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Design and implementation of a microcontroller-based classroom sign-in system

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ABSTRACT:

The sign-in system in modern university classroom management still continues the traditional way of verifying the arrival of personnel through on-site roll-call, which exists to waste a lot of manpower as well as class time. To address this problem, this paper designs and implements a microcontroller-based classroom check-in system, using an RFID module to read data from the campus card, an LCD screen to display the check-in time and other information, then a DS1302 clock chip to control the time, plus four keys to control the time setting, a voice announcement of successful check-in, a serial port to transmit the information to the upper computer for processing, and the upper computer then transmits the processed data to the development board. The upper computer then transmits the processed data to the development board, and finally rewrites the data to the LCD display for display, thus realizing the information interaction between the classroom monitoring platform and the monitoring terminal to facilitate teachers to manage the classroom order and carry out teaching activities. The upper computer part of the design uses SQL server 2017 database and Visual Studio 2019. The monitoring part includes MFRC522 radio frequency identification, LCD display, voice broadcast and key adjustment. The design process includes circuit and program design, where the circuit design uses Proteus simulation software and the program design uses Keil5 software. The system achieved the sign-in test of student personnel in classroom management and was able to achieve the expected objectives.

Keywords: Internet of Things, microcontroller, RFID, database

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1. INTRODUCTION

Traditional classroom check-in is mostly people-based, especially in university classrooms nowadays, where teachers and students do not have a fixed classroom and there is no corresponding management staff to control the students' classes. Modern university classroom management sign-in systems still continue the traditional way of verifying the arrival of people through on-site roll-calls, and there is a lot of wasted manpower as well as class time in this way. The IoT design for classroom check-in systems is based on a thorough study of the school's needs. [1] The IoT system is designed to make classroom management more efficient and reduce the cost of manual management, by enabling easy observation of the arrival of personnel through IC card check-in.
The construction of campus information technology is equally significant. Through the Internet of Things (IoT) technology, the microcontroller is connected to various sensors to form a complete intelligent device to achieve the functions of classroom management regarding student sign-in systems, which can greatly improve the efficiency of classroom time management. Today, IoT technology is developing rapidly, with communication networks and the Internet as an extension, using RFID technology, various sensor information, positioning systems to obtain data for scientific management and real-world forecasting. [2] The management system designed for this project is designed to alleviate the need for a new and improved management system. The management system designed in this case, to ease the teacher's observation of the students, is signed in through an IC card placed in the top left corner of the table by a reader, which not only saves unnecessary time before class to know if students are absent or late, but also saves financial and material resources, as well as relieving the teacher's energy.

2. OVERALL SYSTEM DESIGN

The microcontroller-based classroom sign-in system consists of two main parts: the lower computer and the upper computer. On each desktop in the classroom, there is a card reader device, which reads the card through the card reader operation, collects the student information, sends the data to the upper computer using serial communication, and the system automatically analyses the data to provide a viewing service for the teacher. The system is designed in two main parts: firstly, the hardware design, using various IoT modules to extend the STC15F2K60S2 MCU development board to meet the monitoring requirements; secondly, the upper computer design, which mainly processes the data collected by the lower computer, and finally displays the results to the teacher for viewing and management of student information[3] The second is the design of the upper computer, which mainly processes the data collected by the lower computer and finally displays the results to the teacher for viewing and management of student information. Figure 1 shows the overall structure of the system, the lower computer will collect the data transmitted through the serial port to the upper platform, the teacher in the monitoring interface can see the data processed by the upper computer, the collected data is always displayed on the system page, convenient for managers to manage the classroom.

The workflow of the system: students sign in by swiping the card, the card reader reads the information in the card, then the microcontroller control chip processes the student information and sends it to the upper computer through the serial port, the upper computer first decrypts the data, then compares the collected data with the information in the database, after the information is correct, the upper computer interface will display the student sign-in information and transmit it to the lower computer through the data line. After the information has been correctly compared, the upper computer interface will display the student sign-in information and transmit it to the lower computer via the data line, and finally the LCD display above the lower computer will display the student sign-in time and other information, while the JQ8900 voice module will broadcast the successful sign-in. The whole system simulates the whole classroom check-in system in a simple and convenient way and realizes its check-in function.

