Journal of Zhejiang University SCIENCE A
ISSN 1009-3095 (Print); ISSN 1862-1775 (Online)
www.zju.edu.cn/jzus; www.springerlink.com
E-mail: jzus@zju.edu.cn

Design of intelligent detecting system based on wireless transmission

GUO Li-wei[1,2], LIU Dong-hui[2], ZHANG Xin-ling[†2], SUN Xiao-yun[†2]

([1]*Department of Electrical and Information, Huazhong University of Science and Technology, Wuhan 430074, China*)

([2]*Department of Electrical and Information, Hebei University of Science and Technology, Shijiazhuang 050054, China*)

[†]E-mail: redxinling@126.com; sunxy@hebust.edu.cn

Received Dec. 19, 2006; revision accepted Jan. 5, 2007

Abstract: An intelligent detecting system based on wireless transmission is designed. Its hardware includes the card reading module, the wireless digital transmission module, the LCD module, the random password keyboard module and a 16×16 lattice word database based on e-Flash MM36SB020. Its software is a communication protocol between the central control computer and the entrance management base station. To resolve the conflicting problems occurred during the data transmission, a method of delaying time at random is proposed.

Key words: Communication protocol, Delaying time, Random entrance management base station, Random password keyboard, Wireless digital transmission

doi:10.1631/jzus.2007.A0490 **Document code:** A **CLC number:** TB114.3; O224; O211.6

INTRODUCTION

The entrance management system (Cha and Zhu, 2003), or so called the access management system, is a system of detecting personal coming and going. The entrance management system is an effective measure to keep security for important areas. With the development of wireless radio frequency identification (RFID) technology and IC card, especially the non-contact-type IC card technology (Wang and Rao, 2005; He, 2005a), the entrance management system has been widely used in both residential and business buildings.

However, the data transmission in most of the current entrance management systems is based on cable networks, like RS-485 bus or CAN bus. It needs long wires. The workload of wiring is heavy. The connections between equipments are complex. Besides, the cable network is easily damaged or impacted due to misoperation, over-voltage, or lightning while its defecting point is hardly to be located.

It is the reason that an intelligent entrance management detecting system (Wang, 2003; He, 2005b) based on micro-power data digital transmission module SRWF-501 was designed and presented in this paper, which can meet the requirements of detecting all entrances of the building.

SYSTEM STRUCTURE

Fig.1 shows the system structure block diagram. The detecting system consists of the central controlling computer (host), the wireless digital transmission module, and the entrance management base stations (slaves), which are distributed around the detecting points. The two-way wireless communication is applied between the host and the slaves. The host sends the operation command, the district broadcasting messages, downloads users' card messages, and receives the base stations' messages. All stations send new brushing card records to the host by the wireless digital transmission module. The information is received by the wireless digital transmission module in the host direction, and then the serial communication is realized.

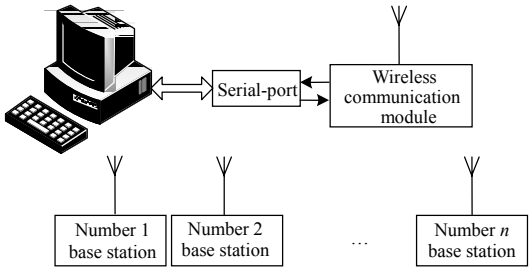

Fig.1 System structure block diagram

The management progress including delivering card, searching, reporting loss, canceling report, descending blacklist, receiving brushing card records, analyzing and printing statement, etc. is completed by the host. The entrance management software of detecting system plays the role of central management organization such as setting-up and maintaining database, downloading system database, collecting and writing the information that all host equipments upload, and downloading the relevant information to the host equipment regularly according to the users.

Fig.2 shows the base station's hardware structure diagram. The base station is mainly composed of the host control equipment, the wireless transmission digital module, the card reading module, IC card, the liquid crystal display module, the electricity controlling lock, and so on.

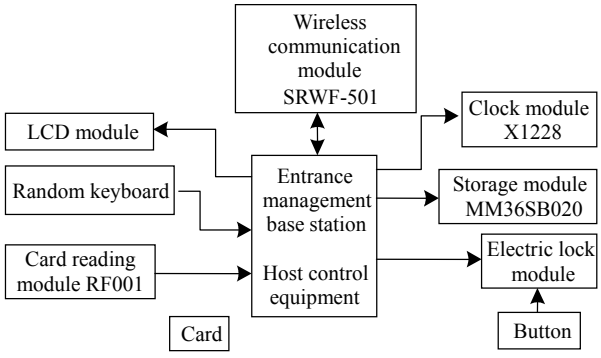

Fig.2 System base station's hardware structure diagram

The host control equipment is a key part of the entrance management system. The micro-power wireless module RWF-501 is used to communicate between PC and the host control equipment. The card-reading module reads data in the non-contact-type IC card, and sends it to the host equipment in Manchester code form.

