Design of Intelligent Crutch System Based on STM32 and Raspberry Pie

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Abstract

In order to strengthen the development of China's elderly care industry, the project has designed an intelligent crutch based on stm32 and raspberry pie. This product adds many functions on the basis of general intelligent crutches. It is equipped with real-time GPS monitoring and uploading APP. When the elderly fall, they can immediately and automatically alarm. When they fall, they can simultaneously emit an alarm sound of about 100 decibels to the surrounding. It provides a touch screen, supports voice recognition, and can achieve multiple functions. It is equipped with a step counting function, temperature and humidity display and other functions. The product uses 4G modules to communicate with the APP.

Keywords: Elderly care industry; Intelligent crutch; STM32; Raspberry pie; APP

1. Introduction

At present, the trend of aging in China is getting worse. In order to protect the due rights and interests of the elderly in China and comply with the development of AI, an intelligent crutch with AI elements has been designed. At present, the society is developing rapidly. Young people go out and leave the elderly at home alone, unable to contact the elderly in time. If the elderly go out and have an accident, their children cannot get the news at the first time, which makes the elderly accidents happen frequently. The appearance of this product has ingeniously solved this problem. First of all, this product is equipped with GPS technology for real-time monitoring and uploading to the supporting APP[1]. There is no need to worry about the elderly getting lost when they go out. Second, it is equipped with a one button alarm: after the crutch falls to the ground, it will send an alarm at about 100 decibels and upload it to the APP at the same time to remind users[2]. Many elderly people can't adapt to smart phones. This product can be used to call their children by voice one button, making communication between children and elderly people more convenient and fast[3]. This product also provides a touch screen and speech recognition[1,4], which can display time and current position, and can play music through the touch screen. You can also listen to plays on your daily trip[5]. Many elderly people have inconvenient legs and feet and are not suitable for too much walking and physical exercise. Through the step counting function of this product, they can get the exercise time of the elderly in real time. When the exercise reaches the standard, they can be prompted to have a proper rest. The steps of the elderly and the ambient temperature and humidity will be transmitted to the screen in real time. Finally, this product is equipped with video camera and flashlight functions, so that users can fully monitor the elderly to ensure that their rights and interests are not violated, so that the fraudsters can not escape, and night travel can also be guaranteed [6-8]. Fig.1 is a real product diagram, and Fig.2 is a 3D modeling diagram.

Fig.1 Real product diagram

Fig.2 3D modeling diagram

2. The System Design

2.1. Embedded system design

First of all, the sensor data collection part is dominated by stm32. We distribute the controller in the upper part of the crutch and the sensors around the controller. When the sensor data collection is completed, the result is sent to stm32. After stm32 completes receiving and processing, it is sent to the 4B end of Raspberry Pie again. Raspberry Pie 4B is responsible for the output and interaction part as well as the communication with the APP. On the LCD resistance touch screen, we carry a self-designed UI interface to achieve the interaction design of various functions, supplemented by a voice control system. Through voice recognition, we can quickly retrieve all functional modules and find satisfactory choices. Fig.3 is the design framework.

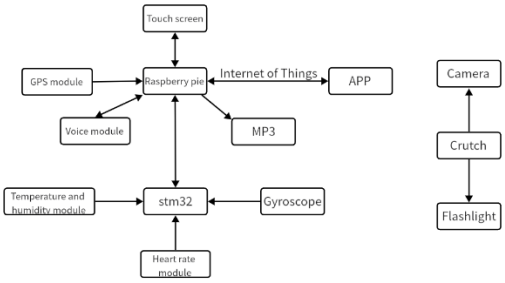

Fig.3 The design framework

2.2. APP system design

APP application is designed on Android system, which is mainly divided into three interfaces. The main interface is the status interface, with step counting display, heart rate and blood pressure display, temperature and humidity display, connection status display, and music switching function. The second interface is the alarm communication interface, which has the functions of receiving alarm, dialing with one button, and manual shutdown. The third interface is the GPS system, which calls the Gaode navigation API to monitor the crutch positioning information in real time. The data is transmitted from Raspberry Pie to the APP through 5G network, so that the APP can be updated in real time. Fig.4 is an APP display.

