Design of Intelligent Warehouse Management System Based on RFID Technology

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Abstract: In view of the complicated wiring and low efficiency of traditional warehouse management system, a remote storage management system scheme is proposed. The RFID electronic label is used to realize the automatic identification of goods out of the warehouse, and the ZIGBEE technology is used to realize the wireless collection and storage of LAN storage environment parameters. The environment is not suitable for timely alarm, the storage environment parameters can be transmitted to the remote monitor or mobile phone using 4G network, and the hardware design and wiring structure are simple. The system composition of the system is introduced, and the software and hardware design of the concentrator and collector are analyzed. The test results show that the remote management system can accurately complete the goods in and out of the warehouse record and the storage environment measurement and remote transmission, and has a wide range of application.

1. Introduction

Warehousing is a key part of supply chain management. The automation and informationization of warehousing system is related to the cost and efficiency of warehousing. At the same time, the quality and longevity of warehousing items are closely related to the warehousing environment. At present, in terms of warehousing records, China is basically in the manual processing stage of manual registration and manual supervision, and the semi-automatic management state of computer input after manual operation. A small number of enterprises adopt bar code technology, and bar code technology also has many problems, for example, when large quantities are used. When the goods enter the warehouse at the same time, the barcode can only be read manually, At present, the manual timing inspection and wired monitoring are mainly used. The manual timing inspection wastes a lot of material and manpower, and the wired monitoring wiring method is more complicated. The emergence of RFID has made it possible to automatically identify warehousing goods. The emergence and maturity of 4G technology has facilitated the remote transmission of data. With the improvement of these information methods and the development of information technology, warehousing has become more and more intelligent. Type warehousing development [1] [2].

Literatures 3 and 4 mention RFID-based cargo entry and exit warehousing records, system implementation of cargo inventory, and better solve the problem of automatic recording, but the system has information that can not be transmitted far, can only be monitored on site and can not monitor warehousing Disadvantages such as environment; in the literature 5, the warehouse management system based on ARM and GPRS is mentioned. The information collection remote transmission adopts the GPRS method. The GPRS technology has problems of low data transmission rate and network instability compared with 4G. In Document 6, the concept of intelligent warehousing based on ZIGBEE technology is proposed. The environmental parameter collection is collected by ZigBee local area network, but the remote transmission of information is still wired, and the wiring method is complicated. In view of the above system deficiency, the 4G technology, RFID technology and ZigBee technology are combined to propose a whole design scheme of the remote warehouse management system. It mainly includes three processes:

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warehousing, warehouse management and delivery. The main functions are as follows: 1. Goods storage records. When the concentrator of the storage system (installed on the warehouse door) detects that the goods carrying the tag pass, the concentrator contacts the server through 4G. If the goods are not in the server database, the server records the goods and assigns the shelf number to the goods. The server passes the shelf number down to the concentrator and displays it on the concentrator's display. 2. Warehouse management. On the one hand, the system can collect the different environments of the storage space through the ZigBee wireless sensor real-time local area network, and timely alarm when the environment is not suiTable. Each collection point reports the information to the concentrator, and the concentrator reports to the remote server through 4G. The remote server can query the inventory of goods in the warehouse in real time. 3. Goods outbound records. When the warehouse management system concentrator detects that the goods already exist in the system, the system quickly communicates with the server, and the server deletes the goods from the database. The informationization and automation of warehouse management have been realized, and the cost of warehouse management has been minimized.

2. Overall system design

The remote storage management system is built by 4G, RFID and ZigBee technology. The overall structure of the system consists of environmental parameter collection terminals, concentrators and servers. The structure of the remote storage management system is shown in Figure 1.

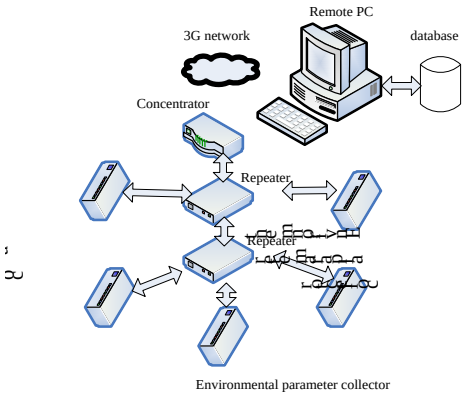

Figure1 Overall structure of the remote warehouse management system

The environment collection terminal is distributed in the warehouse and is responsible for the collection of the storage environment. It is reported to the concentrator accurately through the ZigBee short-range LAN communication technology. The relay is responsible for information forwarding and data transfer. The concentrator is installed at the warehouse door and is responsible for The establishment and management of the entire network and the monitoring of goods entering and leaving the warehouse through RFID readers are also the center of the entire ZigBee network data collection. On the one hand, the concentrator uploads the environmental parameters collected by the environmental parameter collector and the goods in and out of the warehouse through 4G. To the remote server, on the other hand, a series of instructions such as setting instructions and operation instructions sent by the server are transmitted to the ZigBee network. The remote server can be used by the mobile phone to implement mobile monitoring of data.

