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A System for Classroom Selection Based on WIFI and GSM

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Abstract: The purpose of this design is intended to statistics and publishes classroom space information timely to students, and then save students' time for looking study room. The system consists of a master node for remote wireless communication and two subordinate nodes for local communications in the classroom, and that three nodes are star-connected. The tasks of the master node are to collect information from the subordinate nodes and display and transmission. The master node contains count display equipment, and information transmission module. Set up two subordinate nodes for collecting information of the number who inter the bus. The devices for counting include two units, signal acquisition unit is constituted with pyroelectric infrared sensor which contains RE200B probe and conditioning circuit, and the control unit is constituted with STC90C516 for signal processing. LCD screen is used to real-time display in each node for counting the number of coming in or out the classroom. Users query current number in the classroom through SMS, and GSM module sends the data stored in the current register to the user. The manner of local communication is using Serial to WIFI. The entire system uses sensor technology and mobile network communication technology to achieve real-time acquisition and release of information. The ability to identify and stability of the experimental system currently implemented are strong.

Keywords: Pyroelectric infrared sensor, Counting device, STC90C516, Wireless communication GSM, WIFI.

1. Introduction

In recent years, with the development of higher education, the number of college students increases a lot, teaching hardware resource utilization is higher than before, resulting in classroom resources are increasingly strained. Many students often carrying a bag shuttle to each classroom of teaching building at many schools, they are in misery that they cannot find a classroom for self-study. Now, with the development of network technology, classroom management automation technology is constantly developing, and there has many kinds of classroom management systems based images, fingerprints, smart cards and other technology. The main flow of these systems is: classroom demographics, web publishing, students landed inquiry system to obtain information about the current classroom space, with a purpose to find the study room. Infrared detection method has also been applied on a number of statistics, and coach overcrowding monitoring system in this article is also based on infrared detection, combined with networking and wireless communications technology, to achieve signal acquisition, display, wireless transmission, alarm and other functions, and its structure is intact and suitable for many occasions.

2. System Design Scheme

This system includes the following components: number of people testing and statistics, the number of display, transmission of classroom basic information. The system consists of three nodes which communicate by WIFI, and the task of master node is to count the number of people in classroom and transmit text message which contains the number of people and basic information of the classroom to the users, and the subordinate nodes collect the number of incoming and out of the classroom.

Classrooms are generally equipped with two doors, which are located at both ends of the classroom, but students do not necessarily choose the same door to enter and exit the classroom, therefore, the subordinate node which attaches to the door of the classroom needs to determine the student who is through the node is entering or leaving the classroom.STC90C516 whose cost-effective is higher than others is used to be the core processor of the subordinate node [1], pyroelectric infrared sensor as detect unit, and the result is sent to the master node through the serial WIFI module. The master node collects data from the from node through serial WIFI and calculate to determine whether more than a predetermined value and the output alarm signal, while the recorded data is displayed on the LCD screen. At the same time, the master node will send the basic information of the classroom to the application users through the GSM module. System design block diagram shown in Fig. 1.

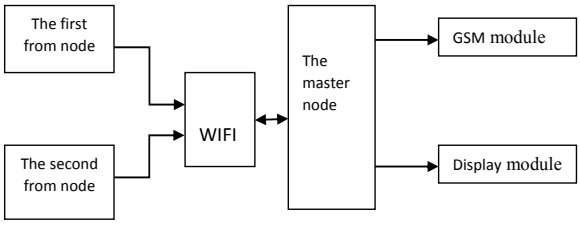


Fig. 1. Block diagram of the classroom automatic selection system.

3. Functional Design for the Subordinate Node

The tasks of the subordinate node are signal acquisition, display and transmission. The structure and function block diagram shown in Fig. 2.

The signal acquisition device of the subordinate node is pyroelectric infrared sensor module which includes RE200B and its Conditioning circuit [2, 3], and the master chip STC90C516 signal responses of the sensor module. It should design a counter to record the number of persons who enter the classroom. When people come around to the sensor, it will appear a signal which is a state different from original state, and the MCU must record the state as a data. Meanwhile the MCU drive the LCD to display the number of population dynamic. Design three buttons are used to control the subordinate node like opening and closing nodes, clear, WIFI open.

