Journal of Computer Science and Electrical Engineering
ISSN: 2663-1946
DOI: https://doi.org/10.61784/jcsee3036

DESIGN OF INTELLIGENT NURSING HOME MONITORING SYSTEM BASED ON WI-FI AND GSM COMMUNICATION TECHNOLOGY

HuiXian Chen, PengHui Liu, MengYang Zhang, Guan Wang*
Pingdingshan University, Pingdingshan 467000, Henan, China.
Corresponding Author: Guan Wang, Email: wangguan0123@163.com

Abstract: With the aging of the population, intelligent nursing homes have become the key to improving the quality of life of the elderly. In this paper, a smart nursing home monitoring system based on the STM32 microcontroller is proposed. The system carries out comprehensive data collection and monitoring through modules such as the DHT11 temperature and humidity sensor, sound sensor, infrared sensor, heart rate and blood oxygen sensor, and MPU6050 gyroscope. The system utilizes Wi-Fi wireless communication technology to upload the health monitoring data to the cloud, and at the same time combines with GSM communication technology to realize the SMS alarm and one-key dialing function of the GSM module. The system not only has efficient and real-time monitoring capability but also provides comprehensive health monitoring and security for smart nursing homes through OLED display, voice announcement, and buzzer alarm.
Keywords: Intelligent nursing home; Single-Chip microcomputer; Wireless communication; Health monitoring

1 INTRODUCTION

With the increasingly serious problem of global population aging, how to improve the quality of life and safety of the elderly has become the focus of social concern. Traditional nursing homes have problems such as rudimentary hardware and software facilities, unqualified supervision, and low service quality, so how to solve the existing issues to create a high-quality nursing home and effectively improve the quality of life of the elderly has become a social problem that needs to be solved in China [1]. Intelligent technology is actively introduced to improve the efficiency of nursing home services and the safety of the elderly. The smart nursing home monitoring system, as a solution integrating environment monitoring, physical signs detection, emergency response, and remote management, can collect real-time health data of the elderly and monitor environmental changes, to realize comprehensive management and rapid response to the health status of the elderly.

This paper proposes an intelligent nursing home monitoring system design based on Wi-Fi and GSM communication technology, aiming to realize efficient linkage and information transfer between system modules through wireless communication technology. The system focuses on monitoring the heart rate, blood oxygen, and body position of the elderly, keeping an eye on their physical health and alerting them to whether they fall. The system is supplemented by environmental detection and intelligent control, monitoring the air temperature and humidity, as well as the sound decibel, to provide a warm and comfortable environment for the elderly to live in, and the combination of the two builds an efficient and safe intelligent monitoring system. By exploring the design and implementation of the system in depth, this paper aims to provide a feasible technical solution for the construction of intelligent nursing homes, promote the thoughtful process of elderly services, and help the sustainable development of the aging society.

2 INTELLIGENT NURSING HOME MONITORING SYSTEM DESIGN

2.1 System Design Objectives

The requirement of this system design is mainly to create an intelligent nursing home with a comfortable environment, health, and safety through the combination of environmental detection and the detection of physical signs of the elderly. The functions to be realized include:

2.1.1 Real-time environment monitoring

The DHT11 temperature and humidity sensor module detects the environmental temperature and humidity, the sound sensor detects the sound decibels, and the infrared sensor monitors the entry and exit of personnel to ensure the comfort and safety of the nursing home environment.

2.1.2 Accurate monitoring of the signs of the elderly

Using heart rate and blood oxygen sensors to monitor the vital signs of the elderly in real-time, and the MPU6050 gyroscope to detect whether the elderly have fallen, to detect and deal with the abnormal problems of the elderly in time.

2.1.3 Abnormal Alarm and Broadcasting

When the old man's physical signs exceed the preset threshold, the voice broadcast module will broadcast the abnormal

physical signs, and the buzzer alarm will remind the guardian to pay attention to the old man's condition in time.

2.1.4 Data display and uploading

The OLED display shows the monitoring data in real-time, which is convenient for on-site checking; meanwhile, the data can be uploaded to the cloud via ESP8266 to realize remote monitoring and data storage.

