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Sickbed Calling System Based on Single Chip Microcomputer

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Abstract: Sickbed Calling System is a special call system, which is used by sanatorium and hospital as a tool to communicate between nursing stuff and patients. It enables hospitalized patients to contact nurses and medical staff in a timely manner and is a necessary equipment used by hospitals to improve the overall level. The quality of the sickbed calling system is directly related to the safety of patients, so all major hospitals attach great importance to the sickbed calling system. It is required to be timely, reliable and accurate, and it is required that its operation is convenient and simple, and can be popularized on a large scale. The sickbed calling system is designed by STC89C52 single chip microcomputer, and the hardware and software are analyzed and designed. In this article, the location of the bed is sent to the master of the monitoring unit through the nRF24L01 wireless transmission unit located in the ward from the computer. When the master computer receives the data sent from the master computer, the LED screen on the master computer displays the sickbed data and broadcasts the voice. When the supervisor notices, the display can be cancelled through the master computer control to realize wireless communication. The system is divided into a slave machine sickbed information detection part and a master machine display broadcast part. The system has stable performance, small area, less material consumption, fast speed and long distance. It is a reasonable application of wireless technology in clinical medicine and is feasible and innovative.
Keywords: Wireless sickbed call, nRF24L01 radio frequency chip, Single chip microcomputer

I. INTRODUCTION

In the process of modernization, the sickbed calling system has entered the commercial operation phase from the application level. Many domestic call center service models have changed from simple customer service to mixed service and operation mode[1]. This is first and foremost the result of responding to market demand and the inevitable result of call technology and management development. In the process of modernization of social development, various devices have begun to develop in an intelligent direction, and various information has been transmitted more efficiently in this modern society with rapid development of network. Therefore, in this era, the management of medical institutions has changed from the traditional direct management between people to the intelligent way of indirect management between people through the network and electronic equipment[2]. The sickbed calling system can realize the call, display the bed information, etc., and the communication between the patient and the medical institution is more convenient.

At present, some medical monitoring fields in foreign countries have developed to a very high level. Biomedical sensors have been applied to clinical medicine, and some large scientific research institutions have developed micro-biomedical sensors with wireless transmission technology based on ZigBee technology[3]. Therefore, some medical institutions have begun to establish a kind of wireless local area network for monitoring. The biosensor monitors the physiological information of the human body in real time, and feeds the patient's information back to the network through the sensor. The system analyzes and detects the physiological condition of the patient in real time, for some Sudden conditions can provide timely assistance to protect the health and safety of some patients or the elderly. Among them, IBM's body LAN, the MARSIAN project of the French CRNS research institute, and the individual life state remote monitoring and positioning system of the First Military Medical University are representative[4].

In China, only about 30% of the approximately 30,000 hospitals have information management systems, and even fewer hospitals have front-end telephone access systems. In the current domestic medical device market, according to the difference of function and type, the sickbed calling system is mainly wired and wireless. In hospitals with backward facilities, most of them use the wired sickbed calling system, which needs to fix the call button on the hospital sickbed and communicate by telephone line. This kind of equipment needs to be re-routed,

and the wiring is complicated[5]. When the equipment breaks down, the maintenance is very inconvenient and the real-time performance is relatively poor. With the development of intelligent modernization, the wireless sickbed calling system has begun to be adopted by large and new medical institutions. It does not need to lay lines, but its radio waves may affect other medical equipment. However, with the development of science and technology, the interference of radio waves has become smaller and smaller, and the wireless sickbed calling system has become a trend.