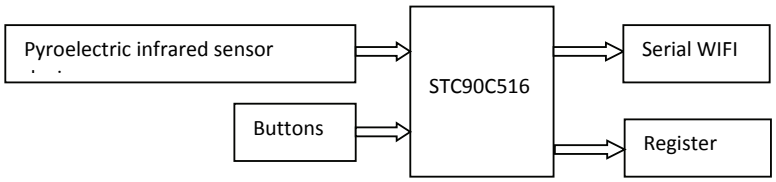


Fig. 2. Block diagram of the from node.

3.1 Pyroelectric Effect

The phenomenon of outside temperature changing lead crystal internally generated spontaneous polarization is termed the pyroelectric effect, and pyroelectric infrared sensor uses the pyroelectric effect to detect infrared radiation in the light-receiving device [4]. It is made of ceramic oxides or piezoelectric crystal components, whose two surfaces are made of electrodes. When the temperature changes ΔT within the sensor monitoring range, the pyroelectric effect will generate charges ΔQ on the two electrodes.

$$\Delta Q = p\Delta T , \qquad (1)$$

where p is the pyroelectric coefficient, its value is

$$p = \left(\frac{\partial D}{\partial T}\right)_{E,X} = \frac{-\alpha_0 D_0}{\alpha_0 (T - T_0) + 3\beta D_0^3} , \qquad (2)$$

where D0 is the electric displacement field E at temperature T caused.

It produces a weak voltage ΔV between the two electrodes. Due to its high output impedance, there is a field effect transistor in the sensor impedance transformation. Charge ΔQ generated by pyroelectric effect will disappear due to bound the ions in the air, as to say, when the ambient temperature is stable and unchanging, ΔT = 0, the sensor is no output. When the body enters the detection zone, because of the difference temperature between the body and surroundings, it comes an output ΔT; if the body is not active after entering the detection zone, the temperature does not change, the sensor does not output.

Typical application of pyroelectric infrared signal detection is to install on the sensitive devices. Fresnel lenses are mostly made of polyolefin material which is injection pressure to the sheet, the lens surface is smooth on one side, and the other side burned steeled concentric circles. This Fresnel lens can limit peak frequency of the incident light to about 10 microns (human infrared radiation peak). The roles of the Fresnel lens are the following two: one is focusing effect, pyroelectric infrared signal refraction (reflection) on the sensitive device; the other is divided the detection area into a number of bright and dark areas, that moving object entered the detection area can produce pyroelectric infrared signal on the sensitive devices in the form of a temperature change. It uses special optical lens principle, and engenders an alternating "blind spot" and "sensitive areas" in front of the detector in order to improve its detection and receiver sensitivity. When someone walked from the front of the lens, infrared body would continue to alternate from "blind" into the "sensitive areas", o that the received infrared signal is pulsed input suddenly strong suddenly weak, thereby enhancing its energy margin. Pyroelectric infrared sensor signal acquisition works shown in Fig. 3.

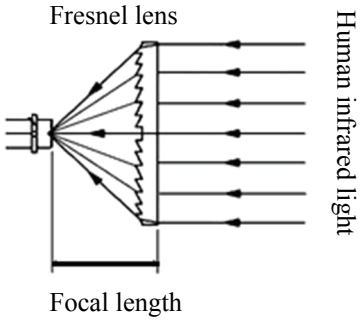
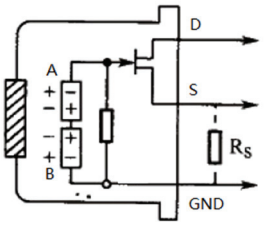


Fig. 3. Signal acquisition principle of pyroelectric infrared sensor.

Fresnel lens is made of a cap which buckles on the sensitive element when used, and the top cap is engraved with concentric surface. Because the human face and arm infrared radiation is stronger, so that these parts should be just in front of the lens when sensor placed. Signal acquisition device should be placed in the door at a height of about 1.5 meters.

3.2. Sensor Signal Acquisition and Processing

The system uses a dual element pyroelectric infrared sensor RE200B.This sensor uses two opposite polarity sensitive pyroelectric unit fitted on the same wafer, and it not only can play the role of temperature compensation [5], but it can output different characteristics in the direction of body movement waveform. The internal structure of RE200B is shown in Fig. 4.



