Design of Blood Circulation System of Medical Simulation Robot

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Abstract

Medical robot is the most active direction in the research field of medical industry in recent years. Its development potential is very huge. It has greatly promoted the progress of modern medical equipment. The blood circulation system of our medical simulation robot can be used in medical universities, medical clinical training and even military fields. The robot adopts ROS robot operating system and FreeRTOS real-time operating system, and uses multi-sensor fusion data analysis to obtain the information in the blood sample and realize the simulation of blood circulation. Iit can simulate the touch of syringe in human injection. The whole medical process is optimized.

Keywords: Medical robot, ROS, Free RTOS, simulation, medical clinical

1. Introduction

The combination of artificial intelligence and medicine enables patients to get a better treatment experience. Doctors diagnose and treat patients through advanced medical equipment. In recent years, artificial intelligence has been more and more widely used in medical treatment.

Based on the similarity principle of electricity and hydrodynamics: the resistance element is used to simulate the blood flow resistance, the inductance element is used to simulate the blood flow inertia, and the capacitance element is used to simulate the compliance of blood vessels, the electrical network model of centralized parameter blood circulation system is established, in which the heart adopts the time-varying elastic model, which is the description of Frank staring law of the heart.[0]

For example, Magnetom Sempra of Siemens is equipped with Siemens second-generation ai artificial intelligence platform, which can intelligently generate personalized and standardized scanning schemes and automatically complete the whole process of magnetic resonance scanning. Sempra inherits the excellent hardware genes of Siemens magnetic resonance: trueform intelligent magnet, cold head intelligent start and stop, intelligent targeted shimming and tim4g platform, which improves Sempra's image quality and scanning speed synchronously. This is a typical example of the application of artificial intelligence in medicine. In the learning stage, many medical colleges and universities use rabbits, mice and other living animals as experimental objects. Although they can simulate the human body to a great extent, they are not as good as the actual treatment of the human body.

In the case of high integration of artificial intelligence and medicine, aiming at this problem, this paper designs a medical simulation robot, which is used to simulate a series of indexes such as body reaction, expression, blood pressure and so on.

2. The Hardware Design

Intelligent Through comparison, we use the stm32f407 minimum system as the embedded main control, and connect the circulating pump, drv8701e motor drive module, encoder, pressure sensor, air pressure sensor, hydraulic sensor, plastic hose, 4.3-inch LCD display screen and esp8266wifi module with the external power

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source and the signal IO port of the minimum system to form the sensing part and control part of the robot, The embedded master is communicated with the Jetson nano microcomputer to form a decision-making system. All the hardware is finally assembled on the robot, as shown in Figure 1.

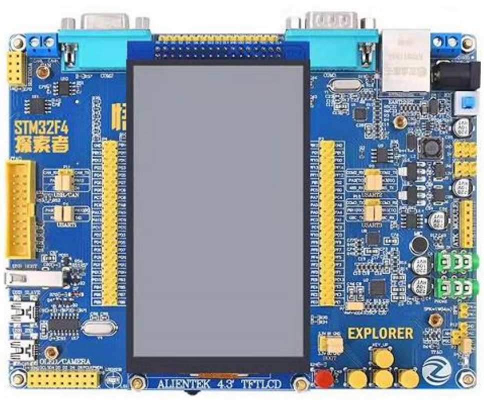

Fig.1 The design of the PCB board

2.1. Embedded main control chip

STM32f407 is a 32-bit high-performance arm cortex-m4 processor, up to 168mhz. In fact, it can overclock a little; Support FPU (floating point operation) and DSP instructions. Stm32f407zgt6: 144 pin 114 IO ports, most of which are resistant to 5V (except analog channels); Memory capacity: 1024k flash, 192K SRAM; Powerful clock system: 4~26m external high-speed crystal oscillator, internal 16mhz high-speed RC oscillator, internal phase-locked loop (PLL, frequency doubling). Generally, the system clock is obtained by external or internal high-speed clock after PLL frequency doubling, and the external low-speed 32.768k crystal oscillator is mainly used as RTC clock source; Low power consumption: three low power consumption modes: sleep, stop and standby. The battery can be used to power the RTC and backup register; 16 DMA channels with FIFO and burst support, supporting peripherals: timer, ADC, DAC, SDIO, I2S, SPI, I2C and USART; There are up to 17 timers, such as 10 general timers (32-bit TIM2 and tim5), 2 basic timers, and up to 17 communication interfaces, such as 3 I2C interfaces, 6 serial ports, etc

