Design of access control system based on the near field communication (NFC) technology

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Abstract. With the development of mobile Internet technology, Android smart phones is gradually integrated into people's lives, and become important information terminal. Short-range wireless communication (NFC) is one of the technologies for use in access control systems, this kind of short-distance wireless communication standard can be achieved within a few centimeters of data exchange between devices. NFC is also in full compliance with ISO standards for management of contactless smart card, which is a notable feature of it an ideal platform. Android smartphones are gradually replace most of the commonly used tools in our lives, such as cameras, maps and so on, and NFC functionality based on the Android platform will gradually replace the life of cash payments and IC card access control system, NFC has become an important trend of development of intelligent access control system. This design from two aspects of hardware and software to take on Android platform-based NFC function plays an important role in access control systems. This design is based on the Android phone's NFC features using single-chip computer system relays, electromagnetic locks, smart home functions, NFC contactless door way humans bring more convenience, farewell forgot to bring my keys at home will not be suffering.

Key words: NFC; intelligent phone; Android; access control system.

1. Introduction

This design put forward the function of using Android smartphone replaces ordinary key to open / close the door, and completed the design of NFC intelligent door lock, providing a reference for the development of intelligent access control system. The mobile access control technology improves the practicability, convenience and security of the access control system, and reduces the cost. Compared to the traditional approach, mobile access system is more conducive to the security of user protection facilities, rooms and storage areas, creates opportunities for innovative applications and integrates many access applications into a single, convenient solution, as shown in: firstly, the approach brings a huge advantage to the users of integrated applications to access control system solutions. In addition to providing centralized management for organizations, access control system, which integrates multiple

applications, provides convenience to employees, who, with no multiple cards required, can open doors, log on to computers, use attendance and security printing management systems, pay for meals or transportation, perform non-cash transactions and other applications. Secondly, it makes it easy for users to join other new applications. Currently, biometric templates, including fingerprints, iris or palm geometry, veins, and so on, can be securely stored on a card as additional conditions for authentication, realizing access control function of other applications include building automation and medical record management.

2. Design Requirements and Scheme Selection

2.1. Design requirements
Unlock by access card, smart phone or key; control by electronic lock;
    The alarm system adopts buzzer and LED lamp;
    The time and times of unlocking can be recorded;
    (1) Realize access card unlock, 5 sets of card number can be saved, and can be modified;
    (2) Realize the unlocking of the intelligent machine, 5 groups of addresses can be saved, and can be modified;
    (3) The key can be used to open the lock when the cell phone is out of power or the power is off;
    (4) Acousto-optic alarm for 10 consecutive verification failures;
    (5) Logging function.
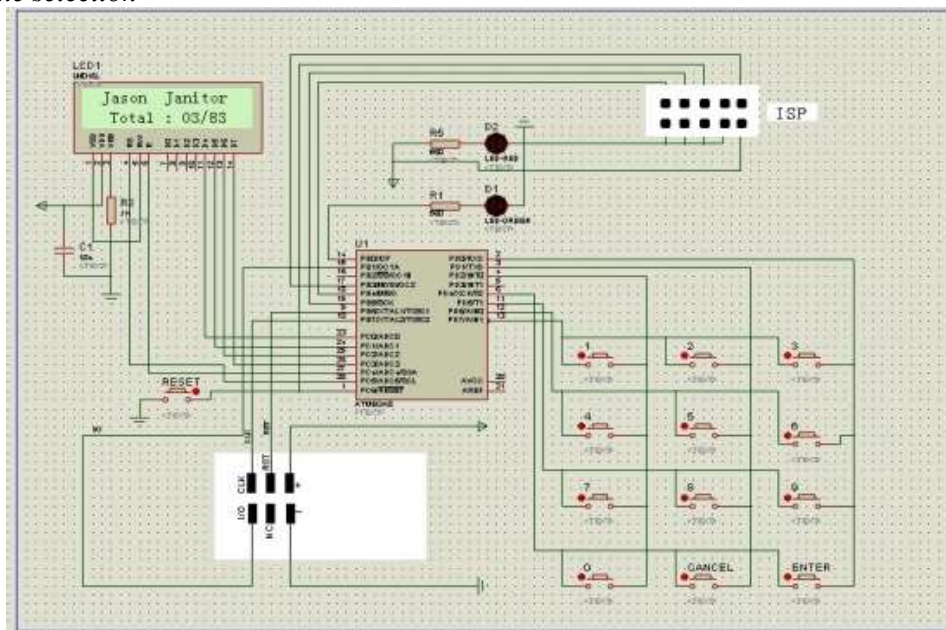
2.2. Scheme selection

