Design of Intelligent Health Assistant Robot Based on RK3399

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Abstract: Based on RK3399 chip, XFM10621 microphone array, wireless communication module and mobile phone APP, a highly integrated intelligent health assistant robot is designed and implemented by integrating multiple sign detection modules. The robot can conveniently and accurately detect multiple signs of the human body, and the data can be stored in the cloud in real time. For example, man-machine interaction with mobile phone APP and voice commands. Robots can meet the needs of people for home self-examination and auxiliary diagnosis and treatment.

Keywords: robot; RK3399; microphone array; wireless communication module; physical sign detection; cloud storage; APP

1. Introduction

With the continuous improvement of people's living standards, health problems are getting more and more attention. Especially China has gradually entered an aging society, more and more patients with chronic diseases such as hypertension. Physical examination is an important means for people to understand the health status and to conduct early screening for diseases. At present, the medical examination must be carried out in the hospital, which requires large time and economic cost. With the development of technology, talkable medical robots provide possibilities for home or community medical examinations[1].

Medical robots have developed rapidly in recent years. Intuitionistic surgery Da Vinci surgical robot is leading the industry; apan's Cyberdyne and Honda Robotics have developed exoskeleton robots and telemedicine robots; German and Israeli enterprises have certain advantages in the field of dispensing robots and exoskeleton robots. Since 2014, some tertiary hospitals in central cities in China began to introduce surgical robots. However, the application of medical robots capable of intelligent voice dialogue in China's medical field is still in its infancy[2].

Using RK3399 main control chip as the core, a health auxiliary diagnosis and treatment robot with intelligent dialogue is designed and implemented. It can detect body temperature, blood pressure, blood oxygen, respiration and other typical physical signs, help users understand their health status in real time, provide auxiliary diagnosis, and achieve disease prevention and control.

2. Robot System Design

The system microcontroller uses RK3399 as the control core and Android as the software platform. The peripheral circuit is mainly composed of the sign module (body temperature module, blood pressure module, blood oxygen and heart rate module), power module, display module, Bluetooth module, voice module and other modules to realize voice control, sign detection, auxiliary diagnosis and treatment. The system framework is shown in Figure 1.

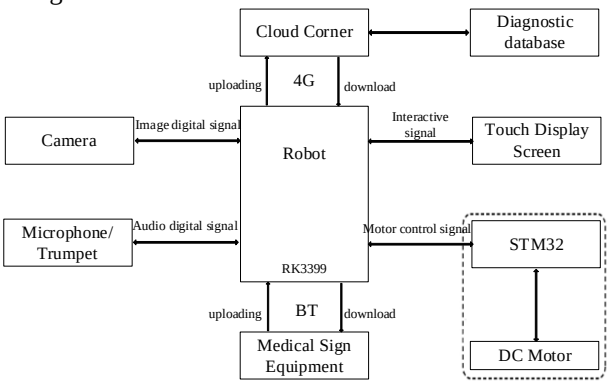

Figure 1. System hardware diagram

3. Hardware Design of Robot

3.1. Overall Circuit Design

The hardware is mainly composed of RK3399 motherboard, XFM10621 microphone array, STM32 control board and motor drive, display, speaker and sign detection module. The control circuit adopts the modular design idea, the whole robot control is divided into three parts - chassis, body, and head. The three control circuits are independent of each other, and they are managed uniformly through RK3399, which can expand other modules at any time, maximize the realization of adding new functions without affecting the existing system, and quickly remove unnecessary modules. The chassis, body and head circuits are shown in Figures 2 to 4.

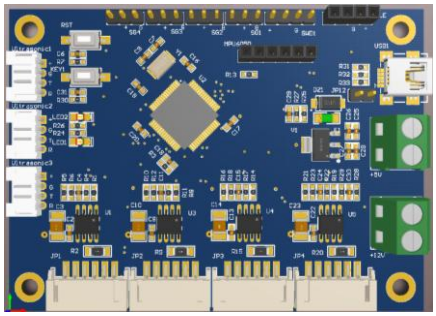

Figure 2. Robot chassis circuit board 3D diagram

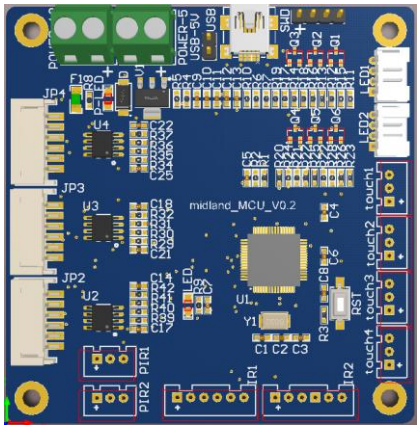

Figure 3. Robot body circuit board 3D diagram

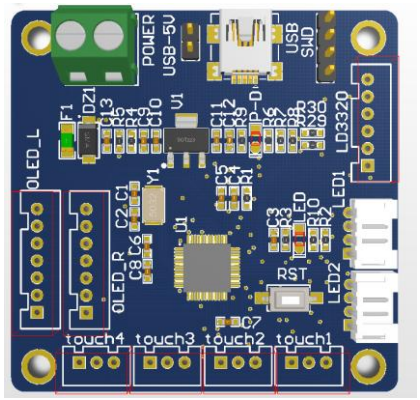

Figure 4. 3D diagram of the circuit board of the robot head

3.2. Power Circuit Design

The robot uses 12.6V lithium battery to supply power for the whole system. Because the robot has designed multiple control boards and motors, the power supply requirements of the control board and the motor are different. The power supply requirements of the control board are 5V, and the power supply requirements of the motor and the RK3399 main board are 12V. Therefore, a power supply circuit is designed to convert 12V power supply into 5V power supply for the control board. The designed buck circuit is shown in Figure 5.

