

Pig Slaughtering Traceability System Based on RFID and ZigBee Technology

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Abstract—In order to improve the management of information slaughterhouse and automation, ensure the safety of pork production, design the wireless RFID reader devices system based on CC2530 by integrating the radio frequency identification technology and the ZigBee network which is used in pig slaughter traceability information. Use CC2530 and MF RC522 to build a wireless RFID reader, build slaughter traceability system software on the Visual Studio 2008 platform. System integration tests showed that the use of ZigBee wireless transmission technology can transmit data with two-way so that the reader system applications more flexible. The system of pig slaughter traceability has high stability of the system, identify the long distance, scalable and improve the pig slaughtering traceability management efficiency. At the same time, the traceability system has a certain reference value applications in the study of domestic food safety issues. It's useful for improving the level of China's food industry information.

Keywords—Traceable system; ZigBee; RFID reader; CC2530; MF RC522

I. INTRODUCTION

In recent years, the production of livestock appears steady and healthy development. However, during the process of pork production, not-standardized corporate governance and product safety issues trigger animal food safety incidents occurs[1]. Therefore, building a perfect traceability monitoring platform is useful to guarantee food security, improve the economy and living standards. Currently, the food traceability generally use RFID radio frequency electronic identification. Since the existing RFID reader is generally based on the cable transmission, there are disadvantages of fixed position reader, poor flexibility, short-distance transmission and high equipment costs. Comparing with cable transmission system, using zigbee wireless transmission technology can achieve two-way wireless data transmission, the reader system applications are more flexible.

At present, China's animal product traceability system based on the theory and practice made significant progress

and breakthroughs, and applied to product traceability. Wang PeiQiang, etc. analyze and design pork traceability management system based on RFID and bar code technology[2], and develop a workable traceability coding rules, associated with the entire logistics chain. But there is no detailed study and design for hardware systems product traceability and traceability information collected information. Bao Xiao Cheng, etc. theoretically analyze traceability of pork products, key factors and traceability information system but[3], but did not realize the system and applied to actual production traceability process.

In this article, we design a portable wireless RFID reader by intergerating ZigBee wireless communication technology and RFID technology. This will make up for the shortcomings of traditional RFID, and it's useful to improve real-time monitoring and network slaughterhouse with the use of ZigBee wireless network technology. Based on C/S we develop traceability system application software on the Visual Studio 2008 platform, and record information of pig slaughter, quarantine and split into the segmentation database center through a wireless RFID reader to achieve production information management; Meanwhile, information inquiry terminal provides information services for enterprise management, and managers can query the corporate information, employee information and product information through the terminal.

II. SYSTEM ARCHITECTURE

A. System Design

Slaughter traceability system consists of a wireless RFID reader, ZigBee wireless sensor networks and C / S application software developed on the Visual Studio 2008 development platform. Based on the production process of meat processing factory in Lanzhou, consider HACCP system as theoretical basis [4], combining with the actual production process, to determine the function of the system. With this traceability system record the information of production process into the database, achieve inquiry and management of the enterprise and

employee-related and maintenance of the system-related information. Fig.1 . shows the system architecture.

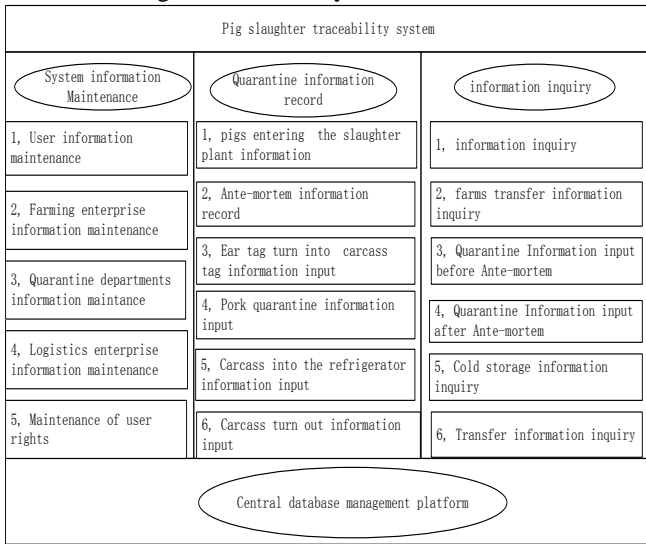


Figure 1. Slaughterhouser traceability system structure

B. Main system flow chart

Throughout the system, ZigBee coordinator form entire ZigBee communication network, waiting for routers and end nodes to join it. During slaughter surveillance process wireless RFID reader collects related node information, and then send it to the first bit machine through ZigBee network, and finally store related information into the database. The main system flow chart is shown in Fig. 2.