II. OVERALL DESIGN

Based on STC89C52 single chip microcomputer, the wireless sickbed calling system is mainly composed of two parts: the master and the slave. Its wireless aspect uses the nRF24L01 wireless transceiver chip to realize the wireless transceiver function of data, up to 100 meters of long-distance data transmission. The main job of the slave is to receive the information from the patient's bed and then send it out by radio transmitter through the wireless transmitter module. The main work content of the master is to detect and process the data received on the wireless receiving module, and then control the liquid crystal display module to display the sickbed information according to the received sickbed information, and remind the sounding module. When the medical caregiver receives the call request from the patient, the display can be cancelled by the reset button on the master computer. The transmitting module of the nRF24L01 has a function of resending when data transmission fails, and a CRC verification is performed when receiving data. And it also has ShockBurstTM mode, which can receive data without affecting the progress of other work, and can send data at the same time.

A.Main Control Circuit Design

This system uses STC series single chip microcomputers, which has many advantages compared with other series of single chip microcomputers. Generally, the STC single chip microcomputer has more resources than other single chip microcomputers, and the execution speed is fast; the STC series single chip microcomputer uses the serial port to program the single chip microcomputer, and it is more convenient to download programs; STC89C52 single chip microcomputer integrates the watchdog circuit internally; and has strong anti-interference ability; STC89C52 single chip microcomputer operating voltage range is 4V-5.5V, so it is usually given to the external 5V DC power supply of the single chip microcomputer; the connection mode connect to the positive 5V to the 40 pin VCC of the single chip microcomputer , and connect the 20 pin VSS to the power supply ground terminal. It is a low power, high performance bit microcontroller with 8K programmable Flash memory. The STC89C52 has the following standard functions: 8k byte Flash, 256-byte RAM, 32 bit I/O port line, watchdog timer, 2 data pointers, three 16-bit timer/counters, one 6-vector level 2 interrupt Structure, full-duplex serial port, on-chip crystal oscillator and clock circuit. This module takes the program code into the center of the microcontroller and then connects the reset circuit, the oscillation circuit, the keyboard control, the LED display circuit, the alarm circuit and other sub modules.

The clock circuit is an oscillating circuit that generates precise motion like a clock. It provides a sine wave signal to single chip microcomputer as a benchmark to determine the execution speed of single chip microcomputer, which is generally composed of crystal oscillator, crystal control chip and capacitor. X1 and X2 are used as I/O pins of the amplifier to provide clock pulses for the chip. If external clock source is used to drive the device, X2 should not be connected because one machine cycle contains 6 state cycles, and each state cycle has 2 oscillation cycles. Therefore, there is a total of 12 oscillation periods in one machine cycle. If the oscillation frequency of the external quartz crystal oscillator is 12 MHz, one oscillation period is 1/12 *us*. The system adopts an internal clock circuit and a reset circuit that is powered on and reset, as shown in the following Fig. 1.

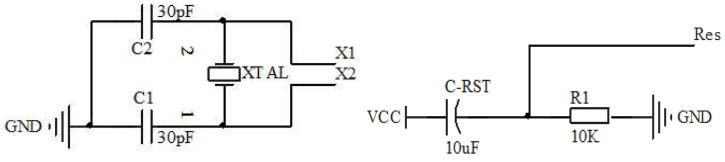

Fig. 1 Clock circuit and reset circuit

B. Extended Circuit Design

The display module adopts LCD1602 liquid crystal display, which has low power consumption, small size, rich display content, and can clearly display characters and numbers on the liquid crystal. It is commonly used in pocket meters and low power applications. The level of the control circuit is connected to the data pin, and the pins responsible for command operation are RW, EN, RS, and the circuit is as shown in Fig. 2.

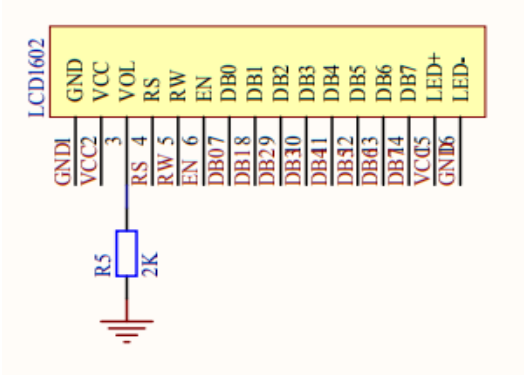

Fig. 2 Display circuit

LCD1602 is an industrial character type liquid crystal, also called character type liquid crystal, which can display 16x02 or 32 characters at the same time (16 columns and 2 lines). The character type liquid crystal display module is a dot matrix type LCD which is specially used for displaying letters, numbers, symbols, etc. Currently, modules such as 16*1, 16*2, 20*2 and 40*2 lines are commonly used.