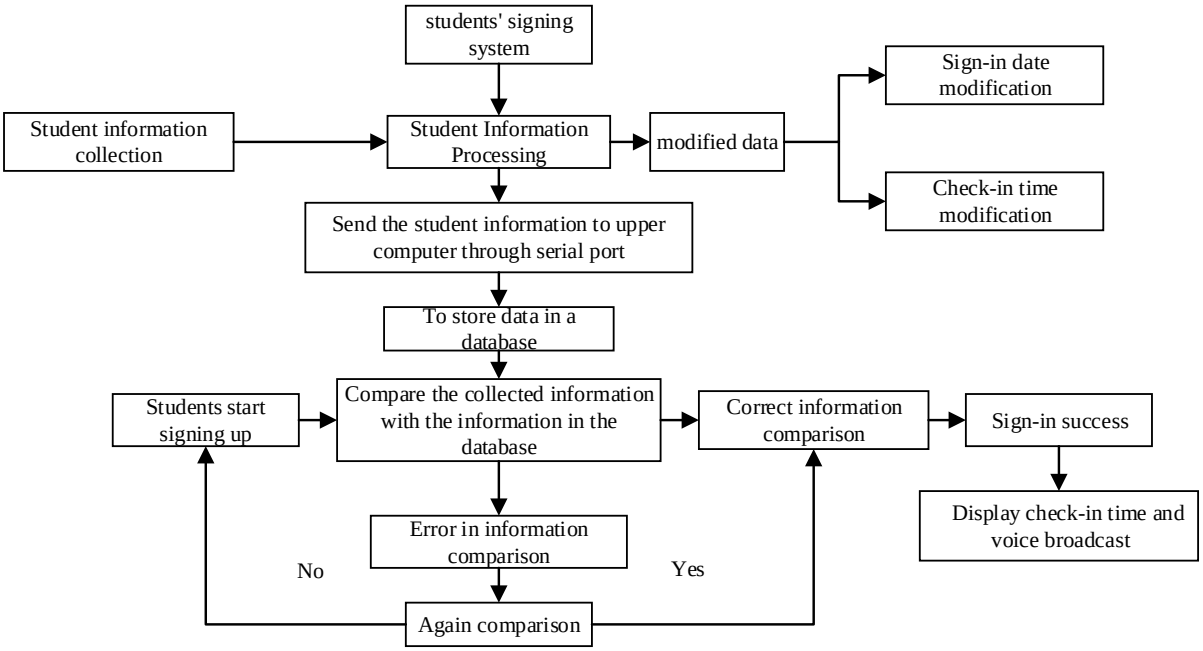

Figure 1 Overall system structure

3. CIRCUIT DESIGN

(1) Microcontroller minimum system
This design uses this design STC12C5A60S2 microcontroller, compared with other microcontrollers, the microcontroller has strong anti-interference, high integration and fast processing speed, etc., there are many peripheral functions concentrated in the microcontroller, build peripheral circuit is convenient and simple [4] The schematic diagram is shown in Figure 2.