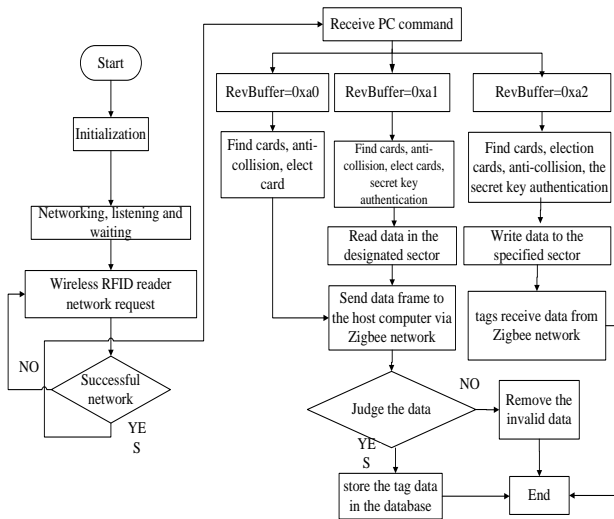


Figure 2. System main program flow chart

In wireless RFID reader, RF chip MF RC522 communicate with electronic tags following the communication protocol of ISO/IEC14443A . Through SPI(Serial Peripheral Interface), CC2530 controls communication between MF RC522 and type matched cards within the range of the antenna, and reads information in card, deals with the information accordingly to make it compliant with the ZigBee protocol packets[5-6], and then sends the packets to the coordinator in ZigBee network following IEEE 802.15.4[7-10]. Coordinator connects with the host computer via the UART interface, and ultimately send the

data to PC for processing. Similarly, the host computer can send control commands to cooperate the electronic label, such as modification of the information.

II. DESIGN OF WIRELESS RFID READER

The main function of mobile RFID reader is information collection, transmission and modification of slaughterhouse traceability. Hardware design of Wireless RFID reader system is about to design RF communication module circuit and ZigBee terminal node and ZigBee coordinator circuit.

A. Design of RF Communication Circuit

RF function consists of the microprocessor and RF chips, its main function is to communicate with the electronic tag for completing the exchange of the tag information [11]. The core chip of RF module is Philips MF RC522, electronic tags is M1 card produced by Philips. Fig. 3 shows RF communication module circuit.

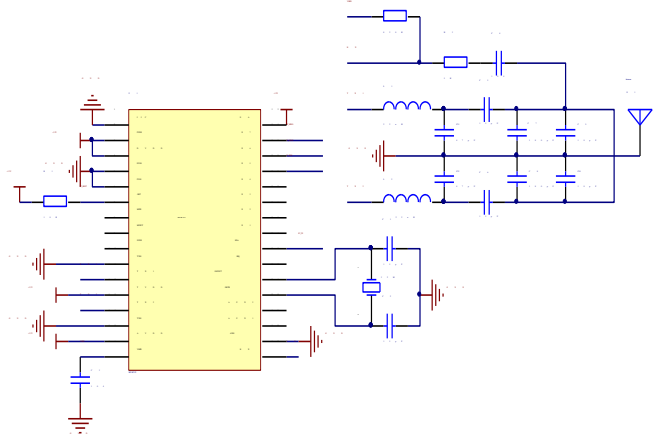


Figure 3. RFID read-write system radio frequency communication module

Fig.3 shows that RF power module 13.56MHz carrier signal modulated envelope signal sends to antenna module via pin TX1 and TX2. EMC filter circuit consisted of L1, L2, C11 and C12 ,with C5-C10 component drive the antenna, and then send out the signal. In the receiving end , stabilize the DC input voltage of RX pin stabilize through C3 and R2, and adjust the AC input voltage through C3 and C4.