The sickbed wireless calling system adopts three 1.5 V dry batteries with a total of 4.5 V as the power supply. After the experimental verification system works, the working voltage stability of the single chip microcomputer and the sensor can meet the requirements of the system. In this system, the nRF24L01 wireless distance data transmission is used, so a 3,3V voltage stabilizing circuit is needed. In this design, the ASM1117-3.3V DC voltage stabilizing chip is used to stabilize the voltage into 3.3V, and capacitors C4, C5, C6, C7 filter provides stable 3.3V power supply for the nRF24L01 wireless module. The power interface circuit is shown in Fig. 3, where DC5V is the battery interface, SW1 is the power switch, R6 is the diode current limiting resistor, and LED5 is the power indicator.

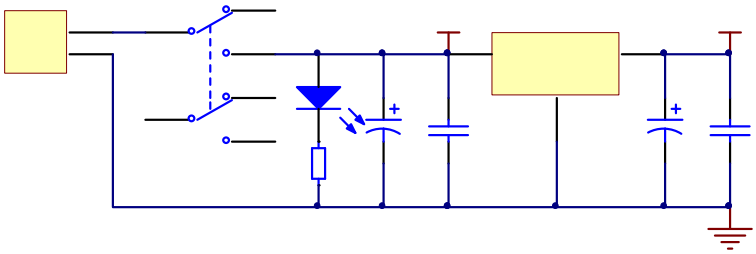

Fig. 3 Power interface circuit

C. Wireless Data Transmission Circuit Design

The wireless data transmission of the sickbed wireless calling system adopts the NRF24L01 wireless module, which is composed of the nRF24L01 radio frequency chip, the power supply circuit and other connecting parts. It is typically used at a frequency of 2.4 GHz, with a maximum operating voltage of no more than 3.6 volts and a minimum of 1.9 volts. It has a high data reading and writing capacity of up to 10Mbit/s and has an automatic retransmission function. The chip consumes very little power during data transmission and reception and consumes less when no data response. The circuit connection is shown in Fig. 4, one of which emits electrical energy for transmission and one for electrical energy reception.

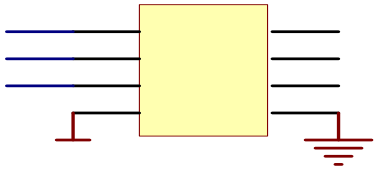

Fig. 4 nRF24L01wireless transmitting and receiving module wiring diagram

III. SOFTWARE SYSTEM DESIGN AND IMPLEMENTATION

The application software in the application system is designed according to the system function requirements, and the various functions of the system should be implemented stably and correctly. In this system, the software design requires are as follows:

(1) Understand the current development environment and conditions, the software structure is clear, and the process is reasonable;

(2) The system is modular, each module can be independently developed, tested, and finally assembled into a complete program;

(3) Each module completes a relatively independent specific subsystem and has a simple connection with other modules;

(4) The program and data should be stored in different areas, and the running status and results should be marked to facilitate query when necessary;

(5) The components of each program are packaged in a single module, and the internal processing is exposed as little as possible when defining each module. Packaging can improve the modifiability, testability, and portability of software.

D. Main Program Flow Chart Design

The general idea of one loop in the sending part is: first initialize the pin of nRF24L01, through the STC89C52 single chip microcomputer as the working processor core, collect the sickbed number data and write it into the sending data array, then initialize nRF24L01, and send the sickbed number to the master; The general idea of the receiving part is as follows: first initialize nRF24L01, and then enter the large loop to determine whether the status register has a receive interrupt. If there is, read binary data from the FIFO_buffer, and then convert the data to decimal system and display it on LCD1602 liquid crystal.