2.1.5 Emergency communication function

When the old man falls, the GSM communication module automatically sends a message to notify the relevant personnel; when the old man is uncomfortable, he can seek help by pressing the button to broadcast a call to ensure that timely help can be sought in case of emergency.

2.1.6 Stability and safety of the system

To protect the safety of the elderly, the system has a certain fault-tolerant design, such as automatically switching to the standby mode in the event of a communication failure, to ensure that the key functions are not affected. The system needs to ensure that the data uploaded to the cloud has sufficient security to prevent data leakage and protect the privacy of the elderly.

2.2 General Design Ideas

The system aims to realize the all-around monitoring of the intelligent nursing home by integrating multiple sensors and communication modules with the STM32 microcontroller as the core. Specifically, the system utilizes DHT11, sound sensors, and infrared sensors to monitor the environmental conditions; real-time monitoring of the elderly's physical signs and activity status through the heart rate and blood oxygen sensors and the MPU6050 gyroscope; the combination of voice announcements, buzzer alarms, OLED displays, and cloud uploads to ensure that the abnormal information is handled and recorded promptly; and is equipped with a GSM module to achieve rapid emergency It is also equipped with GSM module to realize fast communication response in emergency.

2.3 Overall System Framework

This system is an intelligent nursing home monitoring system based on an STM32 microcontroller, which mainly includes two modules: environmental detection and detection of elderly signs. It consists of an STM32F103C8T6 microcontroller core board, DHT11 temperature and humidity sensor, sound sensor, an infrared detection module, heart rate, and blood oxygen sensor, MPU6050 gyroscope, SU-03T voice announcing circuit, OLED display circuit, WIFI module, GSM communication module, key circuit and power supply.

The environmental detection module in this design integrates a DHT11 temperature and humidity sensor, a sound sensor, and an infrared sensor. The DHT11 sensor is used to monitor the temperature and humidity data in the nursing home in real-time, the sound sensor detects sound decibels in the environment to assess the noise level, and the infrared sensor monitors the entry and exit of the personnel and ensures the safety management of the nursing home.

The Elderly Signs Detection Module has a heart rate oximetry sensor and MPU6050 gyroscope. The heart rate oximetry sensor monitors the vital signs of the elderly in real-time, including heart rate and oxygen saturation, to assess the health of the elderly, while the MPU6050 gyroscope is used to detect changes in the posture of the elderly and determine whether a fall has occurred.

The system also contains a voice announcement module, a buzzer alarm device, an OLED display, an ESP8266 cloud upload module, and a GSM communication module. When the physical data of the elderly exceeds the preset threshold, the voice announcement module will announce the abnormal situation in time, and the buzzer will sound an alarm to alert the staff, the OLED display can show the monitoring data in real-time, which is convenient for on-site viewing, and the ESP8266 module is responsible for uploading the data to the cloud to realize remote monitoring and data analysis. If the old man falls, the GSM communication module will automatically send an emergency message to the preset contact person, and when the old man is not feeling well, he can trigger the broadcast call function by pressing the button to seek help. The general framework diagram of the design is shown in Figures 1 and 2.