B. Wireless ZigBee module circuit design

The main function of ZigBee module is to send and receive data. The system uses a CC2530 With low power consumption produced by TI/Chipcon, It integrates IEEE 802.15.4/ZigBee RF transceiver and industry-standard enhanced 8051MCU kernel, the kernel control circuit is shown in Fig. 4.

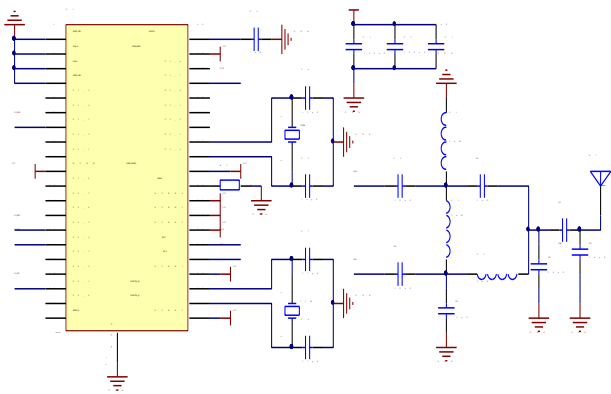


Figure 4. ZigBee core control circuit design

C. Hardware interface circuit of CC2530 and MF RC522

The system uses 32MHz crystal oscillator as a clock signal of CC2530 core controller, CC2530 communicates with RF module through SPI, P1_7 picks SDA end in RF chip MF RC522 as a signal control line. P0_1, P1_3 and P0_4 respectively pick D5, D6 and D7 end in MF RC522, control MF522 related registers write and read through SPI. P0_5 pick Reset pin of MF RC522 for the controller reset. Fig. 5 shows I/O interface connection of CC2530 and MF RC522.

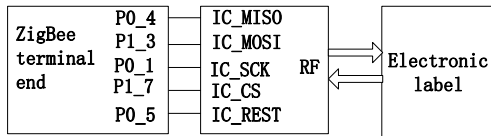


Figure 5. The I/O port connection CC2530 with MF RC522

D. RFID reader application software design

In VS2008 development platform, we develop a PC reader software based on serial communication, and use the application software to read electronic label and specified block data, and modify specified block data. The PC reader application software is shown in Fig. 6.



Figure 6. RFID reader application software

The process that user determine to modify data block 00 in sector 01 explain process of PC writing card. In specified data block, select data block in sector 01. Write data in the application software interface "modified data" column "0188888882510199990000251110088", click

on "Edit Data" button, the data is encoded as "19A2FFFFFFFFFFFFFF040188888882510199990000251110088". Account for one byte of every two numbers, where "19" represents 25 bytes sending to the reader, "A2" indicates the data write instruction to be executed, "FFFFFFFFFFFFFF" is the initial cryptographic data block, "04" represents the fourth block of data block, PC software encodes the control command string for sending data into a binary format, the serial port is sent to the ZigBee coordinator through the PC, and then sent to the ZigBee coordinator through the terminal nodes, terminal nodes control MF RC522 store the data in electronic tag into the corresponding data block. In order to verify whether the data is correct or not, we can read the data in the specified block where just write into it. As Fig. 6 shows, select sector number, data block number, click "read data", "data read" box can show the data just written.

E. The test results of Wireless RFID reader system

In order to verify the stability and accuracy of the system, both indoors and outdoors to test the system. Indoor test is to detect the reader transmission distance through the wall, and outdoor is used to detect the reader transmission distance with no obstacle in open area. At temperature 28 °C and Zigbee nodes transmit power is 4.5dbm, the use of electronic tag reader system for reading and writing tests. The test results are shown in Table I, from the test results, the data transfer distance for system is 80m-100m in outdoor, the transmit distance through walls is 30m-50m, effectively improve the recognition distance of the reader.