Figure 1. NFC Functional Access Control System

The design of the access control system based on Android NFC included the following three steps:
    (1) Programming
    (2) Data packet transmission
    (3) Program flow processing.
    The design of the access control system based on Android NFC function communicates with the NFC card reader in the access control system through the NFC function of mobile phone, which can quickly identify and verify identity, compatible with the traditional IC card, and has high recognition rate. The NFC card reader, based on Android NFC function, can communicate directly with devices

with NFC function such as mobile phone, touch card, tag, etc., maximizing the advantages of the NFC access control system, and is superior to the currently used IC access read head, which can only be used as a card reader to read contactless cards. The NFC access control system is closely designed and continuously optimized, with the functions of data storage and forwarding, in order to record the UID, storage data of a plurality of NFC devices and authorize them. When the NFC device of the recorded UID is close to the NFC card reader for identification and verification, the door lock is opened or closed. The NFC access control system has the following advantages:

(1) Based on Android system, compatible with ISO14443A standard, Android is open source and developable, the NFC function on Android platform is practical, and smartphones, tablet computers, etc. are adding the NFC function step by step;

(2) The near field communication technology has strong confidentiality and is not easy to be cracked and attacked, which is also the primary consideration of the security of access control;

(3) ITEAD PN532 NFC module, compatible with various control boards;

(4) It is convenient to use. Nowadays, people carry their mobile phones with them, so they do not have to worry about the embarrassment of forgetting keys.
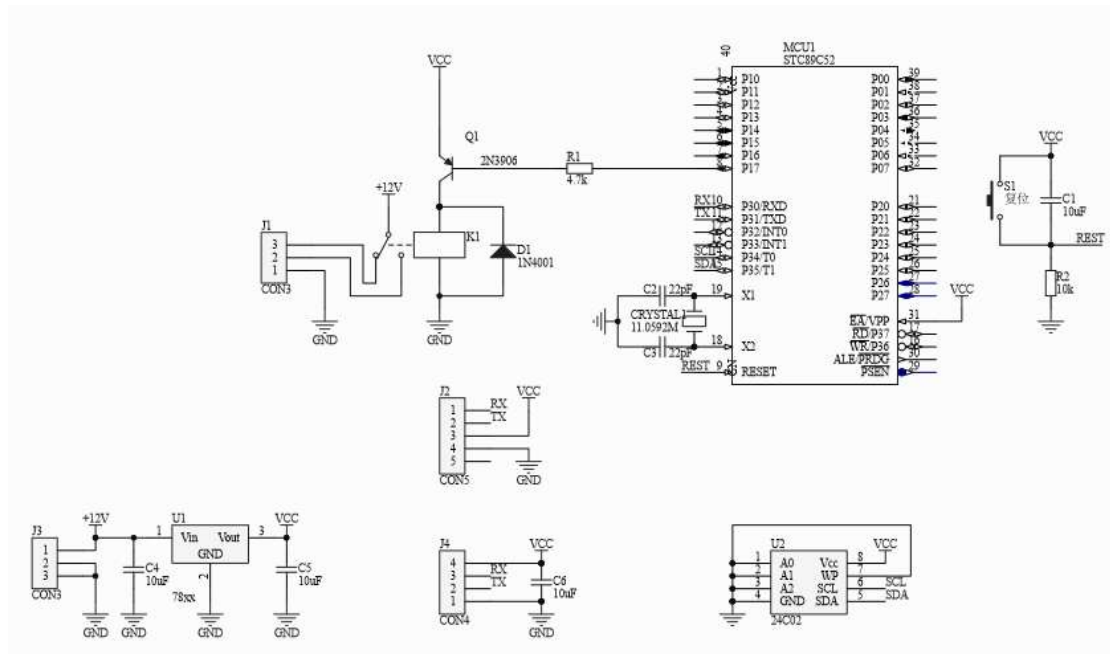