A - Forward sensor, B - Reverse Sensor

Fig. 4. RE200B pyroelectric infrared sensors.

Since the voltage which pyroelectric infrared-sensitive device output is extremely weak and accompanied by numerous noise, it cannot directly be used, and it need for signal preprocessing [6]. This system uses BISS0001 which is a processing chip for processing the sensor signal, and the chip is shown in Fig. 5.

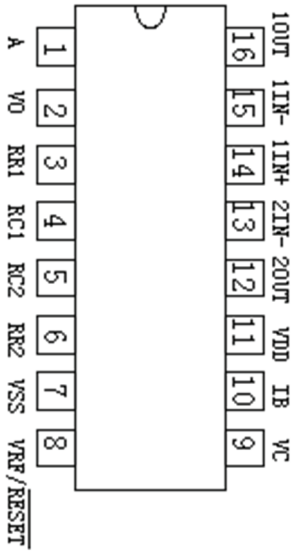


Fig. 5. BISS0001.

Its working principle is: operational amplifier OP1 in it enlarge the signal which pyroelectric infrared sensor output as a first stage, and then the pin 1out external capacitor C coupled to the operational amplifier OP2 as the second stage. The output signal is further processing by the bi-directional voltage comparator which is constituted by the voltage comparator COP1 and COP2. Effective trigger signal Vs detected starts the delay timer, and it generates an output signal Vo. This signal needs external transistor T for amplifying voltage to drive the relay module which is the output to connect microcontroller or other loads.

After pretreatment the high level of the sensor module output is 3.3 V and the low level close to 0 V. To enhance the usefulness of the module, it installs delay adjustment potentiometer on the sensor module to control their response time is adjustable

between 0.5 ~ 200 s, and installs distance adjustment potentiometer for adjusting signal accuracy. The module's output OUT connects STC90C516 of P1.0, and is defined as the infrared signal IO port. Fig. 6 shows the output signal of the sensor which oscilloscope observed when someone through the sensor from A to B, and Fig. 7 shows the output signal when someone through the sensor from B to A.

Fig. 6. Waveform of single direction along A to B.

Fig. 7. Waveform of single direction along B to A.

The signal acquisition device is sealed and attached to the door of the classroom. When someone enters the room, the sensor's output is falling, the microcontroller call count counting procedures; the other hand, when someone out of the classroom, the counter counts down.

The number which obtained from the node is transmitted to the master node through the wireless communication system which composed of serial connection WIFI module. This system uses ESP8266-12WIFI modules to communicate with the microcontroller. The module supports three operating modes as STA / AP / STA + AP, supports UART data communication interface, 3.3V single power supply, low power consumption, and it is a highly intelligent wireless communication module. The module has an 8-pin output, except for power and ground connections, the WIFI's RXD connects with the TXD in the microcontroller and WIFI's TXD connects with the RXD in microcontroller, and then it achieves the hardware connection for the microcontroller and the WIFI. In order to achieve the automation of the from node, there is no control key for sending and receiving data, therefore whether or not to send signal is determined by the master node. Meanwhile, this system designs the delay program to control the time of receiving data. When the time that no data transmission over 1 s, it considered that the system has stopped data scenting. Process of communication between WIFI modules with the microcontroller is shown in Fig. 8.

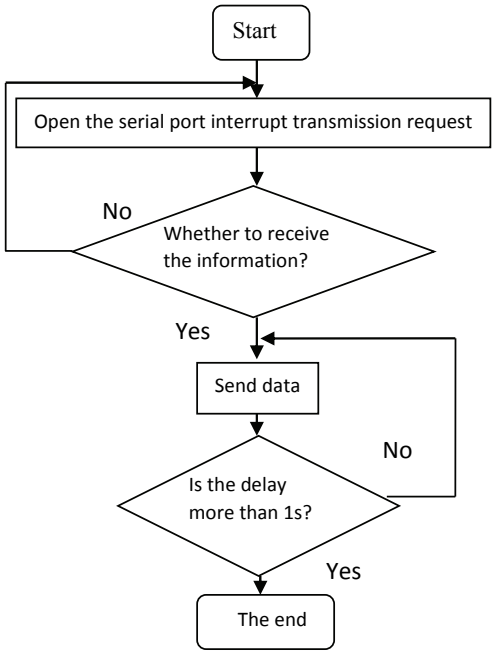


Fig. 8. WIFI transmit data flow.