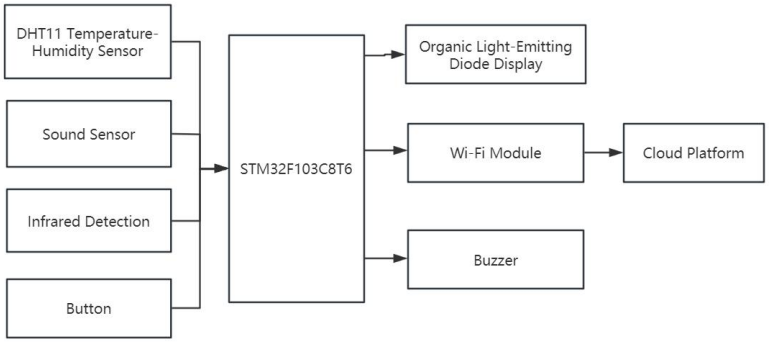

Figure 1 General Framework Diagram for the Design of the Environmental Module

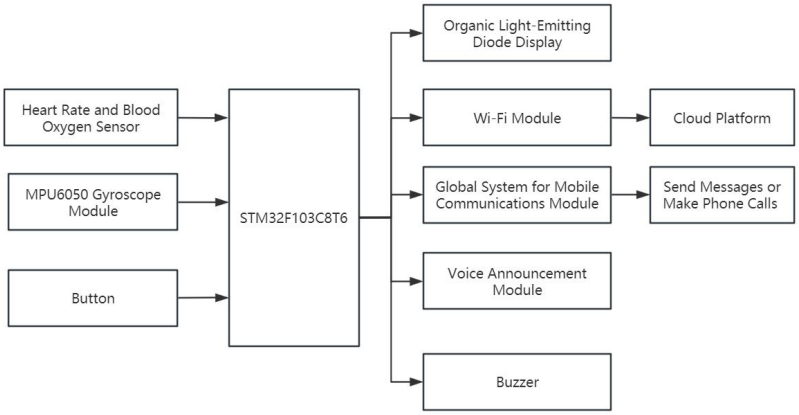

Figure 2 General Frame of the Design of the Physical Signs Detection Module for the Elderly

3 SYSTEM HARDWARE DESIGN

3.1 Master Module

According to the function of the system, the STM32F103C8T6 minimum system board is selected for this design, which is based on the ARM Cortex-M3 core with high performance and low power consumption, and the main frequency of the 32-bit architecture can be up to 72MHz, with highly efficient operation, rich peripheral interfaces (such as multiple communication interfaces and timers, etc.) and reasonable memory configuration (64KB flash memory, 20KB RAM), and programming is more efficient through the SWD interface. Reasonable memory configuration (64KB Flash, 20KB RAM), programming is convenient with the help of official libraries, and debugging is carried out efficiently through the SWD interface; compared with the 51 series of microcontrollers, it has a faster computing speed, richer memory resources, stronger peripheral functions and high programming efficiency, which gives STM32F103C8T6 a significant advantage in complex applications.

3.2 DHT11 Temperature and Humidity Sensor Module

In this system design, the DHT11 sensor module is used to collect the temperature and humidity data in the air and detect the changes in temperature and humidity data in real-time. The DHT11 sensor module is a high-performance temperature and humidity composite sensor, which is built-in a resistive humidity-sensitive element and an NTC (Negative Temperature Coefficient thermistor) temperature measurement element to complete the acquisition and processing of temperature and humidity signals through the internal microcontroller. The DHT11 sensor module is a high-performance temperature and humidity composite sensor with a built-in resistive moisture-sensitive element and an NTC (Negative Temperature Coefficient thermistor) temperature-measuring element, and the temperature and humidity signals are collected and processed through the internal microcontroller [2]. The module can accurately measure the temperature and humidity of the environment in real-time through the dedicated digital module acquisition technology and output the results as calibrated digital signals. It has a wide measurement range, high accuracy, excellent long-term stability, and anti-interference capability. In addition, the DHT11 sensor module uses a single bus digital signal transmission protocol, simplifying the external circuit design and facilitating communication with a variety of microcontrollers, which is ideal for embedded system applications. The circuit diagram and physical diagram of the DHT11 module are shown in Figures 3 and 4 respectively.

