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Study on a Medical Automatic Venous Infusion Detection Device

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Abstract: *Intravenous infusion therapy is commonly used in hospitals. In the process of intravenous infusion, adjustment and extraction can not be timely adjusted. Therefore, this paper designs a device that can accurately control the flow rate of droplet, estimate the infusion time, and alarm the exhaustion of liquid medicine. The device takes STM32F103 single chip microcomputer as the core, including display module, automatic control module, alarm module and wireless communication module. After testing and verification, it can realize the functions of liquid drug speed control, alarm, time prediction, data upload and so on. At the same time, the equipment is simple to operate, convenient, convenient installation, can be used in a variety of environments, change the traditional infusion management mode, greatly reduce the manual burden, reduce the labor intensity of medical staff, is conducive to improve the level of medical services.*

Keywords: *Fluids for Infusion; Microcomputer; Peristaltic Micropump; Velocity Regulating; Wireless Communication*

1. Introduction

Intravenous infusion is a common treatment method to achieve therapeutic effects by injecting intravenous nutrition or prescribed concentrations of drugs [1]. The nurse's experience is needed to adjust the rate of infusion, and accuracy is not guaranteed. Patients or caregivers often need to pay attention to the infusion bag at all times when patients are receiving infusion, especially elderly and children patients, which brings them a lot of mental burden. However, with a large population and a small number of medical staff in our country, a nurse has to be responsible for multiple beds and consulting rooms, with heavy workload, and must have a high degree of attention and responsibility. Once an emergency occurs, doctor-patient conflicts may occur [2]. Therefore, this paper designs a stable, reliable and safe intelligent drip infusion alarm system based on embedded technology to realize real-time monitoring of patient infusion progress [3].

2. System Total Design

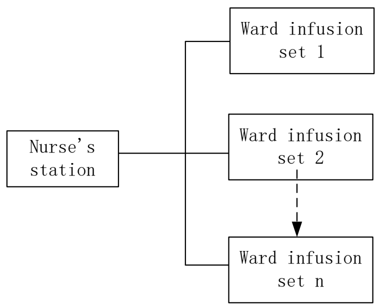

Figure 1: Framework of Automated Medicine Detection System

The automatic medical testing equipment is mainly composed of two parts, all the infusion equipment in the ward as the slave machine and the monitor and computer in the nurse station as the host. The nurse station was connected to the ward by wireless transmission, so that the nurses could control the flow rate of liquid in real time, note the remaining amount of liquid and the expected completion time of infusion. If the liquid level of the reservoir bottle is lower than the set warning value, an alarm signal will be issued, and an alarm signal will also be issued on the interface of the main station to remind the medical staff to

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deal with it in time [4]. If it is not pulled out after reaching the warning line, the flow rate is slowed down by peristaltic pump to ensure the safety of patients. The block diagram of the system is shown in Figure 1.

2.1 Hardware circuit design of the system

The hardware circuit design of the system is shown in Figure 2.

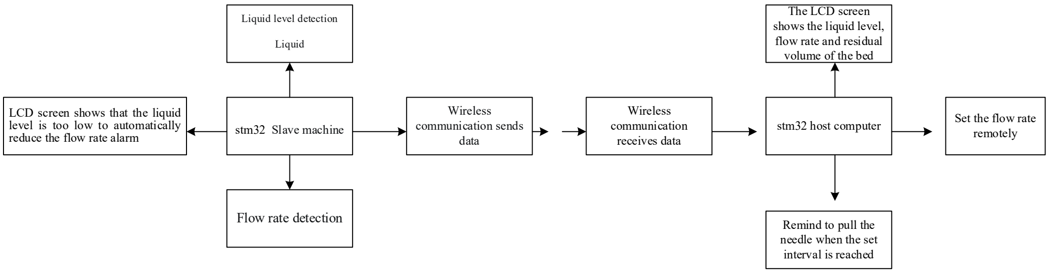

Figure 2: System hardware design block diagram

2.2 Design of drip speed control

The system adopts peristaltic pump to control the drip speed. The peristaltic pump is composed of a DC motor and a pump head. By controlling the DC motor, the roller in the pump head is controlled to press the plastic hose and release the liquid. When the system is working, the speed is adjusted by the independent button, and the single chip microcomputer receives instructions to control the peristaltic pump and the flow speed of liquid medicine. When the flow meter is observed, the speed is stable when the preset speed is reached. Peristaltic pump with no pollution, no noise, high precision, good airtightness, easy maintenance and other advantages, suitable for the application of medical field.