3. System hardware design

3.1 Concentrator design

The remote warehouse management system has a concentrator that mainly performs ZigBee network and 4G network data exchange and RFID monitoring of goods entering and leaving the warehouse. The concentrator is mainly composed of 4G module, RFID module, ZigBee RF communication module, power module, microprocessor module, storage module and clock module.

The structure diagram is shown in Figure 2.

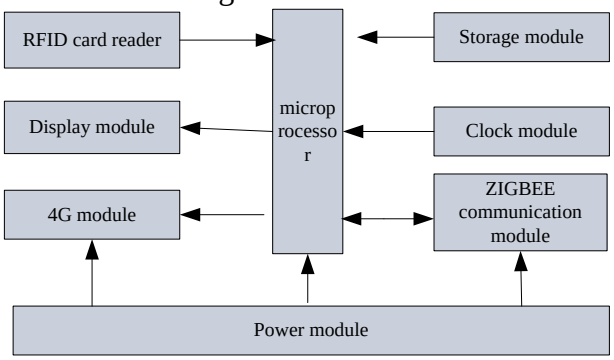

Figure 2 Concentrator structure

Considering that the 4G module and the ZigBee communication module need to communicate with the microprocessor through the serial port, the micro control processing module selects the Winbond dual serial port microcomputer W77E58, which is a brand new core microprocessor, fully compatible with the standard 8051 instructions, and can support The clock is up to 40M, and the instruction cycle is 1.5-3 times faster than the standard 51. The selection of 4G modules mainly considers the following points: industrial grade, low power consumption, and high signal reliability. After comparison, Huawei's 4G module MU736 is finally selected. The MU736 module internally contains TCP/IP protocol stack, and the limit working temperature can reach -20^{o}C~+70^{o}C. The MU736 uses a serial port to communicate with the microprocessor, and the microprocessor controls the operation of the 4G module through AT commands. Zhou Ligong's MFRC522 is selected as an RFID reader. The RFID card can communicate with the reader within the scope of the reader. Both communication can use serial and I^2C communication methods. The MFRC522 card reader in this system The communication mode of the single-chip computer adopts the SPI protocol in the serial mode. Since the microprocessor W77E58 does not have the SPI port itself, it needs to simulate the SPI operation with the common I/O port. The main hardware connection diagram of the concentrator is shown in Figure3, the microprocessor. P2.0, P2.1, and P2.2 are respectively connected to MISO, MOSI, and SCLK in the MFRC522 serial interface, CS of MFRC522 is the chip working strobe pin, and the microprocessor passes P2.3 and the pin. Connected, P2.3 is the low-level strobe MFRC522, otherwise, the reader does not work. The location number assignment of the remote server needs to be displayed on the concentrator. Therefore, the concentrator selects the LCD12864 as the display, and selects the ATMEL24C02 as the temporary storage chip and the DS1302 as the clock chip. The ZIGBEE communication network will be introduced in the collector.

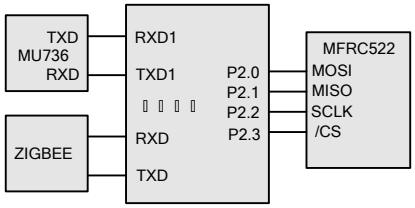

Figure 3 Concentrator hardware connection diagram

3.2 Environmental Parameter Collector Design

ZigBee technology is a wireless communication technology adapted to short-distance, low-cost, low-energy, low-complexity [7]. Its physical layer (PHY) and medium access control layer (MAC) are defined by IEEE802.15.4, by the ZigBee Alliance. Provides network layer and application layer design, data transmission rate is about 20-250KBps, fully meets the data transmission needs of warehouse management system, adopts AES-128 encryption algorithm, has high security, as the storage system LAN data acquisition and transmission, ZigBee The network is very suiTable. There are three main types of ZigBee network: star network, mesh network and cluster network. The ZigBee network in the system is mainly composed of an environmental parameter collector and a concentrator, and the network type used in the remote storage management system is a star network.