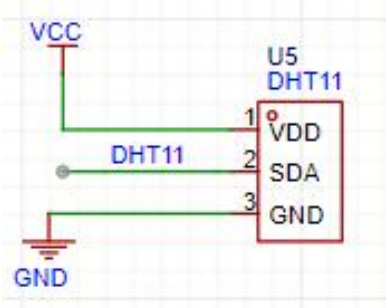

Figure 3 DHT11 Module Circuit Diagram

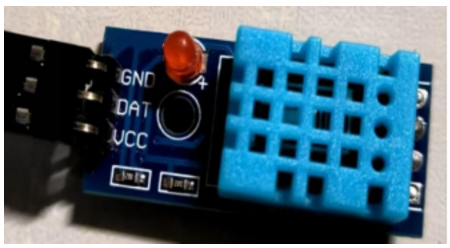

Figure 4 Physical Diagram of DHT11 Module

3.3 KY-037 Sound Sensor Module

In this system design, the KY-037 sound sensor module is used to detect the sound decibels in the environment, if the sound exceeds the threshold value to become noise, the management personnel can check the processing in time. The KY-037 sound sensor module is a high-sensitivity sound detection module with a built-in electret condenser microphone and amplifier circuit, which provides analog and digital dual outputs. The KY-037 module is a highly sensitive sound detection module, capable of capturing small sound changes, and also has the advantages of adjustable sensitivity, low power consumption, and ease of use. The KY-037 module has a high sensitivity and can capture small sound changes, and also has the advantages of adjustable sensitivity, low power consumption, and ease of use. It is very suitable for the environmental monitoring of the intelligent nursing home. The circuit diagram and physical drawing of the KY-037 sound sensor module are shown in Figures 2-3 and 2-4 respectively.

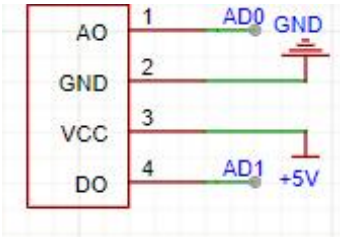

Figure 5 KY-037 Sound Sensor Module Circuit Diagram

Figure 6 KY-037 Sound Sensor Module Physical Diagram

3.4 Infrared Detection Module

In this system design, an infrared detection module is used for in and out-person detection to prevent the elderly from accidentally getting lost when they go out alone. An infrared detection module is an electronic module that uses infrared light-sensing technology to detect changes in objects or the environment. The module consists of an infrared emitting diode (LED) and an infrared receiving diode (photodiode), which detects the presence, distance, or movement of an object by emitting infrared light of a certain wavelength and receiving the reflected infrared signal. The output of the module can be analog or digital signals, easy to interface with microcontrollers (such as microcontrollers), infrared detection module has non-contact detection, fast response speed, detection distance, high detection accuracy, and anti-interference capability. At the same time, the infrared detection module also has a small size, low power consumption, ease of integrate, and other advantages. Infrared detection module circuit diagram, the physical figure shown in Figure 7, 8, respectively.

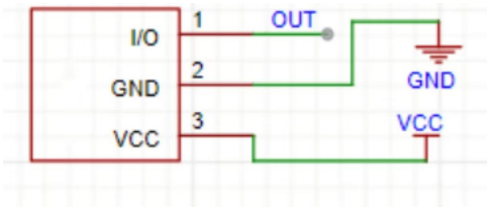

Figure 7 Infrared Detection Module Circuit Diagram

Figure 8 Physical Diagram of Infrared Detection Module

3.5 MAX30102 Heart Rate Oximeter Sensor Module

In this system design, the MAX30102 heart rate and blood oxygen sensor module are used to detect the basic body signs of the elderly. The MAX30102 sensor is a high-performance biosensor module. The MAX30102 is an optically integrated chip that carries red LEDs and infrared LEDs, in addition to being equipped with an optoelectronic detection device and an optimized low-noise AFE. The MAX30102 can regulate the power supply for the built-in LEDs via a 5.0V supply voltage and a 1.8V supply voltage and is mainly used in portable wearable applications, where it can detect the skin on multiple parts of the body, such as the fingertips, wrist joints, and earlobes, through the built-in included blood oxygen and heart rate monitoring solutions. The built-in I2C communication port of the sensor transmits the data received from the sensor to the master MCU, which performs a calculation function to figure out the actual heart rate and blood oxygen values [3]. This optical sensing technology can accurately and non-invasively monitor the physiological parameters of the human body. The circuit diagram and physical diagram of the module are shown in Figures 2-7 and 2-8, respectively.