2.3 Design of droplet flow velocity detection

The system uses the infrared pair tube to detect the falling droplets, directly holds the detection device to the side of the drip pot, and uses the infrared pair tube to detect the flow rate. A separate function key is used as a reset key to control the displayed data. When the set value of flow rate is exceeded, a buzzer is used to alarm. The schematic diagram of the flow velocity detection device is shown in Figure. 3

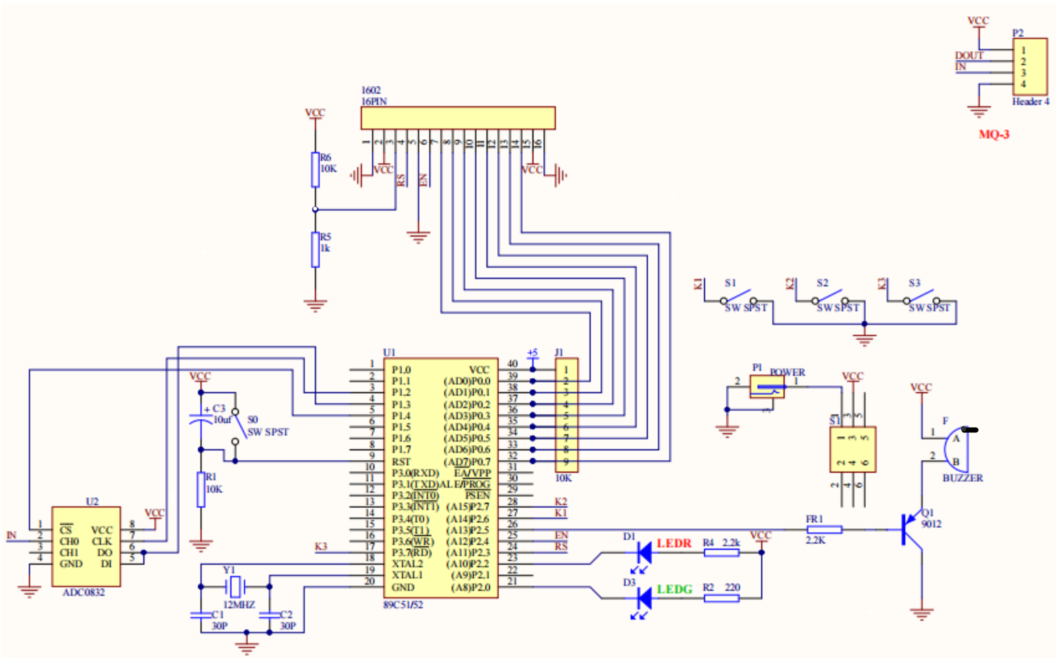

Figure 3: Schematic diagram of the droplet flow velocity detection device

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2.4 Display design of remaining time and flow velocity

The display screen uses a 3.5 inch TFTLCD LCD module. TFTLCD is a kind of thin-film transistor LCD screen, which has good brightness, high contrast, strong sense of hierarchy, bright color of screen information, and high security and reliability [5]. The screen displayed the speed of drip, the remaining amount of drug, and the expected completion time of drip in real time, which was convenient for medical staff and family members of patients to observe. The schematic diagram is shown in Figure 4.

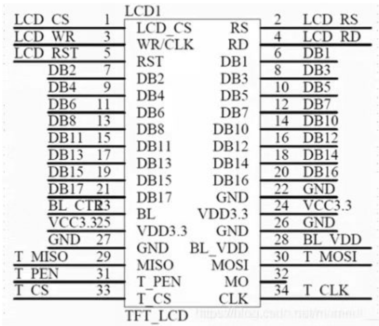

Figure 4: Schematic diagram of TFTLCD LCD module

2.5 Alarm Device Design

The alarm device adopts led lamp and buzzer. The system alarms when problems occur during the infusion. Add a resistor to the light emitting diode, which can reduce the current value and play a protective role. When the SCM implementation of alarm function. Due to the action of resistance, the output is low level, and the led lamp and the buzzer work at the same time to carry out the alarm task. The schematic diagram of the buzzer alarm circuit is shown in Figure 5.