Fig.2. STM32F407 main control chip

2.2. Host computer design

The upper computer adopts Jetson nano and realizes the data transmission between the upper computer and the lower computer through the serial communication with the lower computer (stm32f407); The upper computer Jetson nano is equipped with ROS melody system, and processes the data measured by the lower computer according to the independently developed function package. It is the brain of the whole robot.

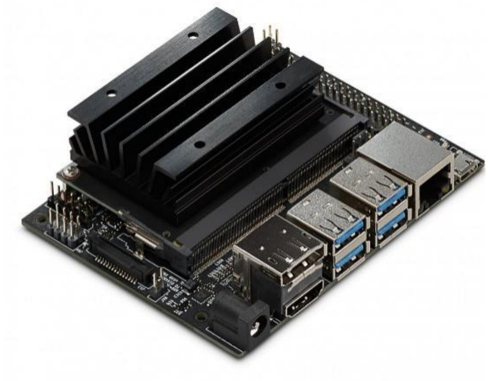

Fig.3. Jetson Nano

2.3. The detection system and feedback

The detection system and feedback are composed of circulating pump, encoder, drv8701e motor drive, pressure sensor, air pressure sensor and hydraulic sensor. This is also the most important part of the whole robot. The working principle is as follows: the drv8701e motor drive module drives the circulating pump to rotate, the encoder measures the speed of the circulating pump motor, feeds back the speed value to the minimum system, calculates the current blood flow rate, and the pressure in the hose measured by the pressure sensor, air pressure sensor and hydraulic sensor is fed back to the single chip microcomputer to calculate the current blood pressure; The characteristics of these devices are as follows:

- DRV8701E is a single channel H-bridge gate driver with four external n-channel MOSFETs. It is mainly used to drive 12V to 24V bidirectional brushless DC motors.

- Encoder is a device that compiles and converts signals (such as bit stream) or data into signals that can be used for communication, transmission and storage.
- The gas pressure sensor is mainly a conversion device for measuring the absolute pressure of gas, which can be used for pressure measurement of blood pressure, wind pressure, pipeline gas, etc.

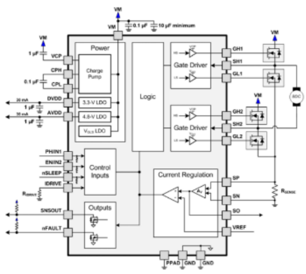

Fig.4. DRV8701E

3. Software design

The decision-making of the robot is completed by Jetson nano sending instructions to the lower computer after data processing and analysis. The lower computer preprocesses the data according to the feedback value given by each sensor module, and then returns it to the upper computer.

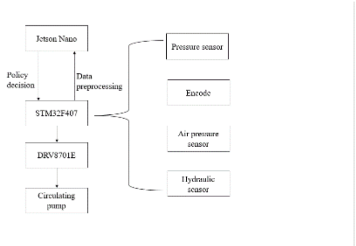

Fig.5. Software design

4. Test

After our test, the robot can simulate human blood pressure and blood flow rate under normal conditions; And it can simulate different blood pressure and blood flow rate according to the settingWireless Ad Hoc Network Design.

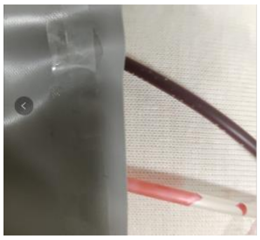

Fig.6. Blood flows through the plastic hose

5. Conclusion

Through the solution of artificial intelligence, the project studies blood pressure, integrated hydraulic pressure, blood circulation system and medical simulation. Through this solution, a medical simulation robot is developed. It is of great significance in the field of medical simulation and teaching in Colleges and universities. Through the simulation of human blood circulation, we can get the motion law of muscle, so as to enter the field of bionic robot by integrating hydraulic pressure.
The project achieves the control of blood pressure through the change of blood flow rate; In order to give users the best use experience.

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