Design of Intelligent Drug Box System Based on STM32
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Abstract
With the rapid development of society and the continuous improvement of people living standards, people's pursuit of quality of life and health has also become higher and higher. In view of the poor memory of older people and the complex and diversified pattern of common drug types, this topic has designed an intelligent electronic pillbox system based on STM32 single chip microcomputer, which is mainly used to help people to take drugs scientifically and solve the problem of forgetting drugs for elderly patients. A series of problems such as taking the wrong drugs and repeating medications. The intelligent drug box system design adopts a modular design method and mainly designs five functional modules: a microprocessor module, a human-machine interaction module, an alarm clock timing module, a voice broadcast module, and a Flash memory module. The intelligent drug pillbox system designed for this project is based on the STM32F103ZET6 master chip as a microcontroller, and is powered by a 3.3V power supply. The RTC real-time clock inside the STM32F103ZET6 chip is used to design the alarm clock timing function, and the touch display function is realized by the TFTLCD screen. Then by the W25Q64 chip to achieve Flash memory function, and finally by the SYN6288 chip designed to complete the voice broadcast related functions. With the wide application of single-chip technology in various fields, smart cartridges are gradually becoming more miniaturized. They are not only small in size, low in cost, easy to operate, but also more human and intelligent, bringing more people. Convenient, with great market potential.

Keywords
Intelligent drug box, STM32 processor, TFTLCD screen display, Human-machine interaction, Voice reminding.

1. Introduction
Nowadays, society is developing rapidly, and the medical field has also been greatly developed. However, most elderly people still face various problems such as forgetting to take the medicine and taking the wrong medicine while taking the medicine. At this time, in order to help these people take medicine scientifically, a intelligent drug box came into being.
At present, intelligent drug box series products are being researched at home and abroad. Compared with the research of similar products abroad, the domestic start is relatively late. In recent years, with the widespread application of single-chip technology in various fields, the domestic intelligent drug box series products have gradually developed and become more complete. From the small drug box that appeared in the market at the beginning, to the electronic drug box composed of a simple circuit, to the intelligent drug box with a single-chip microcomputer as the microcontroller, the domestic intelligent drug box series products have developed to a very high level. This article is based on similar products on the domestic and foreign markets, and aims to design a smarter, more humanized and suitable intelligent drug box system for the public.
2. Overall system design

In today’s society, most of the elderly suffer from forgetfulness. These elderly patients have long been plagued by problems such as forgetting to take medication, taking the wrong medication, and repeating medication. Moreover, the problem of taking medication not only exists in the elderly who are prone to forgetfulness, but most urban youth and patients with chronic diseases also face various problems in taking medication. The intelligent drug box system designed in this project is designed for these people who are troubled by medication.

This project adopts a modular design method. According to the different functional requirements of the intelligent drug box system, five functional modules are mainly designed: a microprocessor module, a human-computer interaction module, an alarm timing module, a voice broadcast module and a Flash storage module. Among them, the microprocessor module is the control center of the entire intelligent drug box system, the human-computer interaction module mainly realizes the LCD screen display touch function, medication setting function and alarm setting function, the alarm timing module mainly realizes the system alarm timing function, and the voice broadcast module mainly realize the voice broadcast function. The Flash storage module mainly realizes the information storage function. In addition, the system also adds reset function design, button function design, alarm function design, and indicator light function design. The overall design block diagram of the system is shown in Figure 1.

3. System Hardware Design

This intelligent drug box system uses the STM32F103ZET6 chip as the system’s microcontroller, uses 5V power supply, and uses the RTC real-time clock inside the STM32 chip to design the alarm clock, which is displayed by the TFT-LCD screen, and the W25Q64 chip realizes the Flash flash memory, and then by SYN6288 The chip realizes voice broadcast. This design adopts a modular approach, using the STM32F103ZET6 chip as the microprocessor, respectively designing the human-computer interaction module, the alarm timing module, the voice broadcast module and the Flash memory module to realize the alarm timing function of the intelligent drug box system, Voice broadcast function, LCD screen display function and touch input functions. The main design of each functional module is as follows:

Microprocessor module: STM32F103ZET6 is used as the core MCU of the system. It is a microcontroller based on Cortex™-M3 core with 512K bytes of flash memory. The maximum operating frequency is 72MHZ and up to 64K bytes of SRAM. Peripheral interface, also has three low power consumption modes: sleep mode, standby mode and stop mode.