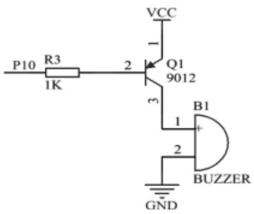

Figure 5: Schematic diagram of buzzer alarm circuit

2.6 Master-slave Communication Design

In order to better transmit information to the nurse station, the master and slave machine choose nRF24L01 module for wireless communication. The SPI interface is used to set the output power and carry out wireless data transmission.

The power consumption of nRF24L01 module is extremely low. When the transmit power is 0 dBm, the current consumption of transmit mode and receive mode is 11.3 mA and 12.3 mA respectively, and the current consumption is even lower in power-off mode and standby mode. At the same time, the small package size can improve the portability of the system [6]. Figure 6 shows the schematic diagram of the nRF24L01 module.

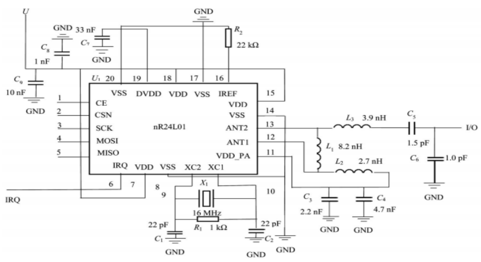

Figure 6: Schematic diagram of nRF24L01 module

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3. System software program design

The system software was programmed by Keil MDK5. According to the principle of modular programming, it was divided into liquid level detection module, flow rate control module, wireless communication module, voice alarm module and LCD display module. The overall structure of the system software is shown in Figure 7. After the system is turned on, the system is initialized, and the liquid level is detected when the system is stable. After reaching the preset value, the information is transmitted to the host computer and displayed from the screen of the machine. The system software flow chart is shown in Figure 8.