In order to reduce the error rate of data transmission, the crystal frequency of MCU is 11.0592 MHz, and serial port baud rate is set to 115200, the baud rate of WIFI is also needed set to 115200 when debug.

Working mode of WIFI can be set by the phone when apply the system in practice. The subordinate nodes are set to STA mode and the network address is set to the slave address.

4. Functional Design for the Master Node

Task of master node is to calculate the number in classroom, according to the two received signals from the subordinate nodes. Then start the GSM module and send the value to the user requested. Structure and function of the master node diagram is shown in Fig. 9.

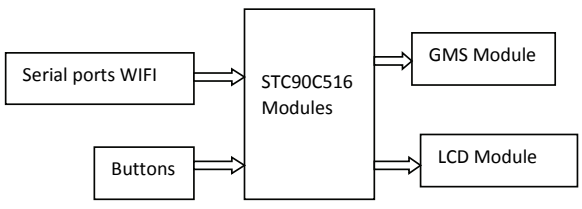


Fig. 9. Block diagram of the master node.

4.1. Operation of Serial WIFI Signal

The master node requires two serial ports which are used for serial WIFI data collection and long-range wireless communications used GSM module [7]. Based on the limited of microcontroller own resources and the speed requirements of entire system, the master node uses two microcontrollers to undertake two tasks: one is classroom signal acquisition and display, the other is remote transmission of information.

The mode of the master node serial WIFI is set to AT. It first sends a signal to open the WIFI of the node in front door when is collecting data and establishes a radio channel to receive node's data and then store it in the register A; then the master node closes the WIFI in the front door and opens the WIFI in the back door to receive data and store it in the register B; the sum of Data A and Data B is the current number of person in the classroom. Data recorded of once work flow is shown in Fig. 10.

4.2. Information Transfer Module

In this system, the remote transmission of information relies on TC35 which is a GSM module [8]. Currently, sending SMS commonly uses Text and Protocol Data Unit (PDU) mode. Sending and receiving text messages with text mode have simple code, it is very easy to achieve, but the biggest drawback is not sending and receiving text messages in Chinese; the PDU mode not only supports Chinese SMS, but also can send text messages in English. It can use three kinds of coding with PDU mode sending and receiving text messages: 7-bit, 8-bit and UCS2 encoding. 7-bit encoding is used to send normal ASCII characters; 8-bit encoding is used to send data messages, UCS2 encoding used to send Unicode characters [9].

This system uses PUD mode to send text messages, the microcontroller sends the pre-stored information in its memory unit issued through the serial port. However, MCU using TTL level, while TC35 using RS232 level, it takes MAX232 level converter chip level conversion.

The 10 pin is connected to the MCU TXD, the 7 pin is connected to RS232 2-pin in TC35, the 9 pin is connected to the microcontroller RXD, and the 8-pin is connected to RS232 3-pin in TC35, the 5 pin is connected to ground.

TC35 module used in the system is provided with a SIM card, it needs to open a SIM card SMS services [10]. It should be AT commands tested through PC serial port before application, specific test steps:

<1> Power the module, AT command PC serial to communicate.

<2> SIM card is not in arrears, and has landed a GSM network.

<3> Input from the serial: AT, then press Enter.

<4> AT + CMGF = 1 is set to TXET mode.

<5> Input from the serial: AT + CMGS = "137xxxx2435", then press the Enter key (set to the number which receives an SMS).

<6> Then there is a ">" pop-up in order to prompt to enter the message content. If you want to send "hello word", directly input it behind the ">" and press "CTRL ^ Z", then a minute waiting the message is sent out. If it is the reservation information, it should write the ASCII code of the information in the program.