Figure 2. Hardware circuit diagram

IC card access control system has been relatively popular, but the technology is relatively backward, and the development prospect is far less than NFC, which mainly exists in mobile phones, is closely related to people's lives. The near field communication is sensitive to induction and has high recognition rate. Decided to use scheme II after comparison

3. Hardware Selection of System

3.1. NFC card reader and writer module
ITEAD PN532 NFC module, as its name implies, is one based on PN532 chip for 13.56MHz near field communication function, equipped with an on-board antenna, so there is no need for an external antenna coil. The module is compatible with SPI, IIC and UART interface communication, can be very convenient for NFC functional product development with the NFC library support of Android and Raspberry Pi.

3

Features of NFC module:
(1) Maximum effective communication distance of 5 cm
(2) Support interface switching of SPI, IIC, UART
(3) Non-contact communication available for 13.56M
(4) Compatible with class A and B standards of ISO14443 TYPE

Figure 3. NFC card reader module

3.2. The minimum system of STC89C51 MCU
STC89C51 MCU learning board is a system based on 8-bit MCU processing chip STC89C52RC, which is a single clock / machine cycle (1T) compatible 8051 kernel MCU, is a new generation of 8051 MCU with high speed / low power consumption, with new pipeline / reduced instruction set structure, internal integrated MAX810 special reset circuit.

3.3. EEPROM data memory
Electrically Erasable Programmable Read-Only Memory (EEPROM), is a kind of memory chip in which data will not be lost when power is turned off,   can erase existing information on a computer or on a dedicated device and reprogram it, generally used in plug and play.

3.4. Electromagnetic lock
The design principle of the electromagnetic lock is the same as that of the electromagnet, that is, the principle of using electric energy to generate magnetic field. When the current through the silicon steel door lock, the electromagnetic lock will produce a strong attraction, then absorbed adsorption iron plate tightly to achieve locking. With a small electric current, the electromagnetic lock will produce a great deal of magnetic force, then power down when the person is identified correctly by the access control system controlling the electromagnetic lock power supply, and opens the door when the electromagnetic lock loses its suction. Because the electromagnetic lock does not have the complex mechanical structure as well as the lock tongue structure, and is suitable in access control for escape doors or fire doors, so it is the best choice for access control system.

4. Design of Hardware Circuit of System

4.1. Design of single chip microcomputer system

(1)Introduction of Single Chip Microcomputer STC89S52

The single chip microcomputer is small in size, powerful in function, and confidential. It is an integrated chip and can save a lot of hardware circuits, which makes it easy to use. The pin package for the STC89C52 chip is shown in figure 4.
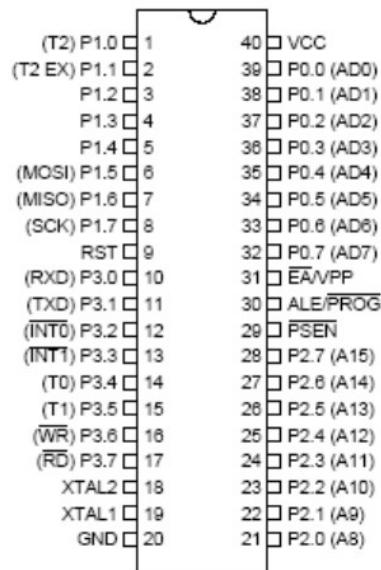

Figure 4. Pin structure of STC89C51

The VCC, GND, XTAL1 and XTAL2 are the pins of the external connected crystal. The input of the internal oscillator inverting amplifier is XTAL1 and the output is XTAL2 . The pins are suspended in an external oscillating circuit.

ALE/PROG, RST and PSEN are used for control, and EA/VPP is a power multiplex pin. RST reset input, which resets through high and low levels of two machine cycles; when oscillator is running.