Fig.4 APP display

3. The Hardware Design

The hardware system is roughly composed of raspberry pie 4B, stm32f103, sensor, 3.5 inch LCD resistance touch screen, 5G module, MP3 module and crutch body. The raspberry pie 4B and stm32f103 are used as the core hardware system, in which stm32 receives and processes signals from various sensors, such as temperature and humidity sensors, gyroscopes, acceleration sensors, and sends them to raspberry pie. The raspberry pie part is connected to the LCD resistance touch screen, 5G module, MP3 module, and stm32 sends data to the raspberry pie through the serial port, then the raspberry pie is used as a transit, and then sent to the client.

Camera: load a small camera under the main control part of the crutch, automatically store the captured image to the SD card, automatically clean it every day, and upload it to the APP for backup.

Light: A small flashlight and manual switch are installed at the front end of the crutch grip.

Alarm: It is set on the upper end of the cane, which can be triggered automatically or controlled by manually pressing the switch.

4. The Software Design

4.1. stm32

The main function of the program is to read and process the data of each sensor, and communicate with the serial port of Raspberry Pie. The stm32 uses the query method to read the relevant sensor data. However, considering the priority of the fall alarm, we need to use the interrupt processing for the gyroscope module to ensure that it takes effect at the first time. After data collection, send the data to Raspberry Pie to complete a cycle structure.

Step counting function: through the data acquisition of the gyroscope and accelerometer, the stm32 completes the data analysis. When the gyroscope senses the vibration amplitude higher than the threshold value, it sends a decision command. At the same time, when the accelerometer senses the change of the center of gravity, it also sends a decision command. When both commands are true, the decision is successful, and the steps are increased by one. Otherwise, it skips the command and the program moves forward. Fig.5 is the principle of step counting.

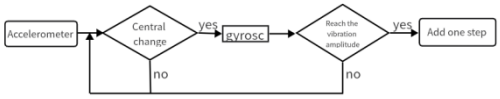

Fig.5 The principle of step counting

Temperature and humidity sensor: after the temperature and humidity module collects data, it is converted into Celsius and relative humidity units through ADC A/D conversion, and collected by stm32. Fig.6 is the schematic diagram of temperature and humidity module.

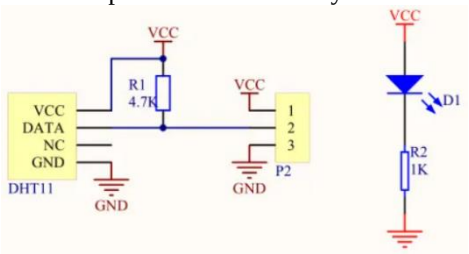

Fig.6 schematic diagram of temperature and humidity module

GPS positioning: GPS module can realize satellite positioning, receive the position information from the satellite, upload the information to stm32, and use stm32 to process the information and send the information. Fig.7 is the schematic diagram of GPS.

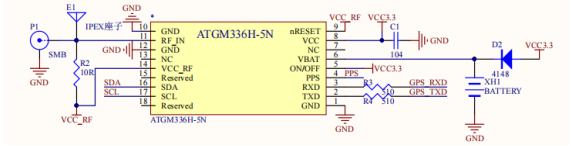

Fig.7 The schematic diagram of GPS.

Data exchange: STM32 and raspberry pie exchange data through serial port. STM32 and raspberry pie cross connect TXD and RXD ports. STM32 sends the data of all sensors to raspberry pie by serial transmission, allowing raspberry pie to complete data collection. Fig.8 is the principle of data communication.