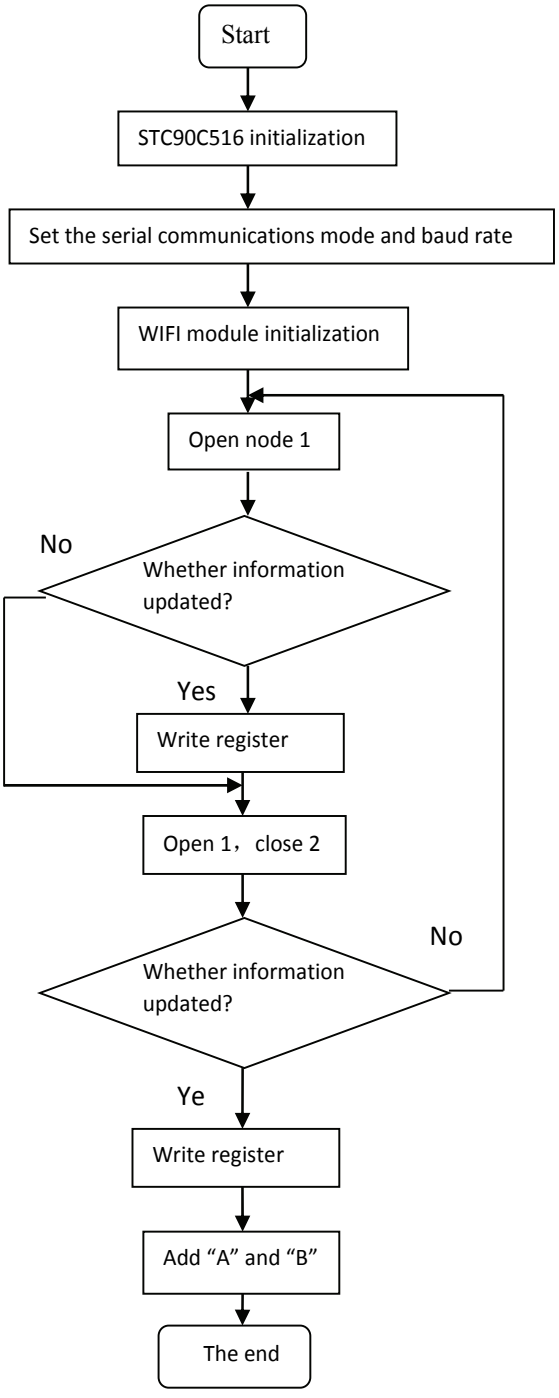


Fig.10 WIFI receives data flow

The code for sending SMS is following.

```
void send_AT ()
{
        serial_send(AT_CMGS);
        delay_ms(1000);
        sendchar(0x1A);
        delay_ms(1000);
}
```

The code for receiving SMS is following.

```
void receive() interrupt 4
{  if(RI)
        {  RI=0;
                if(SBUF==':')
                {re_flag=1;
                        return ;}
                if(re_flag==1)
                {if(SBUF!=13)
                        {value=SBUF;}
                        else
                        {re_flag=0;
                        switch(value)
                        { case 's':f1_flag=1;break;
                          case 'g':f2_flag=1;break;
                          case 'r':f3_flag=1;break;}

                        }}}}
```

In order to display the working status of TC35, there are four light-emitting diodes in P1 port [9]. LED0 is initializing GSM; LED1 represents select Message format .txt; LED2 indicates registration status check the network; LED3 indicates set SMS notification command to determine whether to issue a new message.

Similarities and differences between this system and others currently in use.

5. Conclusions

This article describes an automatic monitoring system for classrooms selection based on WIFI and GSM. The system consists of two subordinate nodes for information collection and a master node for information processing, and they communicate by wirelessly WIFI.

The subordinate node detects signals by dual element pyroelectric infrared sensor. It starts different electrode according to people walking direction. When the man entered the classroom, a falling edge output from the sensor; when the people out of the classroom, the sensor rising output. Therefore, design register of the from node according to the voltage change of the sensor signal, and calculate the number of people in classroom. And then transmits information to the master node by the serial WIFI. The master node receives the information and processes them, and then displays them on the LCD. Meanwhile, the master node sends messages to users upon request information by GSM.

The similarities and differences between this system and others currently in use are following:

1) Use the human body detection sensor as a signal acquisition device;

2) Signal transmission indoor is by WIFI instead of circuit;

3) Transmission of information through GSM to the users enables a direct service to students.

The whole monitoring system automatically recognizes, automatic transmission, to achieve the purpose of the numbers of people in classroom automatic detection and information transformation without human intervention.

Acknowledgment

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