(2)Design of Minimum System of Single Chip Microcomputer

In the minimum system of single chip microcomputer, 20 pins are connected to earthing terminal and 40 pins to power supply, which makes the normal reading and writing of ROM inside single chip microcomputer. The oscillating circuit of this design adopts internal clock mode. When the XTAL1 and XTAL2 pins are connected with a parallel resonant circuit with the crystal oscillator of 11.0592MHz and the capacitance of 30pF usually, the oscillation circuit inside the single chip microcomputer will produce self-oscillation.

The reset function of STC89C51 is realized by external reset circuit, and there are two ways of that, namely, button reset and power-on automatic reset. The latter is realized by charging the capacitor of the external reset circuit. If the rising time of the Vcc does not reach 1ms, it will be automatically reset, otherwise, it will not. At this time, it needs to be realized by button reset. In the actual circuit, R1 acts as a current limiter. The minimum system composed of STC89C51 is shown as follow.
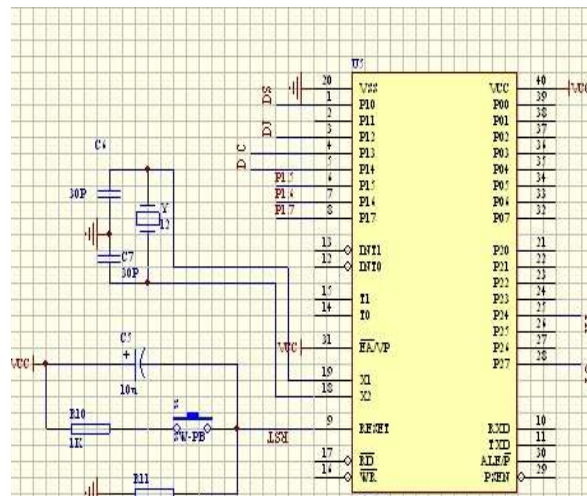
Figure 5. minimum system of single chip microcomputer

4.2. The working principle of NFC

There are three main working modes of NFC terminal:

(1)active mode

In active mode, the NFC terminal can act as a card reader, emitting RF fields to identify and read / write other NFC device information.

(2)passive mode

This mode is exactly the opposite of the active mode, where the NFC terminal is modeled as a card, which only passively responds to the RF field emitted by other devices and is read / written information.

(3)two-way mode

In this mode, both sides of the NFC terminal actively send out RF field to establish point-to-point communication, which equals that two NFC devices are both in active mode.

4.3. Design of hardware structure of nfc intelligent door lock

The hardware structure of NFC intelligent door lock is mainly composed of an integrated circuit board, a set of door lock power supply, a USB interface, a processor chip based on ARM926, two NFC chips, a door lock rotating mechanical interface and a SD card interface. The door lock power interface, the USB interface, the door lock controller chip, the NFC chip, the door lock rotation mechanical interface and the SD card interface are embedded on the integrated circuit board, they are connected by the related circuit on the integrated circuit board.

4.4. Design of system power supply

Control system is +12V DC power supply, in order to obtain DC power supply that is stable and can provide a certain amount of power to ensure that the power supply can provide enough power to the motor, using a double 12V transformer with 15W power, outputting rectified DC power by rectifier bridge, and then filter the jitter DC current by filter capacitor, so as to get a smooth current.

5. System Software Setup

5.1. Program processing flow

The program processing flow of NFC access control system based on Android platform mainly includes the following steps:

(1) Start the main program;

(2) initialize the IO port;

(2) Initialize the NFC card reader PN532;

(3) verify the switch state of the door lock;

(4) Looking for the card reading device (I. e., NFC device);

(5) Verify whether the UID of the NFC device is correct or not;

(6) Verify whether the password of NFC device is correct or not;

(7) verify the existence of collision and start the anti-collision program;

(8) Verification completed, unlock the door.

6. System Production and Debugging

6.1. System production

NFC access control system production is divided into the following three steps:

(1) The design and debugging of the hardware system.

(2) The design and debugging of the software system.

(3) Overall check, modify the problems of each module.

6.2. Software system debugging

This design is based on the Android NFC function, in the Android NFC application, Android mobile phone is usually used as the initiator in the communication, that is, as a reader of various NFC cards. Android's support for NFC is primarily in the android.nfc and android.nfc.tech packages.