The structure of the environmental parameter collector is shown in Figure 4. Each remote storage management system environment parameter collector control center uses the CC2530 chip. The CC2530 not only has the ZigBee function, but also includes an enhanced 8051MCU, which is a true system-on-chip (SOC). The solution, and CC2530 low power consumption, working current is only a few dozen milliamps, because the environmental parameter collector is moved and placed, it is not convenient to route, so the power supply is battery-powered, and the lower power consumption can meet the long-term work requirements. Through the 2.4GHZ radio frequency signal and the concentrator communication, the system environmental parameter collector includes a variety of sensors (temperature and humidity sensors, smoke sensors, flame sensors, etc.), and the collector timely uploads the parameters collected by various sensors to the concentrator through ZigBee. The temperature and humidity sensor uses the new intelligent sensor DHT11. The output signal of the sensor is a calibrated digital signal with long-term stability and reliability. The smoke sensor uses MQ-X sensor, which has high sensitivity to smoke.

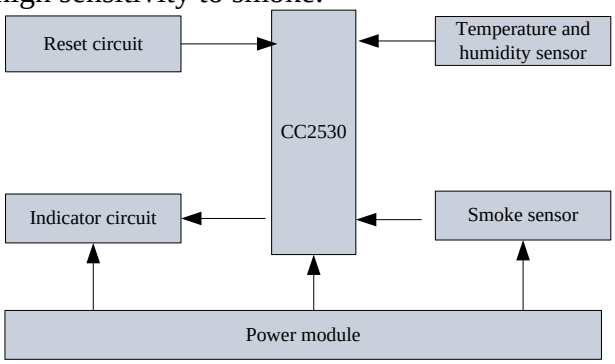

Figure 4 structure of the environmental parameter collector

3.3 Software design

The system combines 4G, ZigBee and RFID technologies, and has a series of functions such as monitoring of goods in and out of the warehouse, collection of warehouse information LAN, 4G reporting, automatic networking, mobile monitoring, etc. The system software is divided into concentrator software and environment collection terminal software.

3.4 Concentrator software

The concentrator is the bridge between the host computer and the ZigBee LAN. The concentrator needs to keep in touch with the host computer at any time, and contact the host computer once every time, that is, maintain a certain “heartbeat” time. If the handshake between the two parties is unsuccessful for a while, you need to re-establish the connection. Contact the server in time when the goods enter and leave the warehouse, the host computer has commands, and the time is reported. The concentrator flow chart is shown in Figure 5. After the system starts working, it is initialized. The initialization includes the following process: configuring the serial port baud rate, configuring the serial port baud rate by configuring the timer counter, and setting a certain timing time (ie, the collector timing) Reporting time), the 4G module and the ZigBee module are initialized according to the configured baud rate, and then the LCD12864 display initialization is performed to ensure that the liquid crystal is normally displayed. After the initialization is completed, the system is mainly divided into three threads. The thread one is the cargo detection thread. The microprocessor of the concentrator drives the MFRC522 to monitor whether the goods pass through the concentrator in real time. If there is cargo passing, the concentrator contacts the remote server. If the goods are inbound, the server returns the assigned shelf number and displays it on the concentrator, and the server deletes the goods record. Thread 2 coordinates the ZigBee network wireless collection and storage environment for the concentrator. The concentrator receives the data periodically reported by each collector and stores it temporarily. After receiving the environmental information reported by the collector, the concentrator performs verification and simultaneously determines whether the value meets the preset value. If the preset range is exceeded, the driver is

driven. The alarm system alarms and reports to the server. The server has an acquisition command or the collector reports the collected time to the concentrator to report the collected data. Thread 3 is the monitoring thread, the concentrator microprocessor starts the serial port interrupt, detects whether the server has preset values, reports, etc., and if so, performs the corresponding operation.