When transmitting data from the wireless transmitter module on the salve, the first step is system initialization to put the registers into operation. Set CE low and set the nRF24L01 chip to send data. After the data channel 0 allows, set the address of the receiving end. Set the CE to high after detecting the destination address and the check code. The working mode of the nRF24L01 chip is set to the transmitting mode, and the data is transmitted after a short delay; when the wireless module of the master receives the data, the initialization operation is performed first, and then the SPI bus sets the CE of the radio frequency chip to be low, so that it can receive data, and maintains the state in which data can be received after a certain time delay. When the receiver detects the effective address and the check code, the data is saved and placed in the register, and the CE is set to high to read the data.

E. Intercom Module Programming

When the walkie talkie is powered on, first initialize the pin serial port of the walkie talkie, and then the single chip microcomputer continuously scans the buttons of the walkie talkie. When no key is pressed, the current state is maintained. When there is a key signal, it is converted into a serial port signal and sent to the comparator

through the expansion circuit. After matching with the corresponding code stored in the comparator, the AT command is called to communicate, and the LCD1062 subroutine is as shown in the Fig. 5 below.

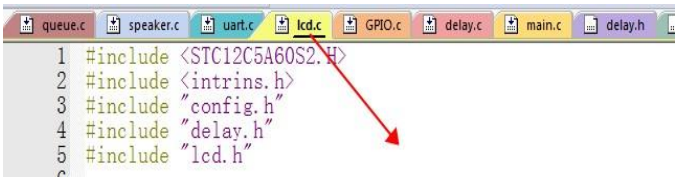

Fig. 5 LCD1062 subroutine

The UART subroutine, data transmission and reception program are shown in Fig. 6 and Fig. 7.

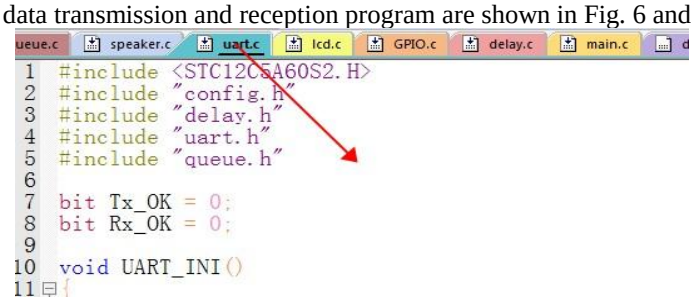

Fig. 6 UART subroutine

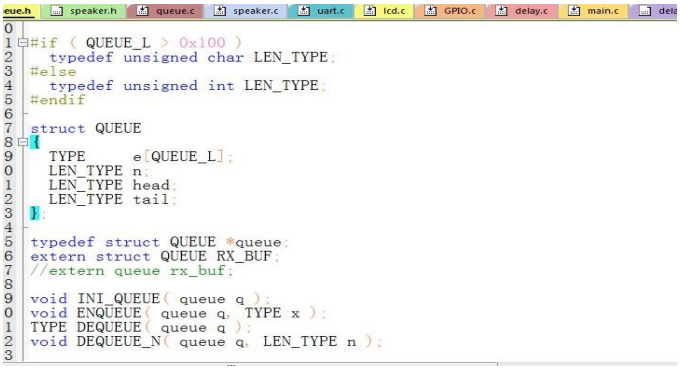

Fig. 7 The data transmission and reception

IV. HARDWARE DEBUGGING RESULT ANALYSIS

A.Hardware Test Steps

Step 1: Use Altium Designer software to first draw the schematic diagrams of each device for packaging processing, then connect all the schematic diagrams together to form an overall circuit diagram, and then use the plate making software to design the PCB layout of the circuit diagram to complete each Layout and routing of components.