(2) Human-computer interaction module: This module mainly includes indicator light design, buzzer design, human-computer interface design and key input design. Among them, the man-
machine interface design is the core of the module design, which mainly includes two parts: LCD screen display design and LCD screen touch design. The man-machine interface adopts the ALIENTEK TFTLCD liquid crystal display, and each pixel of the display is equipped with a TFT, and the quality of the picture is relatively high. The display uses ILI9341 as the display control chip and XPT2406 as the touch control chip. The screen size is 2.8 inches, the resolution is 280*320, the color is 16 bits, the working voltage is 3.3V, and the interface adopts 8080 parallel serial ports.

(3) Alarm clock timing module: The alarm clock timing module mainly implements the function of alarm clock timing. Users can set one or more time alarms to remind of medication according to their own medication time requirements. The function realization of this module is mainly designed according to the internal RTC clock of the STM32F103ZET6 chip.

(4) Voice broadcast module: When the alarm is triggered, the main function is to broadcast the product information entered by the user by voice, reminding the user which drugs should be taken. The module is mainly composed of a controller, SYN6288 speech synthesis chip and speakers. The main controller and the voice chip use asynchronous serial port (UART) communication for communication. The SYN6288 chip can convert the text information received from the controller into the corresponding voice signal and transmit it to the power amplifier. The voice after the amplification process is broadcasted through the horn.

(5) Flash storage module: The main function of the Flash storage module is to store the system software program, the drug information input by the user, and the alarm information set by the user. The storage function of this module is mainly realized by W25Q64 chip, adopts SPI communication, working voltage is 3.3V, current consumption is 4mA, and storage capacity is 8M bytes.

4. System software design

The software development part of this project design uses the Keil uVision5 software of Keil Software for programming. It integrates the corresponding development environment and firmware library for the STM32 chip, which is convenient for developers to develop the STM32 series of chips and can significantly shorten the project development. The software design cycle of the process, so choose this software.

The main program design flow chart of this intelligent medicine box system software design is shown in Figure 2. The specific steps are as follows:

When the user presses the button to turn on, the system initializes the GPIO port and various peripherals (including serial port, SPI, FAMC, RTC, ADC, etc.) and configures the system interrupt priority. The system checks whether the memory chip is ready and whether the voice codec module can be used normally—whether the communication is normal. At this time, the power light of the voice codec module lights up, and the red light flashes once to indicate that the module can work normally.

The system initialization will read and write the Flash and read the unique ID number to test whether the Flash read and write is normal; for the 6288 voice module, the SYN6288 voice chip will return the initialized successful status byte (0x4a) after initialization. Use this to judge whether the voice module is normal.

Check the flag (sys_flag) of the system interface switch, whether it is necessary to switch the system interface. In the normal working mode, the main interface of the TFT-LCD screen displays the current implementation date and time and the current environmental temperature, and the first LED flashes to indicate that the system is working normally. When the user clicks on the screen, the interface for inputting drug information is entered. The upper part of the display screen displays the information that the user has entered, and the lower part simulates a keyboard that supports pinyin and handwriting input. The user can perform drugs through
information addition and modification. After the drug information has been entered, by clicking the physical button on the development board, the storage of the drug bottle information is completed. At this time, you can see the second LED light is on, and the interface enters the alarm time setting interface. In the alarm time setting interface, the user can adjust the hour and minute of the alarm clock through the plus and minus buttons on the screen for the setting of the alarm clock. After the time is selected, you can click the confirmation button at the bottom of the screen to confirm this reminder or cancel this setting. After clicking to confirm, the third LED on the development board lights up to remind the user that there is a timing for taking medicine in the next few hours, and the system returns to the main interface at this time.

