Elderly care system based on cloud platform internet of things

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Abstract. Against the background of a gradual increase in the elderly population, the care system for the elderly appears extremely important. The nursing system based on the cloud platform Internet of Things mainly includes the design of the lower computer, the debugging of the upper computer and the design of wireless communication. The design of the lower computer uses STM32, pulse detector, accelerometer, gyroscope and other modules. And with the cooperation of the host computer and the communication module, it can realize health monitoring functions such as medicine warehouse switch detection, elderly heart rate monitoring and fall detection. In addition, family members can also use the mobile phone APP to control connected devices around the elderly, such as smart pill boxes, to remind them to take medicine. There is no doubt that the design will greatly reduce family stress.

1. Introduction

In recent years, countries have shown varying degrees of aging. According to the World Bank's forecast, the proportion of the elderly population aged 60 and over in countries around the world has increased in recent years, and it is expected that by 2050, the world's elderly population will increase to 25% of the global population, that is, jump from 800 million to 2 billion[1]. Faced with the ever-increasing population of the elderly, more and more problems are gradually exposed. For example, the elderly often show problems such as falling easily, forgetfulness, and difficulty finding physical abnormalities. To this end, a system that serves the elderly has been developed using IoT-related technologies.

The system can detect the heart rate of the elderly, transmit the relevant values to the children through the wireless transmission module, and display the values on the LCD screen for easy viewing by the user; the system also designed a smart pill box to achieve eating reminder, prevent accidental medication, record medication cycle, etc. In addition, the system also has fall detection and protection and rescue functions. The design of the system will bring unexpected benefits to the elderly, families and society.

2. Overall design ideas

The main control chip selected is STM32F106 series with Cortex-M3 as the core, which can receive external data input, including data from heart rate detection module, drug warehouse switch detection module and fall detection module. The incoming data can then be processed and judged. Finally, the processed data is sent to the mobile APP through the Gizwits cloud server on the one hand, and sent to the lower computer on the other hand, and the heart rate data, medication status and fall detection status can be notified to the person or relatives.
Wireless communication mainly uses services provided by Gizwits. Gizwits is a development platform dedicated to the Internet of Things and smart hardware cloud services. The platform also provides developers with self-service smart hardware development tools and open cloud services. And only one ESP8266WIFI module can be used to connect the hardware to the cloud, which can realize mobile phone control. The lower computer uses each sensor module and other modules to complete the hardware platform construction. On the standard hardware circuit, the peripheral circuit needs to be connected to the interface on the controller. The cloud-based joint control development system can collect sensor data by using the serial port, interrupt, bus, SPI, etc. of the single-chip microcomputer, and process the data by using a filtering algorithm. Then, the communication between the single-chip microcomputer and the mobile phone client is completed by using the smart cloud data protocol. At the same time, STM32 continuously analyzes and detects after receiving the data to complete the corresponding control. The system integrates new technologies such as the Internet of Things, wireless communication, and cloud computing, which can significantly reduce the burden of traditional human resource management methods on a large number of human resources, and can provide users with real-time and convenient services. There is no doubt that this will be the main trend in the future.

3. Hardware design

3.1. Heart rate and blood oxygen detection module design
Aerobic heart rate detection is the first problem to be considered in the elderly health protection system under the cloud platform Internet of Things. Heart rate plays an indispensable role in the health status of every elderly person[2]. People will inevitably face heart rate problems when they reach middle age. Heart rate problems can lead to dizziness, fatigue, poor mentality, and even fainting, leading to more serious health conditions. Therefore, heart rate monitoring is the primary detection index of the health protection system. Here, we use STM32ZET6 as the control core, and use the pulse sensor SON1205 as an external detection module to detect the change in heart rate. Combining heart rate detection algorithms and related transformations can be used to obtain a person's heart rate. At the same time, the wireless transmission module NRF2401 can realize remote heart rate information transmission, so using this module can let the children of the elderly know the heart rate information of the elderly in real time. At the same time, the wireless transmission module NRF2401 can realize remote heart rate information transmission, so using this module allows the children of the elderly to know the heart rate information of the elderly in real time, and the system can display the detected heart rate information on the LCD module[3]. Among them, the pulse detection module is used to sense the change of the human heart rate, output the change of the human heart rate in the form of a square wave, and then amplify the square wave signal through an amplification circuit, and then send the signal to the microcontroller through the I / O port[4]. Running a heart rate detection algorithm to obtain a person's heart rate enables data sharing and remote monitoring. Its design block diagram is shown in the figure below.

Figure 1. Block diagram of heart rate and blood oxygen detection module design.
The SON1205 detection module can be connected to the STM32’s I / O interface or AD conversion through Vout1 and Vout2 to complete the collection of heart rate by the microcontroller. The sensor includes OUT2, VCC, GND, OUT1 interfaces and an LED indicator. The lights flashed during the heartbeat. And related waveforms can be displayed on the oscilloscope. When using this waveform, connect the Vout1 and Vout2 interfaces to the microcontroller.

