The Intelligent Bookcase System Based on RFID Positioning Technology

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Abstract. This paper introduces a kind of intelligent bookcase system based on radio frequency positioning technology, and introduces a kind of intelligent bookcase system by discussing the misplacing of books in the library in reality. This paper also introduces the related technology of intelligent bookcase system, and proposes and designs an intelligent bookcase system.

Keywords: Internet of Things, RFID, embedded system development, intelligent bookcase.

1. Introduction
Since the 21st century, with the continuous improvement of per capita disposable income of Chinese residents, the quality of people's life has been greatly improved. People's life focus has gradually changed from the pursuit of material life to the desire for spiritual life. Books have become the necessities of more and more residents. As people pay more and more attention to books, more and more bookstores and libraries come into our view. However, through visiting many bookstores, University Libraries and questionnaires, we can find that many people do not have the consciousness of sorting books by category. After reading books in the library, most of the books will not be placed according to their original position when they are returned. A large number of books are placed at will. When we want to find a book, it will be very difficult to find the book we need quickly. It takes a great deal of time and effort for the librarians to sort out books in a comprehensive and efficient way. We visited many libraries nearby, and found that as many as 90% of the libraries had chaotic book management and disordered placement of books, which greatly increased the difficulty of finding books, destroyed the good reading experience of users, brought a lot of unnecessary trouble for users to find the books they needed, and caused trouble for book managers and bookstore managers to arrange books. Generally speaking, the management of books is indeed a headache. It is necessary to summarize and sort out the bookcase regularly, otherwise it may lead to the dilemma of finding the required books quickly.
At present, most of the libraries in the market need to sort out books manually. RFID technology is only used to scan books when they are taken and returned from the library. Books on the bookcase still need regular book placement management and maintenance by the library's book managers. In order to change this rather cumbersome and waste of manpower and material resources, we use radio frequency identification plus wechat small program to solve the pain point of people's life in managing books and reading books, so as to facilitate users to consult and improve the efficiency of books management. The intelligent bookcase system studied in this paper can recognize and record the position of books. When a user finishes reading a book, he only needs to put it back in the bookcase; when he wants to find a book, he can find it quickly through wechat applet. Therefore, we believe that the intelligent bookcase system combined with RFID reading, data management, front-end reference and Internet of things technology can greatly improve the user's experience of consulting and managing books, and help people better live.

2. Key technology

2.1. RFID book positioning system
RFID system is composed of RFID tag, antenna, RFID reader and its supporting software system. RFID tag is the real information carrier of intelligent bookcase system; each RFID tag has unique ID information, which can store the relevant information of the marked book on the tag, and the server can determine the specific book by reading the information; RFID tag is mainly composed of chip and antenna, and communicates with RFID reader through electromagnetic induction or inductive coupling. In RFID system, antenna is an important part of the reader tag Association, which can realize the 2spatial transmission of radio frequency signal. Reader is an important sensing device of RFID system, and half duplex communication mode is used between reader and tag. On the one hand, the reader sends radio frequency signal to the tag for relevant control; on the other hand, the reader receives the radio frequency signal reflected by the tag and interprets it. The software system mainly completes the storage, management and analysis of label information; in the intelligent bookcase system, the software system only needs to complete the interpretation of label information, determine the information and location of the book where the label is, and upload the data to the database.

2.1.1. RFID book positioning system working principle. When the RFID reader slides off the slide, the magnetic field generated by it will make the RFID tags in the book react. The RFID tag on the book receives the magnetic field generated by the reader, and will generate current by electromagnetic induction and activate the current in the chip, which will transmit the information stored in the chip to the reader through the magnetic field. The reader interprets and transmits the information to the main control system to complete the next operation. The system studied in this paper adopts mrfc-522 RFID reader, and its communication frequency is 13.56MHz. It is cheap, powerful and highly integrated. It has incomparable advantages in this small size and high-performance application system.
2.2. Human infrared pyroelectric sensor