TABLE I. THE TEST RESULTS OF WIRELESS RFID READER SYSTEM

Test number	Test environment	Test distance	Test frequency (read, write)	Receive frequency (read, write)	Packet loss rate
1	Indoor	30m	50, 50	50, 50	0
2	Indoor	40m	50, 50	49, 50	1%
3	Indoor	50m	50, 50	48, 49	3%
4	Indoor	55m	50, 50	45, 43	12%
5	outdoor	80m	50, 50	50, 50	0
6	outdoor	90m	50, 50	50, 49	1%
7	outdoor	100m	50, 50	49, 48	3%
8	outdoor	105m	50, 50	44, 43	13%

III. SYSTEMS NETWORK COMMUNICATION STRUCTURE

The existing RFID reader systems are generally based on the cable transmission [14-15], by RS232 or Ethernet interface [16-17] to communicate with the host computer. Because of the RFID reader has poor anti-jamming capability, susceptible to environmental factors. In this paper, it establishes a network based on ZigBee wireless RFID reader by integrating radio frequency identification technology and wireless communication technology. The wireless RFID reader can be achieved related information collection and transmission for the slaughterhouse. The communication system is shown in Fig. 7:

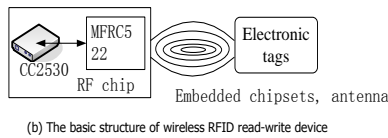
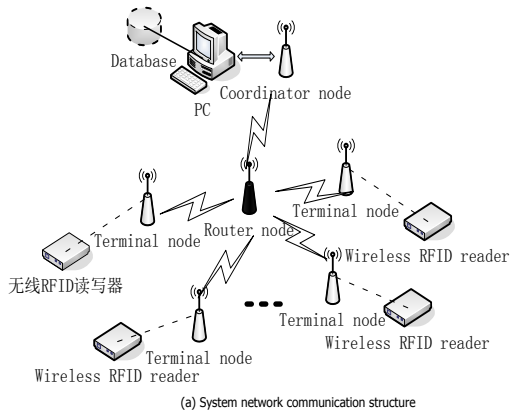


Figure 7. System communication structure

Network communication structure of the system is shown in Fig 7 (a) , including: ① wireless RFID reader: collecting the traceability information, then transmitting them to the ZigBee router node by the ZigBee terminal node. At the same time, terminal node According to transmission over the ZigBee router operating instructions to control the RFID reader to the appropriate action. ② ZigBee router node: responsible for transmitting information. ③ ZigBee coordinator node: responsible for starting the entire ZigBee network, ZigBee router sends the information via the serial port to the host computer system, while the host computer sends control information to ZigBee terminal node. ④ PC: install the application software and achieve human-computer interaction. The basic structure of wireless RFID reader is shown in Fig. 7 (b), including: ① electronic label: Record label card data and pork products information. ② reader: consists of the core control chip and CC2530 RF chip. CC2530 RF chip by controlling the electronic tag identification data, and to read and write and other operations related information. Traceability management system is mainly used to pigs slaughter, quarantine, the segmentation, and other real-time information into database center; At the same time, management corporate information, employee information and product information .

ZigBee is based on the IEEE802.15.4 standard low-power personal area network protocol. The ZigBee protocol stack is Z-Stack 2007 by TI, development program in its application layer. To complete the network and product traceability information. The establish network of ZigBee is shown in Fig. 8:

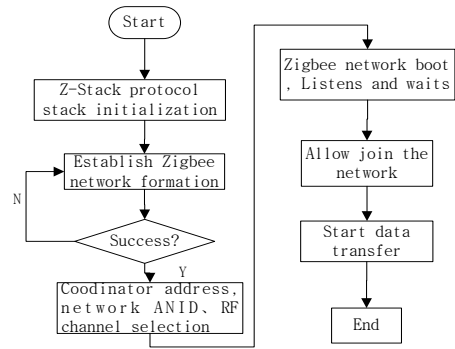


Figure 8. ZigBee network flow chart

IV. THE DESIGN OF TRACEABILITY MONITORING SYSTEM

A. The slaughterhouse Information Query System

Corporate managers can query enterprise information, staff and product information by systems. In the query system, select the check content and the conditions can query to the need information. Information query System module processes is shown in Fig. 9:

