Research and Design of ZigBee-based Indoor Positioning System

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ABSTRACT

The positioning system consists of three parts, namely the hardware platform, the node communications and PC monitoring software program. Hardware platform mainly CC2530 chip as the core, including RF modules, auxiliary circuits, LED status indication circuit and so on. Node communication program is mainly based on the selection procedure for the preparation of localization algorithm, the process of selecting a location positioning algorithm based on acceptable signal strength indicator RSSI (Received Signal Strength Indication) in. PC monitoring software is written in Visual Basix6.0 environment, the main visualization graphics. According to the actual test, the more open the roof, the system can achieve accuracy error of less than 1m; in the classroom, and the system can achieve accuracy error of less than 2m. The wireless location system with low cost, low power consumption, high reliability notable features.

KEYWORDS
ZigBee; CC2530; RSSI; Wireless Indoor Positioning System.

INTRODUCTION

In recent years, wireless communication technology has developed rapidly and the demand for wireless positioning is increasing. Today of modernization and informatization to achieve the broad, multifaceted intelligent life, it needs to organize information well then sent it to the information processing center, and then present all kinds of information to the users and processing center. It is of practical significance for the mobile network planning, the balance of data throughput, radio resource control and so on all. Outdoor positioning technology is an early and mature technology, while indoor positioning technology is a relatively late start with a new field worth further study. The Global Positioning System, based on satellite communications, is the most widely used outdoor positioning system in various fields. It is recognized by the world with excellent performance. However, for complex indoor positioning, due to the blocking of signals, the disadvantages are obvious. Therefore, new wireless positioning system needs to be developed for indoor positioning. At present, the indoor positioning system is not widely popular due to its
high cost, complicated technical difficulties and so on. This paper tries to realize a small volume wireless indoor positioning system with low cost, low power consumption, and low complexity.

TECHNICAL INTRODUCTION TO ZIGBEE

ZigBee protocol has the advantages of low-power consumption, low consumption and high fault tolerance in wireless sensor. ZigBee protocol standards on the basis of giving the OSI (Open system Interconnection) seven layers reference model, according to the characteristics of the wireless sensor, each layer is responsible for its own function. Data is only allowed transmission in the adjacent between layer and layer.

BASED ON ZIGBEE’S INTERIOR POSITIONING SYSTEM DESIGN

Overall design of hardware system

Hardware circuit included two parts: wireless communication module and auxiliary function module. The main function of wireless communication module was to be used as the interface for data receiving nodes, which was an important module in communication process. The auxiliary function module provided the functions of positioning instruction, power supply and serial port communication.

Wireless communication chip CC2530

CC2530 had three different memory access buses: special function registers (SFR), DATA registers (DATA), and code/external DATA registers (CORE/XDATA). CC2530 microcontroller adopted single cycle to access SFR, DATA, and main SRAM. Any interruption could restore CC2530 in idle mode to active mode. Some interrupts could also awaken CC2530 from sleep mode [2].

CC2530 radio frequency module

The wireless communication module included CC2530 chip and its related peripheral circuit. Since CC2530 integrated the 8051 kernel and wireless transceiver module into one chip, which made the whole circuit simplified. In the process of making circuit boards, it reduced the difficulties of production, reducing the production cycle, which was more obvious in circuit wiring.

Auxiliary function module

(1) Power supply circuit

The power supply circuit adopted 5V direct current power supply, and the fixed voltage of 3.3V was output via the AMS11173-3 chip to supply the demand of the circuit.
(2) Serial port circuit
The serial port conversion circuit adopted the MAX3232 chip, which mainly made voltage transfer between the coordinator and the PC serial port voltage.

(3) Status indicator circuit
LED indicator light was used for power supply, node sending and receiving information, location status and other indicators.

**Positioning system node software design**

Software system design basic idea: in the range of the set of blind nodes would be the reference nodes transmit/receive signal strength (RSSI) to return to the
coordinator, and then the signal strength value was uploaded to the PC prior to write
good monitoring software. According to the above algorithms, it calculated and
displayed the blind node on the software of coordinates in real time.

POSITIONING SYSTEM TEST AND ANALYSIS

Test environment

Indoor positioning environment was simulated the roof, classroom. The model
diagram was shown in figure 15. Four reference nodes were arranged in four corners,
labeled 1, 2, 3, and 4 respectively. The coordinator node adopted the direct current
voltage power supply, and the reference node and blind node chose the battery power
supply, and the laptop computer was viewed as the PC software platform.

Analyses of test results

According to the data obtained from the test, the positioning error was larger in the
region near the edge, and the positioning error was smaller in the region near the
center. In the plane with fewer obstacles, the positioning error was smaller, and the
positioning error was larger in the plane with multiple obstacles.

It could conclude that the system could realize certain positioning functions and
achieve the design goal.

| True position | Testing position | error(m) |
|---------------|-----------------|----------|
| (0, 3)        | (0.35, 3.79)    | 0.829    |
| (3, 6)        | (3.55, 6.37)    | 0.655    |
| (6, 3)        | (6.72, 3.61)    | 0.944    |
| (3, 0)        | (3.34, 0.81)    | 0.879    |
| (3, 3)        | (3.29, 3.31)    | 0.425    |

| True position | Testing position | error(m) |
|---------------|-----------------|----------|
| (0, 2.6)      | (1.2, 3.1)      | 1.3      |
| (2.5, 5)      | (2.95, 5.2)     | 0.49     |
| (5, 2.8)      | (3.52, 2.85)    | 1.56     |
| (2.2, 0)      | (1.9,1.1)       | 1.14     |
| (2.5, 2.5)    | (2.7, 2.4)      | 0.22     |
CONCLUSION

Wireless location technology Based on ZigBee was paid more attention by scientists, more and more enterprises and companies and other various aspects and areas. As a new wireless network technology, ZigBee was known for its low-power consumption, low cost and low rate of wireless communication and other excellent characteristics, become a focus of scientific research, and would be more and more fully played a leading role in every field.

Although this paper has realized the requirements of the project, its practical value has yet to be improved. Work can be done in the following areas:

(1) This paper discussed the two-dimensional plane positioning, and the next step could be used to study three-dimensional positioning on this basis to expand the application scope of the system.

(2) It could improve the hardware platform and use the ideal all-directional antenna, and increase the amplification circuit in the CC2530 core module to increase the wireless transmission distance.

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