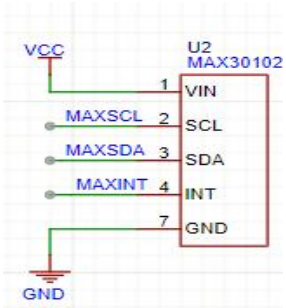

Figure 9 Circuit Diagram of the MAX30102 Heart Rate Oximetry Sensor Module

Figure 10 Physical Diagram of MAX30102 Heart Rate Oximetry Sensor Module

3.6 MPU6050 Gyro Module

In this system design, to monitor whether an elderly person falls or not, the MPU6050 gyroscope module is used. MPU6050 is a three-axis accelerometer sensor that senses the tilt condition of the user's body and calculates the tilt angle of the user's module, which in turn detects whether the user has fallen or not by comparing it to a set threshold [4]. The MPU6050 module is a three-axis gyroscope and a three-axis accelerometer integrated with an Inertial Measurement Unit (IMU) that provides motion and attitude measurements by sensing the angular velocity and acceleration of an object. The gyroscope measures the rotational angular velocity of the object, while the accelerometer measures the acceleration of the object along the three axes (X, Y, and Z). The MPU6050 communicates with an external microcontroller via an I2C interface to convert the acquired sensing data into digital signal output. Its working principle is based on vibration sensing technology and angular velocity detection, which provides accurate attitude estimation and dynamic motion detection by monitoring and calculating the object's motion status in real-time. It can detect the body posture of the elderly in real-time and determine whether the elderly have fallen. The circuit diagram and physical drawing of the MPU6050 gyroscope module are shown in Figures 11 and 12, respectively.

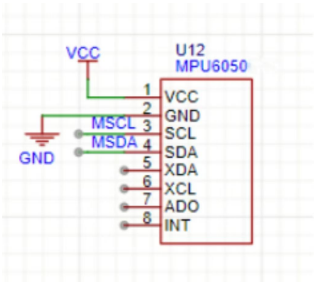

Figure 11 MPU6050 Gyroscope Module Circuit Diagram

Figure 12 Physical Diagram of MPU6050 Gyroscope Module

3.7 OLED Display Module

In this system design, an OLED display module is used to display the data transmitted by each sensor in real-time on the OLED display. The OLED display module is a display module based on Organic Light Emitting Diode (OLED) technology, which has the advantages of high contrast ratio, wide viewing angle, and low power consumption. Unlike traditional liquid crystal displays (LCDs), OLEDs do not rely on a backlight source but are self-illuminated by organic materials excited by an electric current, so each pixel point can be controlled independently, providing sharper colors and deeper blacks. It also excels in terms of response speed, with extremely short response times for pixels, allowing for fast screen switching and effective reduction of ghosting. The module is usually equipped with a controller chip that supports communication with a microcontroller through an I2C or SPI interface. The circuit diagram and physical drawing of the OLED display module are shown in Figures 13 and 14 respectively.

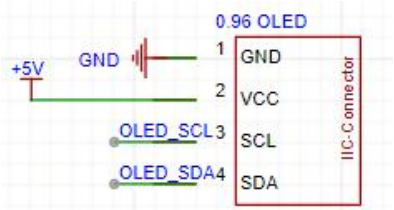

Figure 13 OLED Display Module Circuit Diagram

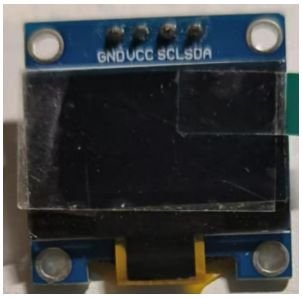

Figure 14 Physical Diagram of OLED Display Module

3.8 SU-03T Voice Announcement Module

In this system design, the SU-03T voice module is used to achieve the effect of voice announcement. When the old man's physical signs are abnormal, the voice module immediately sends out a voice announcement to remind the staff to check the old man's physical condition in time.SU-03T voice module is a kind of integrated voice processing equipment. Its principle is to receive external voice signals through the built-in voice recognition chip, convert them into digital signals, and then use internal algorithms to identify and process the voice content; at the same time, it can also convert pre-stored digital voice information into analog voice signals for playback. It has the characteristics of fast response

speed, high stability, strong security, etc. The circuit diagram and physical diagram of the SU-03T voice module are shown in Figures 15 and 16 respectively.