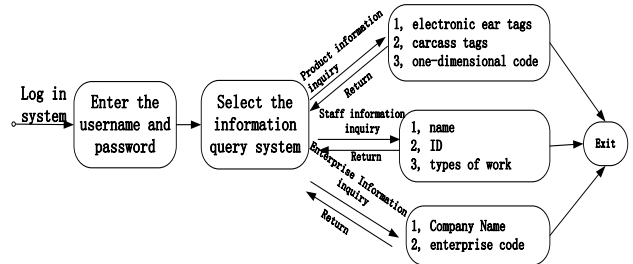


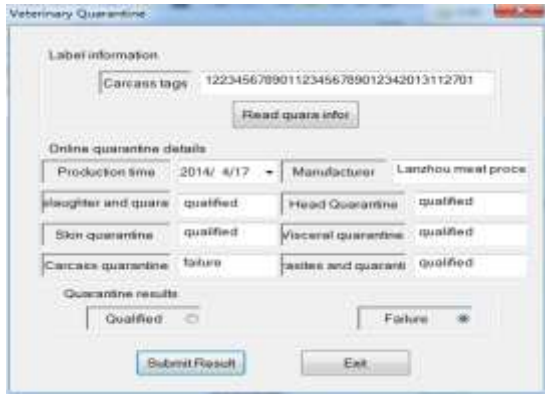
Figure 9. Query module of information system flow chart

B. The quarantine information of slaughterhouse into the system

The relevant information of quarantine is entered into slaughterhouse by the quarantine information module. the quarantine Information module is divided into two parts: quarantine departments and veterinary sectors. To record aspects related indicators are qualified, and recorded the indicators in the central management database. Fig. 10 (a) is a pig carcass visceral the quarantine system modules. Veterinary review the quarantine result for departments and submits audit results to the central database. The the veterinary quarantine system modules is shown in Fig. 10 (b).



(a) department of quarantine system



(b) The veterinary quarantine system
Figure 10. Information module of quarantine inspection

C. The Information Maintenance System of slaughterhouse

The information maintenance system is mainly divided into three parts: 1, new employees registered. The new employee's information is recorded into database, and set staff numbers, passwords, access permissions and job sectors. 2, the old employee data updates. When older employees personal information change, using software update records. 3, pigs information management. Use PC software to encode the pigs, and the encoded information is written to the electronic tag, simultaneously recorded into database, the data collection and management system interface is shown in Fig. 11:

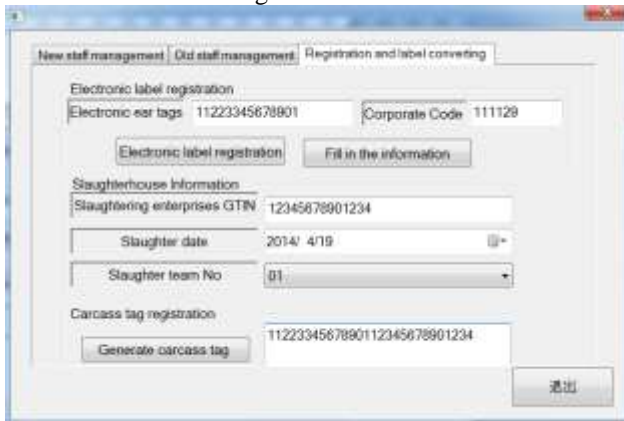


Figure 11. Slaughterhouse data acquisition management system

V. CONCLUSION

The safety issue of food has been much attention to people, establish a complete food traceability system is necessary. In this paper, it designs wireless RFID reader and reader applications based on CC2530 by integrating radio frequency identification technology and wireless communication technology. Not only overcome the shortcomings that the RFID reader short distance, poor anti-interference and susceptible to environmental impacts, but also improve the real-time monitoring of slaughterhouses and network. Development and maintenance the quarantine information subsystem, the information input subsystem and information query subsystem, which based on C/S structure in the Visual Studio 2008 platform. Meanwhile, adopt the CC2530 chip as micro controller of the reader. so that reduces the cost

and power consumption, also eliminates the hassle of wiring. Experiment shows that high stability of the system, long identification distance, application flexibility and extensibility, with the very high economic and practical value.

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