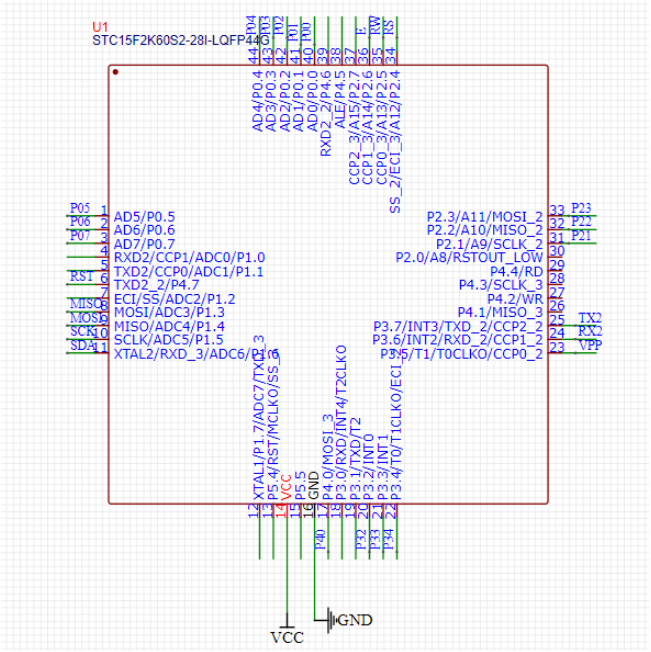

Figure 2 Microcontroller minimum system

(2) Data acquisition circuit

This design uses the MFRC522 RF acquisition[5] module to carry out the reading of the IC card, RFID physical diagram as shown in Figure 3 using serial communication with the CPU for information exchange[6] The RFID uses 3.3V power supply, when the reader reads the card, the RFID will be input and output through MISO and MOSI, IRQ is the interrupt request, SCK is the IIC clock, SDK is the IID data, RST is the reset pin, active high, the RFID module circuit design is shown in Figure 4. When the RFID-RC522 reads the information from the ID card it sends it to the operator via the serial port for information processing.

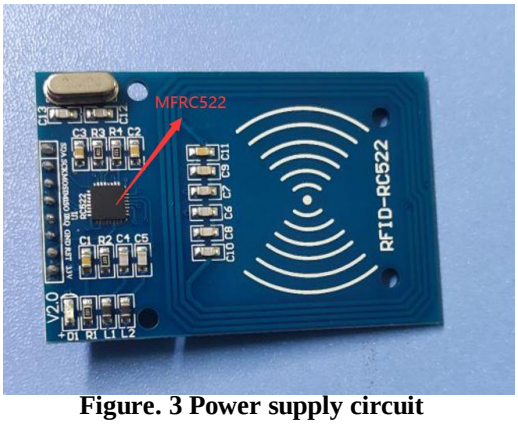

Figure. 3 Power supply circuit

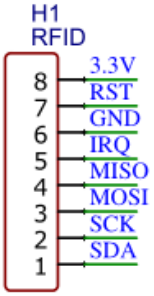

Figure 4 RFID circuit

(3) DS1302 clock circuit

The DS1302 clock is shown in Figure 5 and consists of the DS1302 chip, crystal and two ceramic capacitors, of which CE, IO and SLK are connected to the P2.1 to P2.3 interfaces of the microcontroller.[7] The basic circuit of the DS1302 chip is shown in Figure 6, where the clock circuit adopts a unique power supply mode, so that VCC2 can be replaced in time when the main power supply fails to ensure that the time and date data will not be lost, I/O is the data input and output pins for data transmission, X2 is a 32.768KHz crystal to provide the clock source; SLK is the clock signal; C1 and C2 are 10P capacitors to enhance the stability of the signal transmission[8] The X2 is a 32.768KHz crystal to provide the clock source; SLK is the clock signal; C1 and C2 are 10P capacitors to enhance the stability of signal transmission.

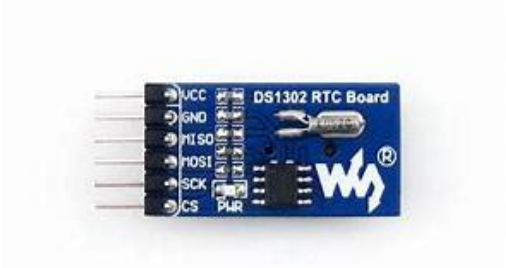

Figure 5 DS1302 clock

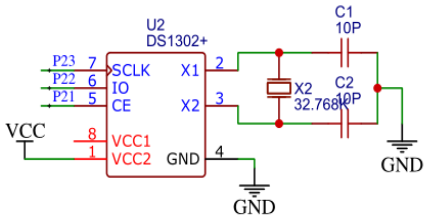

Figure 6 DS1302 clock circuit

(4) Voice circuits

The voice module is mainly composed of JQ8900 chip and flash, using TTL level of 3.3V, a 16-bit MCU is integrated inside, there is a one-wire serial communication protocol, two-wire serial communication and key triggering, this design uses a one-wire serial communication protocol, the guide code delay uses 4MS delay, through the software designed program to convert the voice text into MP3 voice format, broadcast The successful sound of the sign-in can be captured by an oscilloscope waveform[10] The successful sound of the broadcast can be captured by an oscilloscope, as shown in Figure 7. The design uses VPP as a one-wire serial port, VCC and GND for power and ground respectively, other interfaces are in a suspended state, SPK+ and SPK- are connected to the pins opposite the speaker, used to control the sound level. The voice module circuit is shown in Figure 8.