The users' card number and personal information are recorded in the host's database. And then the card number is downloaded to the different base stations as a legal number. Once the IC card is placed in the base station's work area, it launches the card number. Then the base station reads it and judges its legality. If the card number is right, the lock opens and the operation is recorded. Otherwise, the lock cannot be opened and the false operation is uploaded to the host. The detecting system collects, saves, analyzes and handles all records of the stations.

HARDWARE DESIGN

Card reading module

A card reading module RF001 and H4001 card, working at frequency of 125 kHz, is selected for this system. A coil, with an inductance of about 345 mH, area of 81 cm^2 in form of square shape, is wound around with the enamel-insulated wire, whose diameter is 0.21 mm. H4001 is a CMOS integrated circuit for using in transponders produced by EM Microelectronic in Switzerland. It has 64 bits memory array laser programmable, the serial output data string contains a 9 bits header, 40 bits of data, 14 parity bits, and 1 stop bit. When H4001 card is placed into the card reading work area, the coil and capacitor form resonant circuit, receiving carrier signal launched by card reading module. The card gets a work voltage of about 3.5 V through induction, produces the reset signal and system clock, and gets activated; 64 bits data is launched. The card reading module receives and demodulates information, outputs Manchester code to the host control equipment; finally, the 10 card number is decoded.

Wireless digital transmission module

SRWF-501 is used as the wireless digital communication module. Its power supply is 3 V to 5 V, and the biggest launching power is 10 dbm (10 mW). The modulation is based on FSK. The high efficiency forward error correction technology is adopted, and the capability of anti-interference is improved to reduce the abrupt interference and random interference. The noise signal and false data are dropped automatically. 9600 bps is adopted in design. Fig.3 shows the circuit about SRWF-501 and the host control equipment.

LCD module

TM12864 is used in displaying part, which has the controller HD61202 and HD61203. When the management software broadcasts, the host equipment shows the received command and data, inquiring of the word database, and shows the corresponding broadcast information on the screen. Fig.4 shows the connection circuit.

Taking advantage of the serial e-Flash MM36SB020's large capacity, word database with 16×16 lattice is designed. MM36SB020 adopts the serial bus of two lines to link with single chip. Matrix extraction program is designed by using Visual Basic 6.0. 6763 matrixes are composed of the first, the second level character and the radical in HZK16 of 2312-80 GB. They are sent to MM36SB020 after fetching the mould vertically and reversing the byte. As MM36SB020 has 128 byte in every page, the matrixes hold 1691 pages. 1000 card numbers are distributed to every base station, which holds 10000 byte, and the remained bytes are used to record brushing card messages, guard messages. A two-pin serial interface is adopted to connect with AT89C52. The pins of SDIO and SCLK are connected respectively with P1.2 and P1.1.

Random keyboard module

A special-purpose intelligent control chip special-purpose intelligent control chip HD7279A is used to manage a 12 keys keyboard. The user may open the door by brushing card, or by pressing card number with a correct password. The clock pin, data pin and key interrupt pin connect to P1.0, P2.5, P2.3 of single chip respectively. By using *srand*() and *rand*() function, a random sequence from 0 to 9 appears. The sequence is displayed on LCD. According to the corresponding relations of the keyboard and the sequence demonstrated on LCD, the users press the keys. The seed value will be changed with each operation, so as to produce dissimilar random sequence.

