Mobile Node Design of Indoor Positioning System Based on Bluetooth and LoRa Network

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Abstract. This paper introduces an indoor positioning system based on LoRa and Bluetooth network. The system uses LoRa communication protocol for network communication, and uses Bluetooth technology to locate the mobile node in the indoor area. The positioning data is transmitted through LoRa network to realize real-time accurate positioning in a large area. The system is composed of mobile nodes, Bluetooth beacons, LoRa gateway, etc., which has low power consumption and low cost, flexible deployment, high performance and other features, can be widely used in large industrial parks that need to locate personnel and equipment and all other indoor positioning scenarios.

1. Introduction

In recent years, with the continuous development and popularization of wireless communication technology and network technology, a variety of new services and new requirements emerge in endlessly. Among them, location awareness and location-based service (LBS) play an important role in people's production and life. How to determine the target location is the first problem to implement the above-mentioned applications, and positioning technology has attracted the attention of both the research field and the industry[1]. From outdoor positioning technology based on GPS, short-distance positioning technology based on infrared and ultrasonic, and indoor positioning technology based on wifi signal, a large number of application systems have appeared. GPS based on satellite communication is the most widely used positioning technology at present, which has good and stable positioning performance. Its limitation is that it needs to keep the line of sight with the satellite, and can not locate in indoor or building environment.

LoRa technology is a kind of ultra long distance wireless transmission scheme based on spread spectrum technology adopted and promoted by Semtech company. It belongs to the low power wide area network (LPWAN) communication technology[2]. The indoor positioning system based on Bluetooth and LoRa adopts LoRa communication protocol for networking communication. The system consists of mobile nodes, Bluetooth beacons, LoRa gateway, etc., to realize the mutual communication of the entire system.

2. System Framework

The system consists of three parts: Bluetooth beacon, mobile node and LoRa gateway. As shown in Fig.1, in this design, the large area to be located is divided into several small areas. Each area is equipped with a Bluetooth beacon. Each mobile node requiring positioning completes positioning after receiving the signal of the Bluetooth beacon. Then the positioning data is transmitted to LoRa gateway through LoRa, and finally stored on the server for users to view.
3. Hardware Design

3.1 Bluetooth beacon

The Bluetooth chip used for designing the beacon is selected from Texas Instruments' CC2640, and its application circuit is shown in the Fig.2. CC2640 is a low-power Bluetooth SOC solution, which is commonly used for indoor and outdoor personnel real-time tracking[3]. The beacon is powered by two 2100mAh high-capacity button batteries and can be manually switched on and off. CC2640 works in broadcast mode and broadcasts Bluetooth signal outward.
The beacon has the characteristics of low power consumption, long transmission distance, long standby time, etc. The beacon transmission power range is -21dBm~5dBm, and the longest standby time can reach 5 years.

3.2 Mobile node
Each mobile node is composed of MCU, Bluetooth receiving module and LoRa module. MCU adopts STM32F407 chip based on Cortex-M4 core of ST company to process and forward positioning data. The core of Bluetooth module is CC2640 chip of TI company, which is used to receive signals of Bluetooth beacon. LoRa module uses SX1268 RF chip of Semtech company as the core. The design of this chip has the characteristics of high transmission speed and low power consumption. The structure of the Mobile node is shown in the Fig.3.

![Fig.3 Mobile node design](image)

When the mobile node enters the area where Bluetooth beacon is deployed, the Bluetooth module on the node receives the signal broadcast by Bluetooth beacons, and the data is processed by STM32 microcontroller. Finally, the data is transmitted to LoRa gateway by LoRa module.

4. Software Design
The program for positioning is executed by STM32 microcontroller of the mobile node. Both the Bluetooth receiving module and the LoRa module on the mobile node are driven by STM32.

As Fig.4 shows, after the program is started, the STM32 microcontroller will initiate serial communication and establish a connection with the Bluetooth module and LoRa module, then STM32 initializes the Bluetooth module and LoRa module through the serial port setting register, and then the Bluetooth module enters the monitoring mode, waiting for the signal of the Bluetooth beacon. LoRa module enters waiting to send mode. When the mobile node enters the area, the Bluetooth receiver receives the signal sent by Bluetooth beacon, and STM32 reads the beacon id in the Bluetooth signal, then determine the area where the node is located[4]. After that, the program sets the LoRa gateway address and destination channel sent by LoRa, and sends the positioning information to the LoRa gateway.
Fig.4 Positioning program flow chart

5. Summary
A king of indoor positioning system based on Bluetooth and LoRa is designed in this paper. Through Bluetooth technology, the system locates the mobile node, and then transmits data through the LoRa network to LoRa gateway. The system makes up for the shortcomings of the short transmission distance of Bluetooth and the difficulty of large-scale deployment. At the same time, this system has the advantages of low power consumption, low cost and so on.

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