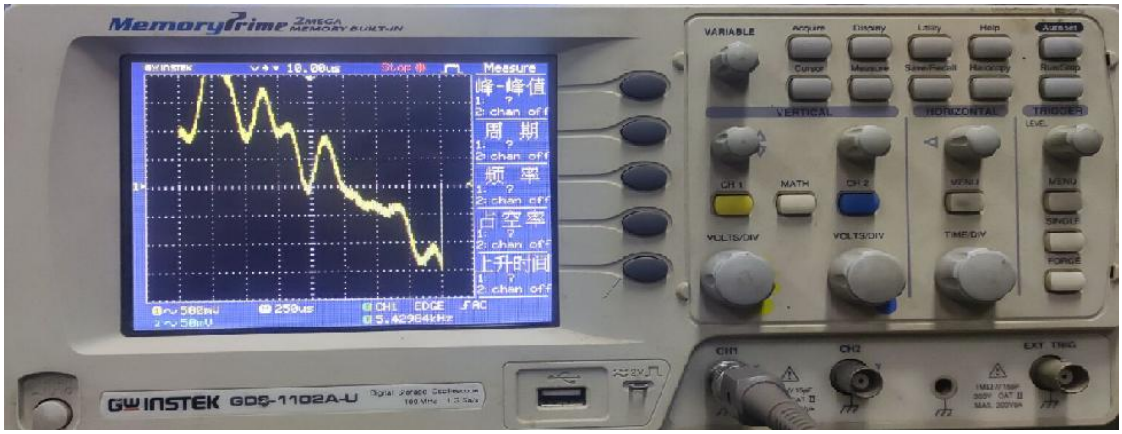

Figure. 7 Voice over diagram

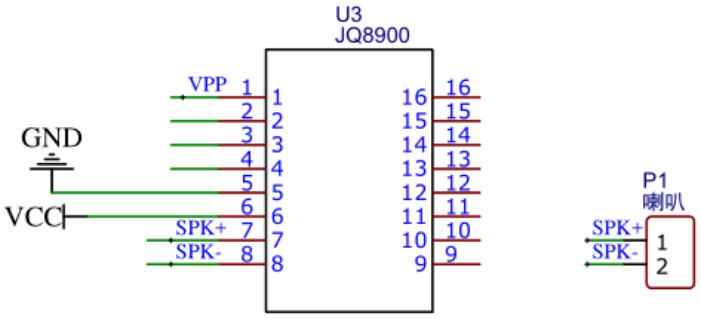

Figure 8 Voice module circuit

4. PROGRAMMING

(1) Main program design

The main program is the core of the whole program, firstly the initialization operation, secondly there will be a loop in the main program, which is used to keep the microcontroller powered on after working, the main program main. c will call "ds1302.c", "JQ8900.c ", "lcd12864.c", "URAT.c" to get the data acquisition, "display time() " and "display card()" to achieve the display of data, the program in the loop can be delayed to execute, SLOW each time added to 5 to execute once to get the card number and get the time function, the main program flow chart is shown in Figure 9.

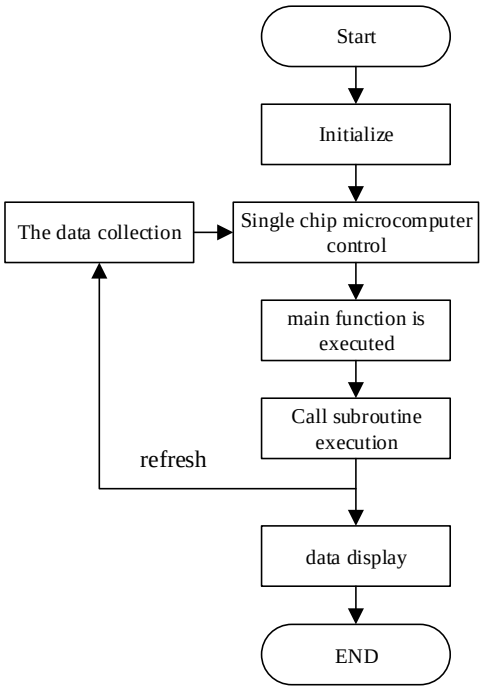

Figure. 9 Flow charts of the main program

(2) Serial communication subroutine design

In this design, the data is transmitted between the host computer and the monitoring end through the serial port. The steps of UART serial communication transmission are to send UART to receive data from the data bus; to add the start bit, parity bit and stop bit to the data frame of UART; to decode the data and sample the data line, UART will turn serial back to parallel again and transmit it to the data bus of the receiving end. [11]. Set the baud rate of communication at 4800bps and the frequency at 11.0592MHz. The flow of the serial communication subroutine is shown in Figure 10.