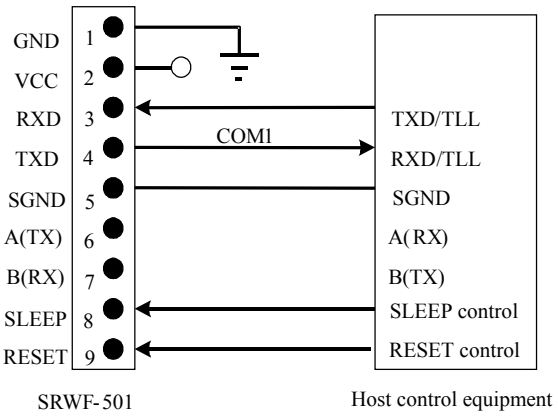

Fig.3 Circuit of SRWF-501 and host control equipment

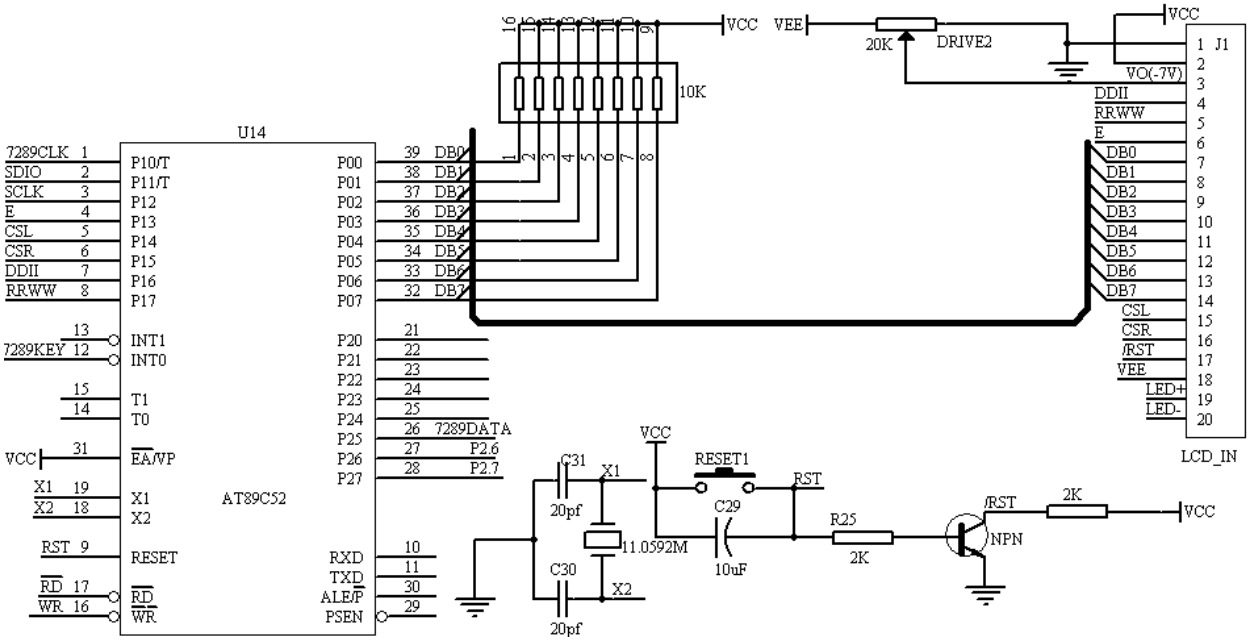

Fig.4 Drive circuit of LCD based on AT89C52

Electric lock module

Fig.5 shows the electric lock drive circuit. When the host control equipment gives the permission to open the door, P2.7 (Control Lock) switches to the low level, and then the photoelectricity isolating device TIL117 works, relay attracts gathers and the lock opens. When P2.7 switches to high level, the relay falls, and the electricity lock closes.

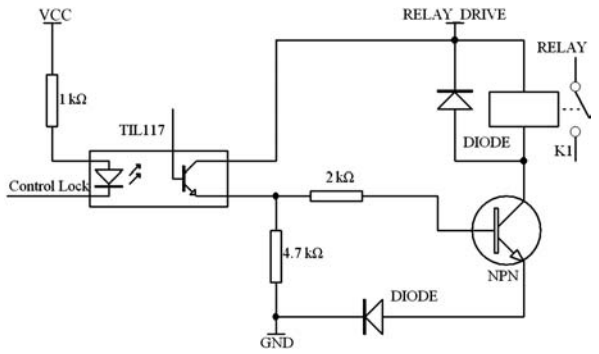

Fig.5 Electric lock drive circuit

SOFTWARE DESIGN

Communication software design

According to the function requires of the detecting system, a dual-direction communication protocol is designed in system communication software, in addition, the PC terminal software and the entrance management base station terminal software are designed separately.

1. Communication protocol

During the progress of communication, the PC terminal is the host and the base station terminal is slave. All slaves are addressed uniformed. The host controls the communication. All slaves receive the data frames (data or commands) sent by the host with address code, and compare with the local address. If they were different, the data frame would be abandoned. Otherwise, the data are sent for local and the slave responses according to the data or command (Mao, 2005), sends responded data back to the host. In every minute, there should be only one SRWF-501 in sending status so as to avoid interference.

In the system, the serial commute rate is set at 9600 bps, the data frame format at 1 start bit, 8 data bits, 1 stop bit. Fig.6 shows the format of the data package.

Distortion FFH, 00H	Start identifier F1H/E1H	Mode control byte	Address command or data	End identifier E1H	LCR check

Fig.6 Data package's format

In Fig.6, 0xFF and 0x00 are added to avoid interfering with signals at the beginning. The third byte is considered as the beginning flag, which means the PC terminal starts to send data to base station when the byte is equal to F1H. The E1H means the entrance management base station starts to send data to the PC terminal. The fourth byte is the control byte. When its value is greater than 7FH, it means that the following byte is addresses byte or command byte. When the value is less than or equal to 7FH, it represents the length of followed data blocks.