Fig.2 Main program design flow chart of the system

5. System debugging results and analysis

After the hardware circuit design and construction of the system are completed, the system program is downloaded to the STM32 main chip through the KEIL uVision5 software, and the
intelligent drug box system is simulated and tested by simulating user operations. This test is mainly to test the functions of the system’s human-computer interaction interface, alarm clock timing and voice broadcast modules.

5.1. Human-computer interaction function test

(1) Test whether the real-time date, time and temperature can be displayed correctly after the system is turned on. When the system is turned on, enter the main interface of the system, as shown in Figure 3-1. The main interface of the system normally displays the real-time time, date and temperature, and the functions are implemented correctly.

(2) Test whether the input keyboard of the drug information input interface can work normally. In the drug information input interface, the user enters through the Pinyin keyboard. The system can quickly detect the user’s input and output the corresponding Chinese characters. After the input is completed, it can be quickly saved. As shown in Figure 3-2, enter "Master, it's time for you to take medicine, please take 1 tablet of amoxicillin" in the drug information input interface, the input keyboard works normally, the LED indicator is correct, press the confirm button to save normally, The interface function is well implemented.

(3) Test whether the timer setting of the alarm timer interface is normal. As shown in Figure 3-3, by touching the buttons on the interface, it is tested that each button works normally and can perform smooth digital switching. The system works normally without any faults.

5.2. Function test of alarm clock timing and voice broadcast

(1) Test whether the alarm timing interface can perform timing operations normally. The time measurement method adopted by this system is a 24-hour system, as shown in Figure 4-1, with the hour setting on the left and the minute setting on the right. Press "+" to increase, press "-" to decrease, press "OK" to save the currently set alarm clock, press "Cancel" to not save. Set the alarm to "15:00" and press the confirm button to save the alarm. The alarm timer function is implemented without error.

(2) Test whether the alarm can be triggered and related voice announcements when the alarm arrives. Set the alarm clock to "15:00" and enter the drug information as "Master, you should take medicine, please take 1 tablet of amoxicillin". When the real-time time arrives, the alarm clock is triggered, as shown in Figure 4-2, the alarm prompt interface pops up and works normally, and at the same time, the voice module performs corresponding voice announcements.
(3) Test whether the voice announcement will ring again after five minutes after pressing the alarm resound button; test whether the voice announcement normally stops after pressing the alarm cancel button. As shown in Figure 4-3, when the "15:00" alarm is triggered, the system will always play the voice in a loop if no relevant operations are performed. Press the "repeat" button to exit the alarm clock interface, and the voice broadcast stops; five minutes later, the alarm is triggered again, press the "Cancel" button, the alarm clock interface exits normally, and the voice broadcast stops at the same time. After many simulation operations, the system's alarm clock timing function and voice broadcast function have been implemented well, meeting the requirements of system design.

![Image of alarm clock interface]

4-1 Alarm timer interface  4-2 Alarm prompt interface  4-3 Alarm Snooze Interface

Fig. 4 Function test diagram of alarm clock timing module

Based on the above simulation tests, it can be concluded that the design of the intelligent drug box system meets the requirements, and the various modules cooperate with each other in tacit agreement. The ability to perform various operations of the user accurately and quickly, especially the friendly human-computer interaction is the design highlight of this system, accurate timing and information storage to escort the reminder function. After many times of debugging and testing, all functions of the system are realized normally, and further development can be carried out and put into market trial. It has quite good development value and room for market appreciation.

6. Conclusion

According to the actual needs of society, this paper designs a set of intelligent drug box system based on STM32, and introduces the design of the hardware and software of the system in detail. The system can well realize the function of intelligently reminding users to take medication, and has low power consumption and low cost. The advantages of stable operation, a wide range of applicable users, and a large market appreciation space.

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References