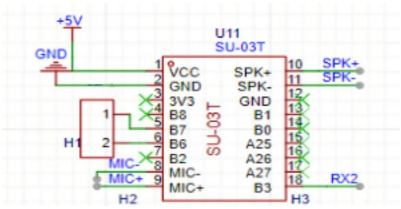

Figure 15 SU-03T Voice Module Circuit Diagram

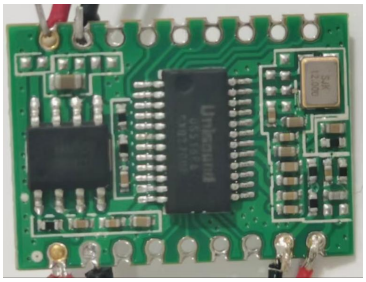

Figure 16 SU-03T Voice Module Physical Drawing

3.9 Buzzer Module

In this system design, a buzzer module is used to play an alarm role. When the environmental data or the signs of the elderly have abnormalities buzzer will sound an alarm to remind the staff to check and solve the problem promptly. This design module uses an active buzzer, The active buzzer module is commonly used in electronic devices in the sound output components, mainly through the built-in oscillator circuit to generate a fixed frequency sound signal. Its working principle is based on the voltage-excited oscillator principle, when power is added to the electrodes of the module, the oscillator inside the module starts to work, thus driving the buzzer to emit sound. Specifically, the module contains an electronic oscillator circuit, a speaker, and a driver circuit, which causes the buzzer to vibrate at a particular frequency through a change in voltage to produce sound. It is characterized by small size, low power consumption, easy integration, and control. The circuit diagram and physical diagram of the buzzer module are shown in Figures 17 and 18, respectively.

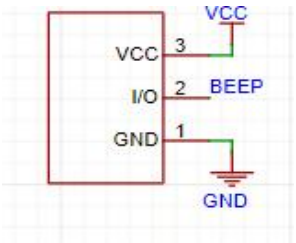

Figure 17 Buzzer Module Circuit Diagram

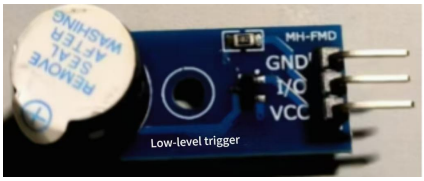

Figure 18 Physical Diagram of the Buzzer Module

3.10 ESP8266 WiFi Module

In this system design, the wireless communication uses the ESP8266 WiFi module, whose function is to connect to the cloud platform to realize the wireless transmission of information data and real-time monitoring. The ESP8266 is a low-cost, high-performance Wi-Fi microcontroller module that is widely used in the wireless communication of IoT devices. It integrates Wi-Fi function and microprocessor, supports multiple communication protocols (e.g., TCP/IP, UDP, etc.), and has strong processing capability to connect directly to the Internet for data transmission.ESP8266 has the advantages of low power consumption, easy to be embedded, easy to be developed, etc. The circuit diagram and physical diagram of the ESP8266 WiFi module are shown in Figures 19 and 20, respectively.