7. Conclusion

(1) The main design of the hardware system was the design and manufacture of the NFC card reader and the MCU control circuit. The problems in hardware were less and were easier to be solved.

(2) The problem, in the aspect of software design, lies in the two modules of program writing and card reader identification, the process of which were tedious and the workload was heavy. The problem, however, solved by studying hard and consulting with classmates and teachers as well as searching for relevant references.

References
[1]   B.Q Li, Y.F Ling, M Tian, S.Y Zheng: Design and implementation of sugarcane growth monitoring system based on RFID and ZigBee. International Journal of Online Engineering, 3(14), 96-106, (2018).
[2]   B.Q Li, M Tian, S.Y Zheng,Y.F Ling : Design and research of picking manipulator obstacle avoidance system based on IOT. International Journal of Online Engineering, 3(14), 96-106, (2018).
[3]   B.Q Li, Y.F Ling, H.Y Zhang, S.Y Zheng: The Design and Realization of Cherry Tomato Harvesting Robot Based on IOT. International Journal of Online Engineering, 12(12), 23-25, (2016).
[4]   B.Q Li, W.L Guan, S.Y Zheng, X.G Yue: Optimisation Design Of Corn Precision Seeder Based On Multi-Route And Multi-Channel Control. Journal Of The Balkan Tribological Association, 21(4a), 1215, (2015).
[5]   B.Q Li, S.Y Zheng,M Qiu:Research on picking identification and positioning system based on IOT. International Journal of Online Engineering, 7(14), 149-160, (2018).
[6]   B.Q Li, et al, Analysis of multi-sensor information fusion and knowledge discovery in coal mine gas monitoring, in: 2nd International Symposium on Resource Exploration and Environmental Science,2018
[7]   B.Q Li, et al, Background and significance of gas monitoring research in coal mines, in: 2nd International Symposium on Resource Exploration and Environmental Science,2018
[8]   B.Q Li, X.M Yang Guan, S.Y Zheng: Internet of Things-based Simulation Study on Lijiang River Water Environment Monitoring. Journal of Coastal Research, 79, 1-5, (2017).
[9]   B.Q Li, et al, The Design and Realization of Fruit Harvesting Robot Based on IOT, in: Proceedings Of The 2016 International Conference On Computer Engineering,Information Science & Application   Technology (Iccia 2016), Guilin, China, 2016, Pp.261-264.
[10]   B.Q Li, et al, A New Type of Automatic Opening and Closing Light-Operated Curtain, in: Proceedings Of The 2016 International Conference On Mechatronics Engineering And Information Technology(Icmeit), Xian, China, 2016, PP.66-69.
[11]   B.Q Li, et al, Design of the Intelligent Air Humidifier, in: PROCEEDINGS OF THE 2016 International Conference On Mechatronics Engineering And Information Technology(Icmeit), Xian, China, 2016, Pp.201-203.
[12]   B.Q Li, et al, The Design Implementation of the APP of Experiencing Guangxi Folk Custom, in: Proceedings Of The 2016 International Conference On Economics And Management Innovations, Wuhan, China, 2016, Pp.47-50.
[13]   S.Y Zheng, et al, Digital Display Design of Ethnic Clothing of Nanling, In: Proceedings Of The 4th International Conference On Mechatronics,Materials.Chemistry And Computer Engineering 2015(ICMMCCE 2015), Xian, China, 2015, PP.2805-2808.
[14]   S.Y Zheng, et al, Design and Implementation of Supermarket Personnel Management System Based On Java, in: Proceedings Of The 2015 International Conference On Ededucation,Management And Computing Technology(Icemct-16), Hangzhou, China, 2016, Pp.957-960.
[15]   S.Y Zheng, et al, Brief analysis on"HeYuanTong"Campus Mobile Phone APP Design, in: Proceedings Of The 2015 5th International Conference On Computer Sciences And Automation Engineering, Sanya, China, 2015, PP.151-154.
[16]   S.Y Zheng, et al, Social Work in Teen Addiction Correction Services Research Under the New Situation, in: Proceedings Of The 2015 4th National Conference On Electrical, Electronics And Computer Engineeering(Nceece 2015), Xian, China, 2015, PP.252-255.
[17]   B.Q Li, et al, The Design of Remote Temperature Monitoring System, in:International Conference on Green Energy and Sustainable Development, MAY 27-28, 2017, PP.20-22.
[18]   B.Q Li, et al, Design of Portable Valuables Touch Alarm Circuit,in:International Conference on Advances in Materials, Machinery, Electronics ,2017, PP.27-32.