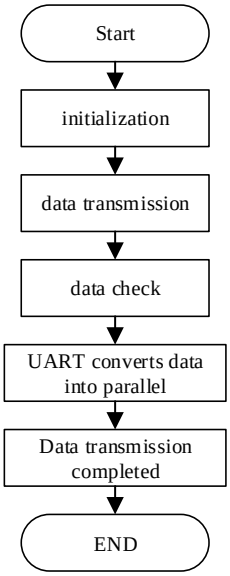

Figure 10 Flow chart of the serial communication subroutine

(3) Data acquisition subroutine design

Data acquisition is completed by the MFRC522, which first performs an initialization operation to prevent residual data from interfering with the next IC card acquisition. The RC522 then performs the card search operation, which includes anti-collision detection of the card number sequence, clearing the register values in the RC522, transferring the data between the RFID and ISO cards, then receiving the data in the cards, reading the data in the timer interrupt service function, and converting the signal into binary code through A/D conversion, and then transmitting the encoded data to the microcontroller[12] The data is then transferred to the microcontroller, stored in memory and displayed on the LCD via the controller. The flow chart of the data acquisition subroutine is shown in Figure 11.

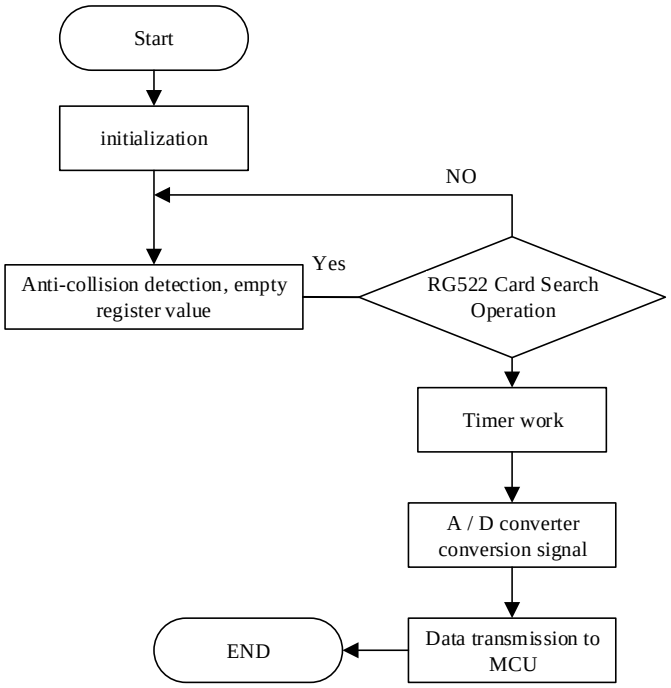

Figure 11 Flow chart of the data acquisition subroutine

5. SYSTEM TESTING AND RESULTS

(1) Testing of data acquisition functions
The function of the lower computer is to collect the date, time, name and student number of the student and upload it to the upper computer through the serial port. The information collected is compared with the data in the database to confirm whether the data collected is correct or not, and if the information collected is correct it is displayed on the display.

This test was conducted on the data in a secondary conversion manner, encrypting the data before and after to ensure the accuracy of the source data. Data is collected at regular intervals, with a set interval of 5 seconds, and the data collection test diagram is shown in Figure 12. Through the RFID module test, the card reading operation is carried out and the data display student information changes. Through different tests of the card, the information collected will be different and the binary code displayed will be different, the upper computer forms the corresponding text by decrypting the binary data to achieve the effect of displaying information on the LCD screen.