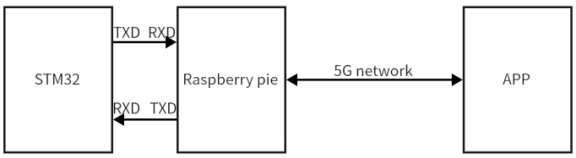

Fig.8 the principle of data communication

Fall alarm: When the amplitude of vibration collected by the gyroscope exceeds a certain threshold or the data collected by the accelerometer exceeds a certain threshold, the alarm will immediately send an alarm, and the signal will be sent to the Raspberry Dispatch controller using an external interrupt. Fig.9 is the alarm principle.

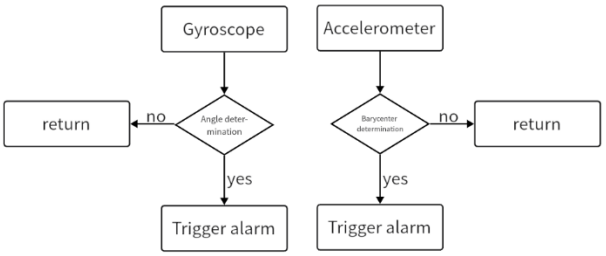

Fig.9 the alarm principle

4.2. Raspberry pie

The program mainly completes data receiving and sending, voice recognition, and smart screen functions. Raspberry Pie communicates with stm32 through serial port, and communicates with APP through 5G network. With 5G network, communication function and alarm signal transmission function can be realized in addition to data transmission. With the touch screen, GPS, time, MP3 and alarm call functions will be freely selected and interacted. The voice recognition module shall also be equipped. After the voice mode is opened on the screen, the above functions can be called by using voice.

Music playing: After connecting USB module and mp3 module, Raspberry Pie can read the mp3 format file of the U disk, and use the touch screen to complete music demand, volume and pause functions. The external speaker can realize voice output, music playing and alarm. Fig.10 is the MP3 module PCB diagram.

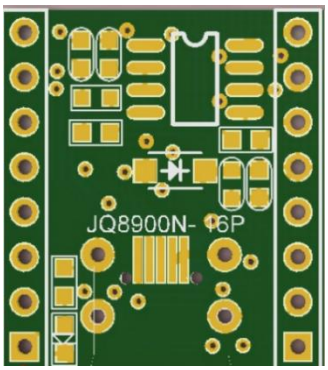

Fig.10 the MP3 module PCB diagram

Network: raspberry pie uses the 5G wireless network communication module to connect to the local network base station, realize the Internet of Things function, and complete some functions and remote communication with the APP. Fig.11 is a 5G module.

Fig.11 5G module

Screen and voice recognition: Connect to Raspberry Pie with the touch screen, draw and import UI icon by computer, and realize UI interaction function by Raspberry Pie. After the voice module is connected, the recognition command will be imported to the module in advance. After debugging to the best performance, voice control can replace the operation of the smart screen. Fig.12 is the schematic diagram of the voice module.

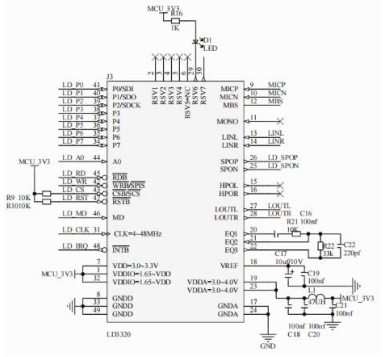

Fig.12 the schematic diagram of the voice module

4.3.APP

The APP program is mainly composed of three interfaces. The first is the device information part, which consists of the connection status of the device, the control of MP3 music, the temperature and humidity, steps, heart rate and blood pressure of the sensor. The sensor data comes from the collection and processing of stm32. After the cane falls, there will be color changes to indicate warnings. The second part is the alarm part, which can control the opening and closing of the alarm of the crutch, and the lower part is also equipped with a call answering module. The third part is GPS positioning, which is connected to the navigation API of Gaode, and the fast navigation function is set. The GPS module transmits the longitude and latitude information collected to the APP through the raspberry pie, and then the APP searches for the position of the crutch according to the data.

5. Conclusion

After testing, the product can operate normally without obvious problems in each module.

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