[19] B.Q Li, et al, Design and Implementation of a Simple Acousto Optic Dual Control Circuit,in:5th International Conference on Computer-Aided Design, Manufacturing, Modeling and Simulation,2017, PP.78-80.

[20] B.Q Li, et al, Design of electronic lock based on single-chip microcomputer,in:4th International Conference on Electrical and Electronics Engineering and Computer Science ,2017, PP.55-60.

[21] B.Q Li, et al, The Design of Chicken House Electronic Intelligent Lighting Apparatus,in:International Conference on Mechanical, Electronic, Control and Automation Engineering,2017, PP.15-20.

[22] B.Q Li, et al, Office Automation Sub-Summary of the Work and the Project Management System,in:International Conference on Mechanical, Electronic, Control and Automation Engineering,2017, PP.46-48.

[23] B.Q Li, et al, The Design of Intelligent Heat Dissipator Control Circuit,In:Proceedings Of The 2017 2nd International Conference On Materials Science, Machinery And Energy Engineering,2017, Pp.22-25.

[24] B.Q Li, et al, The Design of IPv6's Transitional Scheme in University, in: International Conference on Materials Science, Energy Technology, Power Engineering (MEP) ,2017, PP.91-93.

[25] B.Q Li, et al, The Personal Receiving Document Management and the Realization of Email Function in OAS,in:International Conference on Materials Science, Energy Technology, Power Engineering (MEP) ,2017, PP.121-123.

[26] S.Y Zheng, et al, Design and Implementation of an Audio Indicator,in: 5th International Conference on Computer-Aided Design, Manufacturing, Modeling and Simulation,2017, PP.21-23.

[27] S.Y Zheng, et al, Implementation and Application of ACL in Campus Network,in: International Conference on Advances in Materials, Machinery, Electronics ,2017, PP.151-153.

[28] S.Y Zheng, et al, The Design of Liquid Drip Speed Monitoring Device System Based on MCU,in:International Conference on Green Energy and Sustainable Development, MAY 27-28, 2017, PP.51-53.

[29] S.Y Zheng, et al, The Design of Hearing and hypnosis all-in-one Machine,in:International Conference on Mechanical, Electronic, Control and Automation Engineering,2017, PP.66-68.

[30] S.Y Zheng, et al, Campus Network Security Defense Strategy,in:International Conference on Mechanical, Electronic, Control and Automation Engineering,2017, PP.30-33.

[31] S.Y Zheng, et al, Design and implementation of multifunctional charger,in:International Conference on Materials Science, Energy Technology, Power Engineering (MEP) ,2017, PP.71-73.

[32] B.Q Li, et al, Intelligent Control Management System and Its Application, In: Proceedings Of The 2016 International Conference On Economics And Management Innovations, Wuhan, China, 2016, Pp.68-71.

[33] B.Q Li, et al, Design and Implementation of Tanks War Game Based on the Android Platform, in: Proceedings Of The 2016 2nd Wrokshop On Advanced Research And Technology In Industry Applications, Dalian, China, 2016, Pp.963-966.

[34] B.Q Li, Et Al, Design Of A Tea Garden Antifreezing Control System, In: Proceedings Of The 2016 6th International Conference On Machinery,Materials,Environment, Biotechnology And Computer(Mmebc), Tianjin, China, 2016, Pp.736-738.

[35] B.Q Li, Et Al, Design Of Electronic Compass, In: Proceedings Of The 2016 6th International Conference On Machinery,Materials,Environment,Biotechnology And Computer(Mmebc), Tianjin, China, 2016, Pp.1240-1243.

[36] B.Q Li, Et Al, Research Of Automatically Light-Adjusting Lamp, In: Proceedings Of The 2016 International Conference On Computer Engineering,Information Science & Application Technology(Iccia 2016), Guilin, China, 2016, PP.249-252.