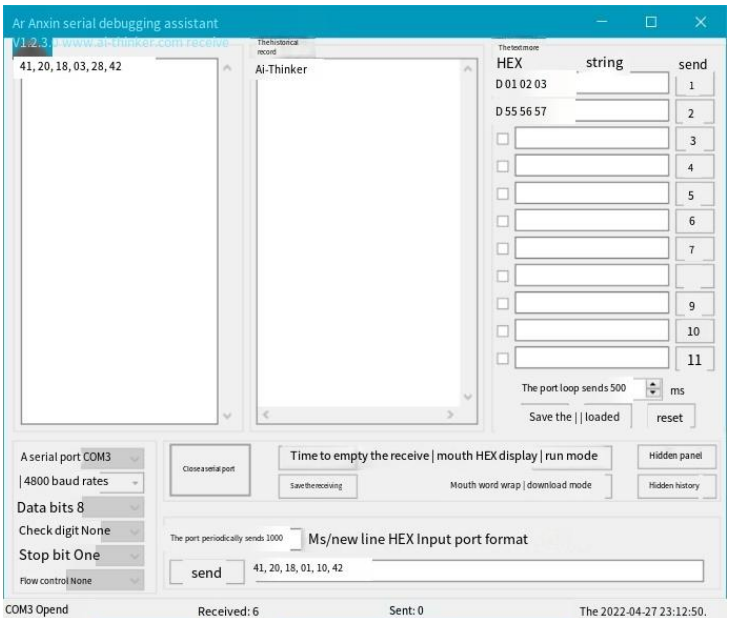

Figure 12 Data acquisition test chart

(2) Upper platform Testing

The interface of the upper platform is shown in Figure 13. After successful login the system can see the functional modules of the system overview: firstly, the topmost data display section, the middle position is the selection of serial port number and bit rate, the lower end is the detection of serial port, closing of serial port, start of sign-in, end of sign-in and viewing of unsigned persons.

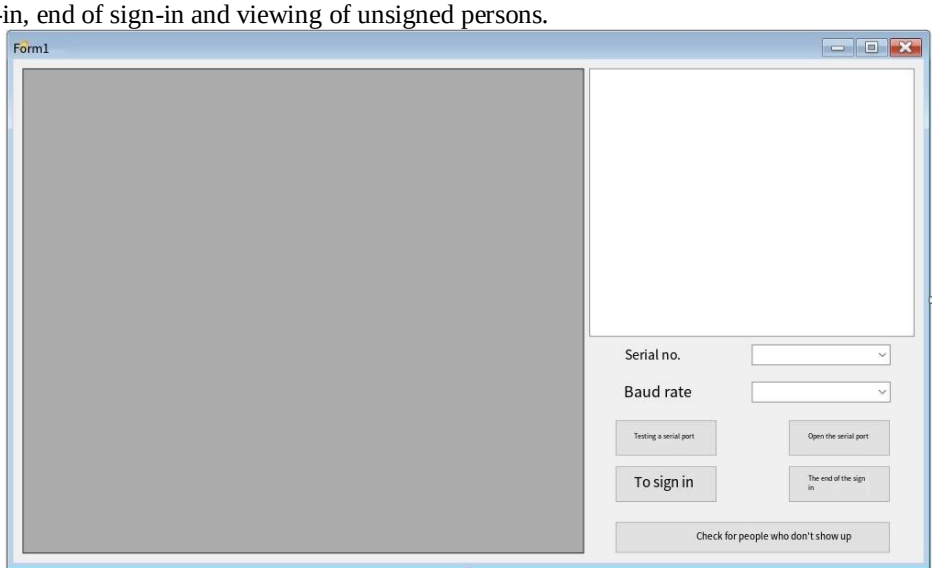

Figure 13 Upper computer monitoring platform

(3) Terminal management and acquisition functions Testing

Access to the terminal management interface can change the operation of all student information, including ID, Name, time view, above this data through the RFID module, serial module and database connection for data collection, upload, display to the terminal monitoring platform. The terminal management platform interface is shown in Figure 14.