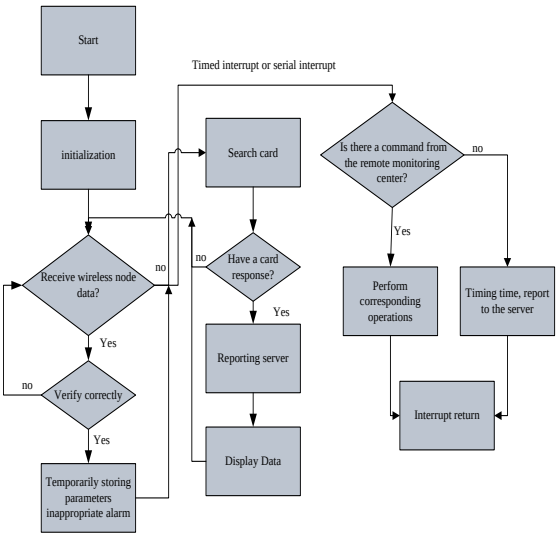

Figure 5 concentrator key flow chart

3.5 Collector software design

In this system, in order to save power, the collector is not real-time reporting, but adopts two modes: timing report and upper machine command reporting. The collector monitors the wireless information in the air at any time, if it monitors valid information (compared with its own address) , the equal time is the valid information) or the timed time (the collector timing reporting time) is up, the collector communicates with the sensor to obtain the monitoring data and then reports it to the concentrator through ZigBee, and the system also contains the repeater, if the transmission distance is too far The relay can be used to forward information. The collector process is shown in Figure 6. Initialization after power-on, including initialization and timing of various sensors, ZigBee network initialization, and then the collector reports in time when the concentrator has instructions or timing time.

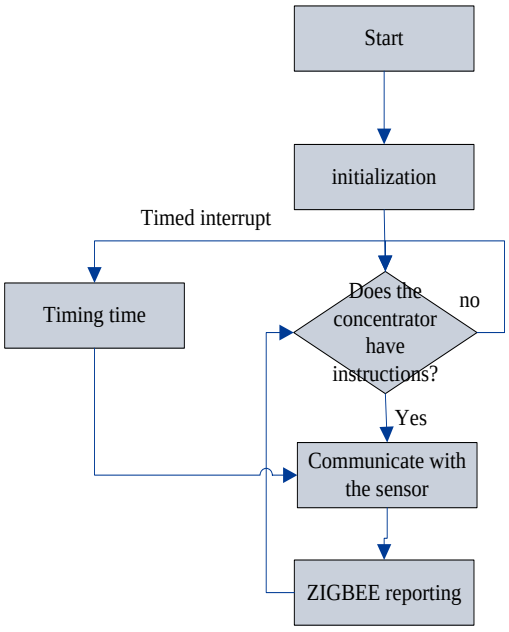

Figure 6 collector flowchart

3.6 System test

Set up a test system in a warehouse, deploy a concentrator, 10 environmental parameter collectors, and use a star network for the network type to test the data transmission rate, power consumption, and communication distance of the system.

ZigBee effective communication distance: The power of ZigBee network design is about 0-35dBm, and the effective communication distance is about 40-120M without repeater. In the signal through-wall function test, the system passes through 3 layers of reinforced concrete. The signal can still be received. Compared with the transmitted signal, there is only a slight delay in the wall-passing signal. The RFID reading distance is about 1 meter. Since the system uses a tree-based algorithm, the card reading success rate is 100%.

Energy consumption and transmission rate: The collector can work for more than half a year under the condition of 4 sections of 5th battery power supply, and the system transmission rate can reach 200Kbit/s without blocking.

According to statistics, the host computer sends commands, the time for collecting 10 collectors is about 2-4 seconds, and the success rate is 100%. Some of the results are shown in Table 1. The test results show that the system has high stability. And security.

Table 1 Part of the data collection Table

time	Concentrator label	Collector number	temperature	humidity
10:23:05	16	1601	2.0	43%
10:23:05	16	1602	2.0	44%
10:23:05	16	1603	2.0	43%
10:23:05	16	1604	2.0	43%
10:23:06	16	1605	2.0	43%
10:23:06	16	1606	2.0	43%
10:23:06	16	1607	2.0	43.5%
10:23:06	16	1608	2.0	43%
10:23:07	16	1609	2.5	43%
10:23:07	16	1610	2.5	43%

4. Conclusion

Integrating 4G technology, RFID Internet of Things technology, ZigBee network technology, designed a remote warehouse management system, which realizes automatic recording of goods entering and leaving the warehouse and wireless collection of storage environment. The hardware structure and wiring are simple and convenient, and the manager is improved. Manage the efficiency of the enterprise and reduce the cost of the enterprise. The overall system adopts a modular design, and can be freely matched with the system functions according to the needs of the enterprise, which will bring obvious effects to the management of the enterprise. At the same time, with the release of 5G licenses, the use of 5G networks will increase the system transmission rate, and the system will be more widely used.

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