Step 2: After the layout is completed, start to weld the device on the circuit board according to the circuit diagram or PCB plate making diagram.

Step 3: Use keil software to write the program to generate. a .hex file, open the STC ISP program, select the STC89C52 series single chip microcomputer, and then select the generated hex file. After setting the baud rate and downloading successfully, the single chip microcomputer burning program is completed.

Step 4: After the program is written, start to test the key and LCD display, and judge whether it works normally through the indicator light on the circuit board and the display on the display. If it is abnormal, rewrite the program to measure again. If it is still abnormal, measure whether the corresponding module on the circuit is short circuited through the multimeter. If it is short circuited, suck out the solder through the straw and reweld. Then burn the program test again.

Step 5: Connect nRF24L01 RF transceiver chip to single chip microcomputer, write a simple addition counting program, observe whether the count is displayed on the LCD, and monitor whether the wireless module can work normally.

Step 6: Integrate the key, display, radio and voice program, check whether the system can measure the distance of radio wave detection at the transmitter and send it to the receiver for display on the LCD, and check the setting of alarm parameters and alarms.

Problems in the debugging process: sometimes there will be a burning failure when the program is burned again. After debugging, it is found that the baud rate of the software should be adjusted during debugging. If it is too high, the burning failure will be caused, then the baud rate can be reduced properly.

B. Debugging Result Analysis

According to the requirements of the system scheme design and the needs of the products in the actual operation, the current, voltage and power of the system are measured. The power consumption of the transmitting module and the receiving module is relatively low, which can reach the initial requirements of the system power consumption. In addition, the system meets the design requirements in terms of wireless transceiver distance under the working state, and the physical debugging is shown in Fig. 8.

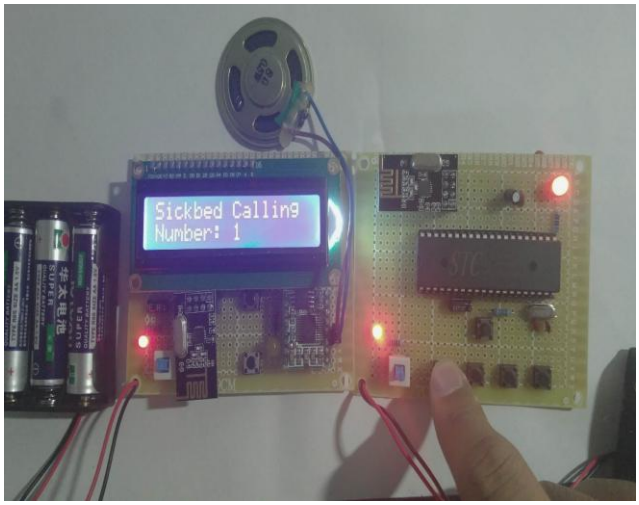

Fig. 8 Physical debugging

V. CONCLUSIONS

In the design of the sickbed calling system, STC89C52 is used as the control center of the sickbed calling system. As one of the most widely used single chip microcomputers, it has been very mature in all aspects and can greatly develop and utilize its function and performance. Moreover, STC89C52 single chip microcomputer has its own characteristics, as a single minimum system, it can control various functions very well. The equipment designed by single chip microcomputer has the characteristics of reliable and stable operation, greatly reducing the cost of equipment, and can be widely promoted in the market.

In this period of learning and design process, through my own practice of learning, I have a new understanding of schematic diagrams, circuit layout, and layout of circuits. Now we need to manually weld components and circuits by ourselves. It is no longer just drawing the software interface, but it becomes concrete and real from the previous one-sided parameter understanding. The teacher put forward the general requirements first, let's design our own plan first, and exercise our ability to control the overall layout. Then the teacher will put forward further optimization for our details. By going to the library to look up relevant materials and search for relevant introductions on the Internet, modify and design the schematic diagram and the circuit diagram. After the process of asking questions and solving problems, the design scheme was improved.

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