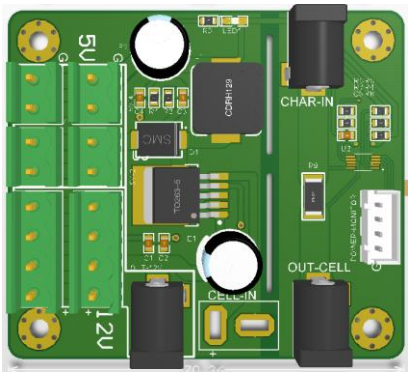

Figure 5. Robot power supply board 3D diagram

3.3. Motion Control Program

The movement of the robot is realized by controlling the speed and position of three DC deceleration motors. The control drive circuit of the motor adopts A4950. The gyroscope of MPU9250 is used to collect the attitude of the robot, and the current attitude angle of the robot is obtained by reading the data of MPU9250. The indoor positioning with Bluetooth low power consumption is used for positioning[3].

3.4. Sign Detection Module Design

Complete the design of body temperature, blood oxygen, breathing, blood pressure and other signs detection module.

(1) Temperature detection module: Using GY-906 infrared temperature measurement. GY-906 temperature measurement module has high precision and is suitable for body temperature detection. Communication with MCU through IIC.

(2) Blood oxygen detection module: The blood oxygen module is detected by the MAX30102 sensor. The module also uses the standard IIC interface to communicate with the microcontroller, with high measurement accuracy and moderate price[4].

(3) Respiratory detection module: The abdominal fluctuation caused by human respiration will lead to periodic changes in the pressure of obstructive airbags. By measuring the changes in abdominal respiratory frequency and intensity, the relevant parameters such as respiratory frequency and respiratory interval can be obtained through single-chip microcomputer processing.

(4) Blood pressure detection module: Photoelectric volume method uses the different transmittance of human tissue during vascular pulsation to measure pulse. When the light beam passes through the human peripheral blood tube, the transmittance of the light beam changes due to the change of arterial pulsatile congestion volume. At this time, the light reflected by the human tissue is received by the photoelectric converter, which is converted into electrical signals and amplified and output. Since the pulse is a signal that periodically changes with the pulse of the heart, and the arterial volume also periodically changes, the electrical signal change cycle of the photoelectric converter is the pulse rate.

4. Software Design

It includes embedded system C language program design, WeChat small program design and mobile phone APP design. The compiler platform of embedded system is Keil; WeChat applet uses Tencent's official WeChat developer tool; robot APP is developed based on Android Studio.

4.1. Sign Detection Module

Software development is completed by Keil combined with STM32CubeMX tool. STM32CubeMX is a graphical programming tool, which enables users to configure the hardware function of STM32 in a graphical way. It can automatically perceive the hardware interference, automatically match the appropriate configuration for each required hardware, and then generate C language code in accordance with the set way.

4.2. Wechat Mini Program

WeChat small program is developed based on JavaScript and HTML and CSS style. The robot matches the mobile phone through the Bluetooth peripheral of the RK3399 system board, and then establishes a data connection. WeChat small program receives data, processes data, and displays them on the software interface. Save the data to the cloud database for remote query and historical data query.

4.3. Robot APP Design

The Android APP of the robot is used to monitor and manage the state of the entire robot, while providing a good human-computer interaction environment. Robot APP is mainly divided into two parts, one is responsible for data transmission and resource management with the hardware control board, and the other is responsible for human-computer interaction.

4.4. Speech Module

The adopted XFM10621 module integrates functions such as 360 ° sound source localization, noise reduction, echo cancellation, and voice awakening. Combined with the voice dictation service of the University of Science and Technology, real-time speech recognition can be realized[5].

5. Diagnosis Database

The physical sign indicators of the human body have a given reference range in medicine. We store the physical sign indicators in the medical reference range in our cloud database, and compare the data detected by the physical sign detection module. When it exceeds the medical reference range, it will send an alarm to remind the detected person. At the same time, the historical records of the detected data will be stored in the local robot for users to query.

6. Conclusion

Based on RK3399 chip, XFM10621 microphone array, wireless communication module and mobile APP, a highly integrated intelligent health assistant robot is designed and implemented with a variety of physical sign detection modules. The test results show that the error between the physical sign data collected by the robot and the clinical diagnosis results is about 1 %. The basic physical signs of the human body can be conveniently and accurately obtained through the mobile phone APP and WeChat small program, and the historical data can be searched to monitor the health status, so as to prevent diseases and assist treatment.

Acknowledgment

Hunan University Student's Innovation and Entrepreneurship Training Program (S202011342016); In 2021, the special project for the construction of the Changzhutan National Independent Innovation Demonstration Zone (numberingCG-YB20211025, CG-YB20211030)

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