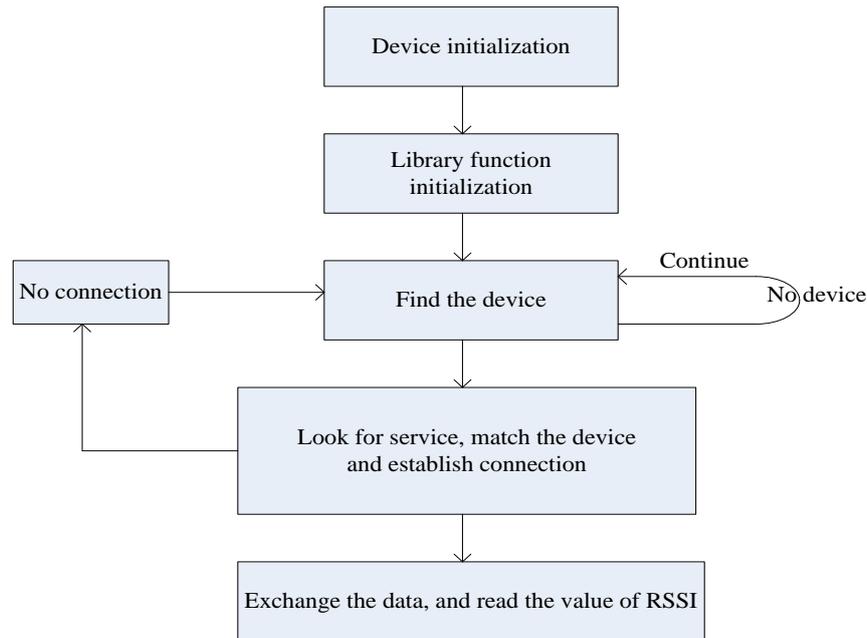


Fig.2 The brief implementation of access point program

4. Conclusion

In conclusion, with the development of the new technology, indoor wireless positioning is more and more widely applied in big occasions, and bluetooth technology owns lower power consumption and wireless connection and high performance, so it is of great importance to analyze bluetooth technology applied in indoor positioning. This paper introduces indoor positioning technology; then explains bluetooth indoor wireless positioning; and lastly analyzes technology implementation of bluetooth indoor wireless positioning.

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References

- [1]Li X, Wang J, Liu C. A Bluetooth/PDR Integration Algorithm for an Indoor Positioning System. *Sensors*. 2015; 15(10), pp.24862-24885.
- [2]Harle, R. A survey of indoor inertial positioning systems for pedestrians. *Commun. Surveys Tuts*.2013, 15, pp.1281–1293..
- [3]Wang, J.; Hu, A.; Liu, C.; Li, X. A Floor-Map-Aided WiFi/Pseudo-Odometry Integration Algorithm for an Indoor Positioning System. *Sensors* 2015, 15, pp.7096–7124.
- [4]M. Ryan, “Bluetooth: With Low Energy Comes Low Security,” *Proc. 7th USENIX Conf. Offensive Technologies*,USENIX Association, 2013, pp. 4–4.
- [5]Liu J, Chen C, Ma Y, Xu Y. Energy analysis of device discovery for bluetooth low energy. In: *IEEE 78th vehicular technology conference (VTC Fall)*; 2013,pp. 1–5.
- [6]Siekkinen M, Hienkari M, Nurminen J, Nieminen J. How low energy is bluetooth low energy? comparative measurements with zigbee/802.15.4. In:*IEEE wireless communications and networking conference workshops (WCNCW) 2012*,pp. 232–7.