2. Base station communication software

For the entrance management base station, to send or receive data is controlled by the PC terminal. When the base station receives FFH, 00H, it shields them. If the base station receives starting byte F1H from computer, it receives mode control byte next. When the base station receives address byte, it compares address value with itself. If the address does not respond, it cancels from interrupt service, or, the address is sent back and address flag is set. It begins to receive PC's data or order. If PC's answering signal cannot be received by the base station in a hypothesis time T_1, it indicates the network is busy. The base station sends address again and makes SRWF-501 in the status of receiving, sets an initial seed value according to its address value, produces the random numbers among 1 to 256. This random number multiplies T_2 (5 ms is supposed) in order to get delay time T_3. After delaying T_3, if the program judges the base station not obtaining PC's answer, the acousto-optic alarm goes off .

3. PC communication software

The wireless communication software program through VB 6.0. The Mscomm communicating control settings caption is "9600,n,8,1". In the process of sending or receiving data, OnComm incident will be triggered. Through visiting CommEvent attributes, the types of communication event can be known. Control provides good functions to transmission and reception of data for serial port. Mscomm control is handled by two ways: the event-drive type, which captures and handles communication errors and in-

cidents by OnComm control; the Inquiring type, by inspecting the value of CommEvent attribute to judge the events and errors (Mao, 2005). This system adopts the event-driven approach. The PC terminal communication flow is shown in Fig.7.

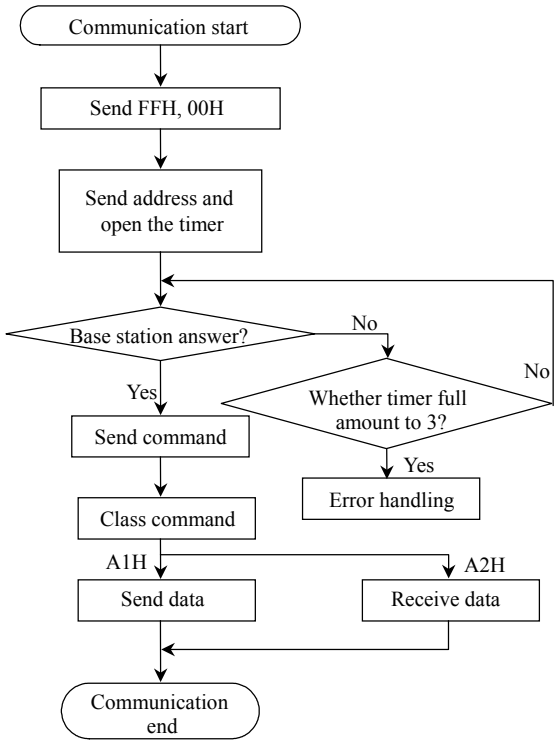

Fig.7 PC terminal communication procedure

Management software design

The entrance management software is the core of the system. Its function includes building, managing and maintaining the user basement, collecting and recording the information, which is uploaded by the main control equipment. Visual Basic 6.0 is adopted for programming the interface. It is composed of the communication processing module, the card management module, the controller management module, the authority management module and so on. All modules make use of Access to run the background basement and share data. The card management module is used to provide or cancel card number. The user management module builds the database, which records the information of the persons who hold the card. The administrator management module sets the administrator for each operator. The processing module is powerful to process report form.

CONCLUSION

Wireless communication can be applied for data transmission to realize the information interaction between the entrance management base station and the PC for the intelligent detecting system. Besides such advantages as no hard wiring, minimizing the capital cost and simplifying the construction, it is easy to be maintained and transformed in future. It is sure that the intelligent detecting system of the entrance management system based on wireless transmission must have a broad application prospect.

References

Cha, Z.Y., Zhu, B.H., 2003. The plan choice of entrance management system. *Development & Innovation of Machinery & Electrical Products*, **2**:13-14.

He, M.Q., 2005a. Wireless communication trends toward unified. *Electronic & Computer Design World*, **9**:46-51.

He, Y.H., 2005b. Analysis on measurements of the access control system based on non-touched RF card. *Electronics Quality*, **5**:15-18.

Mao, F.J., 2005. The application of wireless digital transmitting technology in IC card entrance guard system. *Automation Panorama*, **4**:89-91.

Wang, G.T., 2003. Intelligent district entrance management system. *Intelligent Building & City Information*, **12**:61-62.

Wang, J.B., Rao, Y.T., 2005. The design of RF card entrance management system based on AT89C2051. *Scientific and Technological Square*, **1**:87-89.