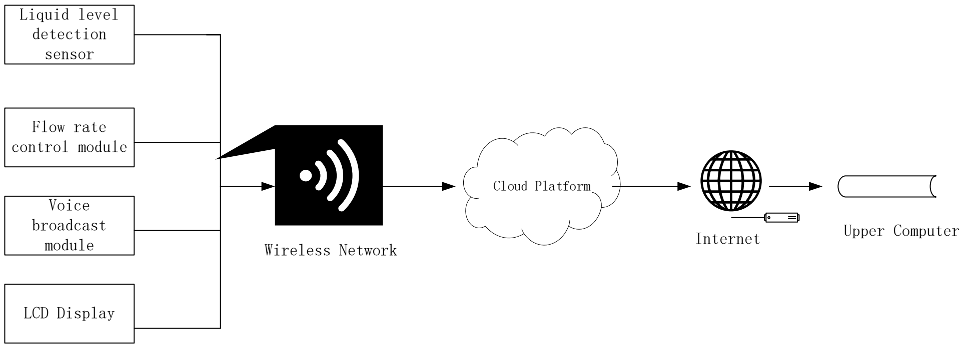

Figure 7: Overall structure of the system software

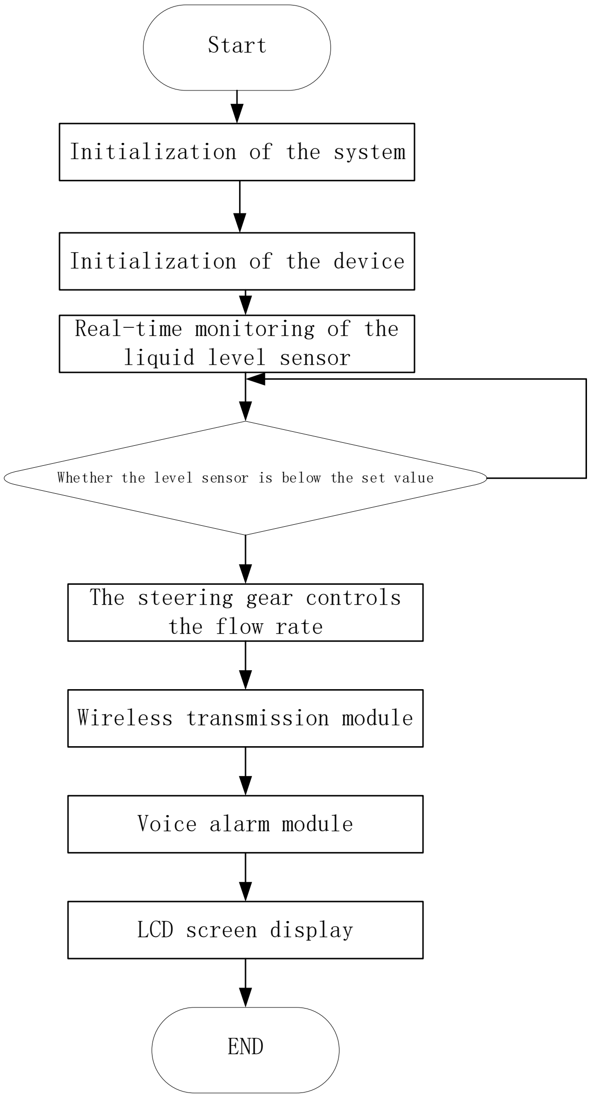

Figure 8: System software flow chart

4. Test results of physical system

4.1 Test of the lower computer of the drip infusion detection system

After the hardware platform of the system is built, the power supply is turned on for equipment debugging. Use nRF24L01 to connect the upper and lower computers. Wait for the transmission signal light to flash and the system to enter the working state. The upper computer uses Matlab interface software to obtain the information of the lower computer and adjust the initial value of the system. The display interface of the lower computer is shown in Figure 9.

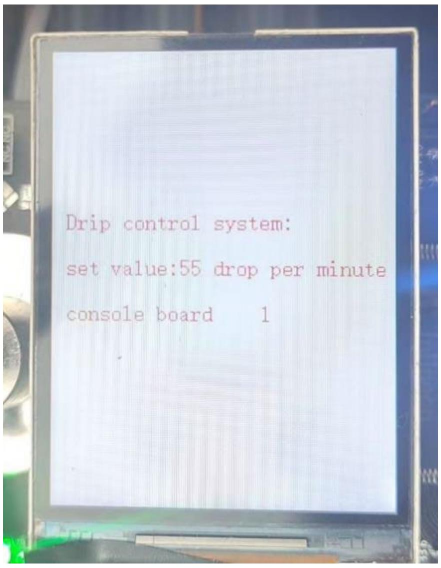

Figure 9: Display interface of the lower computer

4.2 Host computer test of drip infusion detection system

The upper computer of the drip infusion device sends the information to the lower computer through the S7 communication protocol and the callback function, so that the lower computer receives the transmitted information and transmits the information to the screen through the wireless transmission system.

When the titration flow rate is set, the microcontroller receives the speed information and operates it. The preset PWM value was used to automatically regulate the peristaltic pump until the preset range was reached. The Matlab interface of the upper computer will receive the drip speed data sent by the lower computer and display it regularly. When the liquid is about to run out, the host computer changes the information in real time, showing that the droplet is about to be completed. At this time, send an alarm message to remind the staff to deal with it in time.

5. Conclusion

In this paper, a medical automatic titration detection equipment for pharmaceutical industry was designed. STM32F103ZET6 was used as the main control. According to the characteristics of the flow rate of droplets and the needs of remote monitoring, the wireless communication module nRF24L01 was used for real-time wireless data transmission. The infusion speed was detected by an external flow meter, and the infusion speed was accurately controlled by a peristaltic pump. The remaining drug volume and flow time were calculated by the initial drug volume, drug flow rate and other parameters, and the information was displayed. This design can accurately control the infusion speed and calculate the infusion volume, with low cost and large scale popularization. With the advent of the 5G era, the system can be further optimized and upgraded to improve the communication performance of the system, improve the stability and computing processing speed of the system, which is of great significance for the informatization of remote modern medical diagnosis.

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