Pyroelectric effect is a common physical phenomenon. Its specific principle is that because of the change of temperature, some crystals produce equal and opposite sign charges at both ends of the crystal. This phenomenon of pyroelectric discharge is due to the temperature change. From the microcosmic point of view, under normal conditions, the crystal will also have its own polarization phenomenon, which will generate electric charge. However, due to the weak polarization phenomenon, the generated charge will be neutralized by the free electrons in the air on the crystal surface, and the polarization phenomenon will not show. When the temperature of the crystal changes, its internal thermal motion intensifies, polarization phenomenon increases, the positive and negative charge centers in the crystal will produce relative displacement, more and more charges gather at both ends of the crystal, which will produce discharge phenomenon. From the macroscopic point of view, the change of temperature leads to the free charge at both ends of the crystal. When it is connected into the closed electricity with resistance, the charge will move directionally. In this way, the current change in the circuit and the voltage difference between the two ends of the crystal can be detected. Therefore, the material with thermoelectric effect has the ability to detect temperature change, which is called pyroelectric body, also known as thermoelectric element. Single crystal (quartz), piezoelectric ceramics (polycrystalline) and piezoelectric polymer materials are commonly used in thermoelectric components. If the thermoelectric element is connected into the circuit, the temperature can be determined by detecting the current change. Of course, ordinary thermoelectric components cannot meet the needs of the intelligent bookcase system studied in this paper. The influence of human body temperature on the ambient temperature is small, which cannot cause thermoelectric effect well. This requires the use of a converging Fresnel lens. Fresnel lens is a thin sheet formed by injecting polyene vertical material. It was invented by the French physicist Augustine Fresnel. One side of Fresnel lens is smooth, and the other side is recorded with concentric circles from small to large. The texture of Fresnel lens is designed according to the interference of light, relative sensitivity and receiving angle. Fresnel lens can divide the detection area into several bright and dark areas. It can amplify the temperature change of moving objects in the detection area. It can make thermoelectric elements produce pyroelectric effect and generate electrical signals. Combining Fresnel lens with thermoelectric element, the infrared thermoluminescence sensor of human body is formed. Infrared pyroelectric sensor is a kind of commonly used sensor to detect human body by pyroelectric effect. Human body temperature is generally constant at about 37 degrees, and the temperature of the surrounding environment changes due to the movement of the human body. These changes are sensed by the thermoelectric elements in the sensor, which produce pyroelectric effect and produce current changes, which are detected by the peripheral detection circuit. So, the main control system will know that someone is coming. In the system studied in this paper, the human body infrared thermoluminescence sensor is used to detect whether there is a reader to borrow or return books, and to detect the number of layers with book position changes. When the reader is detected to be out of date, start the RFID location detection circuit to determine the location of the book.

2.3. Embedded technology

The intelligent bookcase system studied in this paper adopts STM32F103 microcontroller based on arm Cortex-M3 core. Its price is low and its performance is superior. It is especially suitable for developing some embedded systems. The maximum speed of the central processing unit is up to
72mhz, and the on-chip resources are also very rich. It has 256 KB flash, 16-bit timer, USART, can, I2C, SPI, full speed USB and other communication interfaces to meet the communication requirements of intelligent bookcase system. Its large number of I / O pins also provide a strong guarantee for the control of each module.

3. System design

3.1. System structure
The intelligent bookcase system studied in this paper is mainly composed of embedded hardware terminal, server side and corresponding wechat small program. The embedded hardware terminal is located on the intelligent bookcase, the intelligent bookcase and the embedded hardware terminal. It is mainly responsible for storing books, identifying the detailed information of books, and realizing the positioning of books; when a reader passes by and the position of books changes, the infrared thermal release sensor of human body can sense the external changes and transmit signals to the main control chip. After receiving the signal, the main control chip starts the RFID book position detection circuit. The detection device finds the added or reduced books by radio frequency signal, and determines the position of books by scanning. Then, the main control chip uses a certain protocol to transmit its own information, book information and its location to the server and store it in the database through esp8266wifi module. When a reader wants to query the location of a book, he only needs to take out his mobile phone, scan the QR code on the smart bookcase, and then query through wechat applet.

3.2. Working principle
The purpose of the intelligent bookcase system studied in this paper is to facilitate readers to quickly find the books they want, without the need for managers to sort out books, liberate the labor force, and reduce the workload of library book managers. In order to achieve this function, the system uses radio frequency identification technology. The specific working principle is as follows:

(1) When the user approaches the smart bookcase and stays in front of the smart bookcase, the infrared pyroelectric sensor at the edge of the bookcase detects human preferences. The system records this behavior and identifies the number of layers with book changes through the infrared pyroelectric sensor in each layer. After a period of time, the system starts the RFID detection circuit.

(2) The RFID reader moves to the left side of the layer with books through the sliding table on the side of the bookcase, and scans from left to right along the line. The reader compares the information read out with the information stored in the system itself, records the increased or decreased book information, uploads it to the server and updates the information stored by itself.

(3) The intelligent bookcase uses a certain protocol to report its own information (bookcase location) and the book information of location change to the server through ESP8266 Wi-Fi, so as to complete the update of database content.

Figure 3. Working principal diagram of intelligent bookcase.
Figure 4. Design of intelligent bookcase system.

(4) When users want to find a book, they can query through WeChat applet. The server will return the specific information of the stored books to users, so that users can find books conveniently.

4. Conclusions
With the development of society, people's material life has been greatly satisfied. More and more people have a growing desire to improve their spiritual life. Reading books becomes a good way for people to improve themselves. However, the random placement of books is the biggest obstacle to finding books. People have to sort out the books in the library regularly so that they can find the books they need well. The intelligent bookcase system studied in this paper is dedicated to solving the problem of disordered book placement. We believe that it will change the pattern of library book management and enable readers to find the books they need more quickly and efficiently.

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