3.2. Smart Pill Box Module Design
The design of the smart pillbox utilizes a combination of mechanical and electronic forms. A plurality of medicine warehouses are arranged in the medicine box, including a round medicine warehouse, a square medicine warehouse and a flat shape medicine warehouse, which are respectively used to store medicine packages in different packages. Secondly, a detection device is installed at the bottom of each medicine warehouses. When the medicine time is up, the light of the target medicine warehouses flashes, which realizes visual reminder and avoids taking medicine by mistake. Taking into account the user situation of this system, we also intentionally add a voice prompt function. The kit has the following characteristics:

• No need to open the original drug package, which is easy to identify, safe and hygienic.
• Pill box can visually and audibly remind taking medicine.
• The following situations are difficult to open the medicine warehouse, for example: medicines already taken, medicines that do not need to be taken.
• The pill box is connected to the cloud through the WIFI module, and the medication record is detected in real time. At the same time, send a message to the mobile APP to remind the customer again whether to take the medicine and record the time of taking the medicine.

The smart pill box uses STM32 as the main controller, and the output needs to control 7 electromagnets, 7 medicine storage indicator lights, 1 medication reminder indicator, 1 LCD display, 1 recording and playback module, etc[5].

3.2.1. Opening and closing detection of medicine warehouse. The opening and closing of the warehouse can be expressed by the level of voltage. In this system, if the voltage is detected to be high, it means that the warehouse is open; if it is low, it is closed.

3.2.2. Smart pill box LCD display. The LCD display module uses the LCD1602 liquid crystal display, which has the advantages of high display quality, digital interface, small size, light weight, and low power consumption[6]. The LCD1602 needs to be connected to a 5V power supply. In order to adjust the contrast, a 10K potentiometer can be used.

3.2.3. Voice prompt for smart pillbox. The chip used in the voice module of the smart pill box is the ISD4004 voice chip. The single-chip recording and playback time of the ISD4004 series chip is 8 ~ 16 minutes. The chip design is based on that all operations must be controlled by a microcontroller, and operation instructions are sent through the serial communication interface. P1.5 is connected to the chip select pin of ISD4004; P1.2 is connected to the MOSI end of ISD4004; P1.7 is connected to the MISO end of ISD4004; P1.4 of the microcontroller is connected to the SCLK end, which is used to synchronize MOSI and MISO data transmission; AMCAP is an automatic mute terminal, which is grounded through a capacitor when in use[7].

3.3. Design of elderly fall detection module
This system is based on the wear-resistant equipment anti-fall equipment system developed by STM32 chip, and monitors body posture and movement in real time through accelerometer and gyroscope. The acceleration and angular velocity of the human body are collected, and then judged by the microprocessor using threshold values. Analysis, alert and protect before landing. The entire system is divided into a fall detection part and a protection and rescue part. First use the accelerometer and gyroscope to collect the human acceleration signal and angular velocity signal in real time, and then
convert them into digital signals and transfer them to the STM32 core control module. Then, the STM32 core control module analyzes and processes the received signals. If the fall condition is met, the related actions of the airbag are controlled. The intensity of exercise can be judged by the magnitude of the acceleration vector SVM of the human body[8]. The larger the SVM, the more severe the change in exercise state. When the SVM value exceeds the threshold, it can be judged as a fall[9]. The SVM calculation formula is as follows:

\[ SVM = \sqrt{\alpha_x^2 + \alpha_y^2 + \alpha_z^2} \]  

(1)

Among them, \( \alpha_x \), \( \alpha_y \), and \( \alpha_z \) are X, Y, and Z axis outputs of the acceleration sensor, respectively. The block diagram of the fall detection module is shown below:

![Block diagram of the fall detection system](image)

3.4. Wireless transmission module NRF24L01
NRF24L01 has 125 communication channels, the highest working rate is 2Mbps, strong anti-interference ability, working voltage is 1.9-3.6V, built-in PCB antenna, can realize one-to-many communication, and the receiving mode can be set through SPI interface[10]. When using this module, you need to pay attention to the use steps in sending mode, and keep the sending address, receiving channel address and response channel address consistent.

4. Software design
The software part adopts a modular program design method, which consists of a main control program, a wit cloud communication program, and various sensor signal processing programs, etc. Each program is independent of each other, and only needs to provide the corresponding API function interface[11]. The main control chip is STM32F103ZET6, which has 144 programmable ports, has a powerful interrupt processing function, and has a higher operation speed under the instruction system[12]. Compile with C language in the compilation environment, with high reliability. The program design flow chart of the main module smart pill box is shown in the following figure:
5. Summary
The main content of this paper is to design a joint control development system based on cloud platform and Internet of Things. In the system hardware and software, it mainly involves the design of the lower computer, the debugging of the upper computer, and the design of wireless communication [13]. The design has initially realized functions such as heart rate monitoring, fall detection, and smart pill box reminder. With the rise of smart devices, the penetration area is becoming more and more extensive, and furniture is also developing towards intelligence and integration. In this case, you can take full advantage of the system's powerful extensions, such as adding security door fingerprint verification, smoke alarms, automatic curtains and automatic light switches. There is no doubt that the study of this system can bring great convenience to people, and the research on the Internet of Things of the PTZ will not stop there.

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