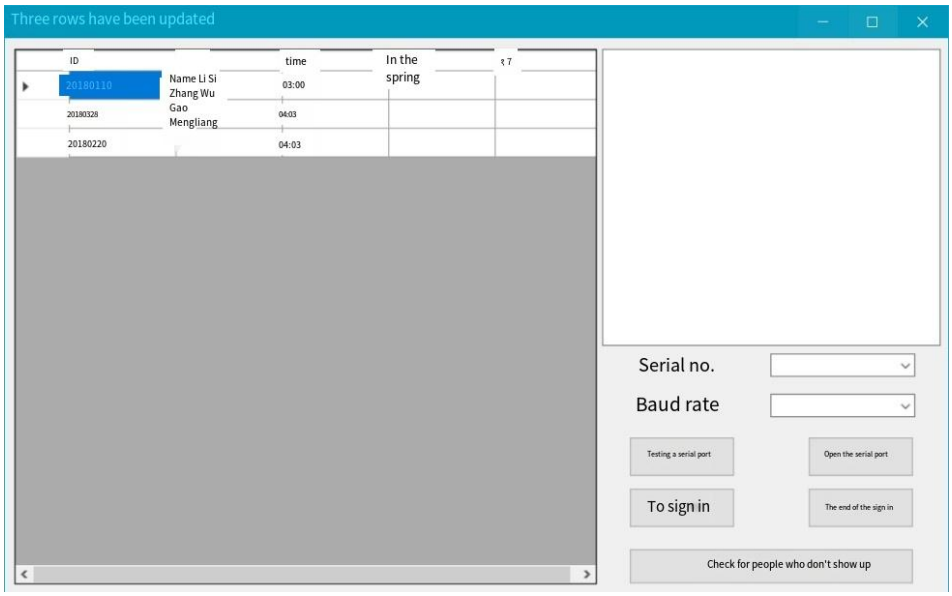

Figure 14 Management interface of the upper computer monitoring platform

(4) Persons not signed in testing

This function focuses on the number of students arriving in the classroom, including information on non-sign-in personnel, and there is a window to view non-sign-in personnel on the PC interface, so click on the button to view the number of non-sign-in personnel and details of non-sign-in personnel, as shown in Figure 15.

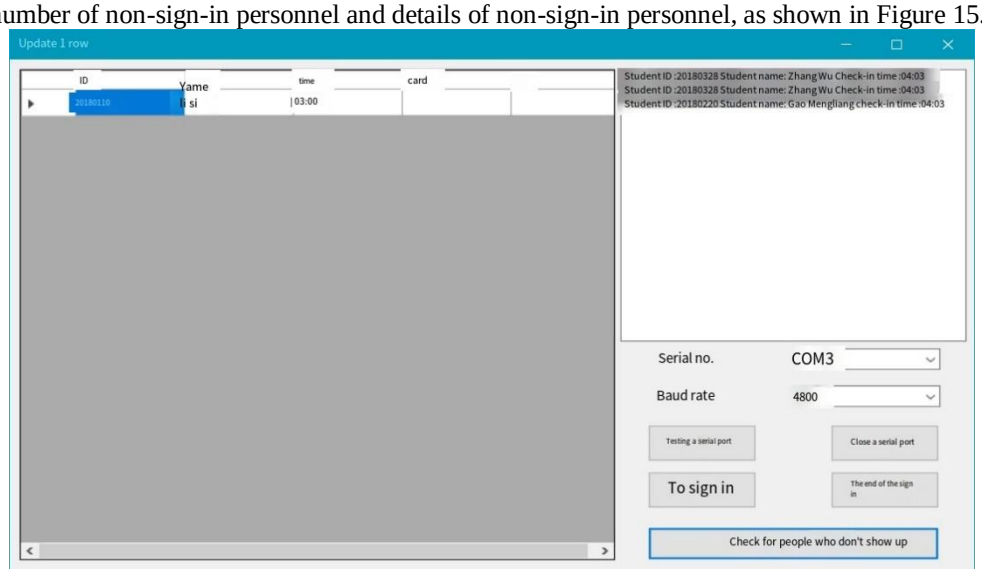

Figure 15 Non-sign-in person

6. CONCLUSION

This paper designs a microcontroller-based classroom check-in system. After circuit design, programming and system testing, the function of this check-in is achieved and the set objectives are met. The design uses a microcontroller as the hardware chip, with the clock module, LCD module and voice module working together, students can easily sign in according to their cards, collect information through RFID and connect to the host computer via USB cable, which then displays the data on the monitoring platform by connecting to the database so that the teacher can observe the number of students arriving in the classroom. The system has proven to be stable and effective in solving the problem of time and manpower wastage due to roll-call during classes and improving the efficiency of classroom management.

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