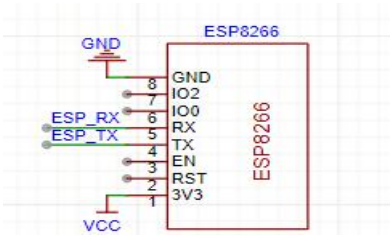

Figure 19 ESP8266 WiFi Module Circuit Diagram

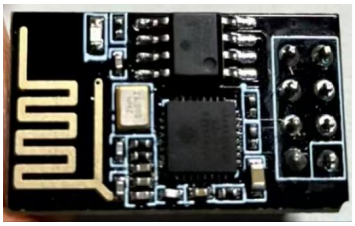

Figure 20 Physical Diagram of the ESP8266 WiFi Module

3.11 GSM Communication Module

In this system design, the wireless communication also uses a GSM communication module. Its function is to send SMS and make phone calls to the staff in time when the elderly fall condition occurs. The communication module is a wireless communication module based on the Global System for Mobile Communications (GSM) standard, which is mainly used to realize data transmission, voice communication, and SMS functions. It realizes the connection with the mobile network by putting the mobile SIM card into the SIM card slot and connecting to the GSM antenna, which can be remotely controlled and monitored, and supports sending and receiving SMS, making voice calls, and serial communication with other devices. The module has an internal integrated GSM modem, RF unit, and protocol stack, and supports serial ports (e.g. UART) for data exchange with external microcontrollers. When the system receives an alarm signal, the wireless communication module is controlled by sending AT commands through the serial port, and the module sends the alarm information to the staff's cell phone after receiving the commands [5]. The circuit diagram and physical diagram of the GSM communication module are shown in Figures 21 and 22, respectively.

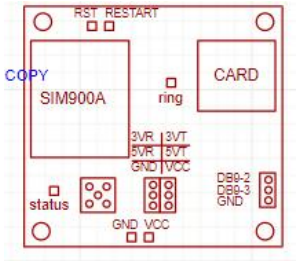

Figure 21 Circuit Diagram of GSM Communication Module

Figure 22 Physical Diagram of GSM Communication Module

4 SYSTEM SOFTWARE DESIGN

According to the system function, the system can be divided into two sub-systems, the main program of sub-system 1 contains two major sub-programs, i.e.: infrared in/out detection sub-system and environment detection sub-system; and the main program of sub-system 2 contains three major sub-programs, i.e.: GSM communication sub-system, elderly sign detection sub-system, and MPU6050 fall detection sub-system.

First of all, in subsystem 1 after connecting the power supply, the whole system is initialized, by the instructions to enter the corresponding sub-system program system overall flow chart, through the infrared sensor to detect whether there is the entry and exit of the person, to remind the guardian to check whether there is an old man out, to ensure the safety of

the elderly, at the same time, temperature and humidity sensors, noise sensors to detect the environmental status of the old people living in the environment, will be collected to display the data on the OLED screen, and through the WiFi module to upload the collected data to the AliCloud platform, real-time view data. The main flow chart is shown in Figure 23.

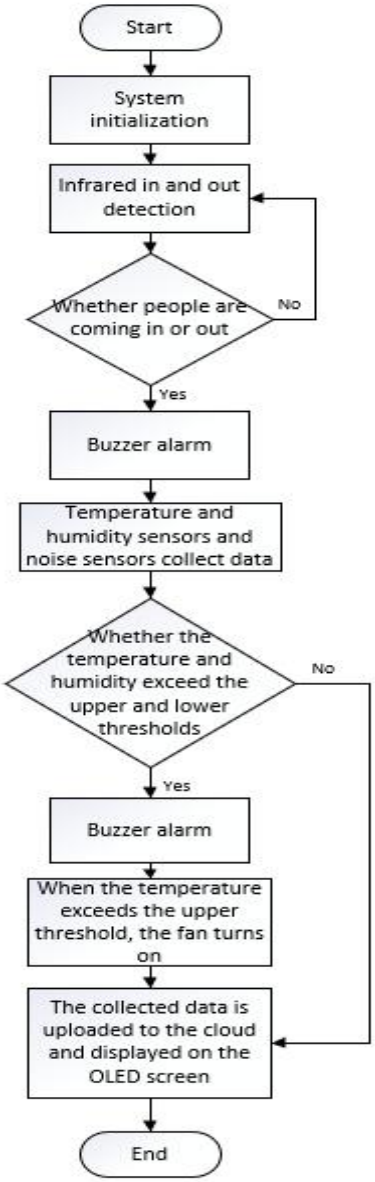

Figure 23 STM32 Main Program 1 Flowchart

4.1 Environmental Detection Subsystem

According to the system function, first, initialize the corresponding functional modules and their pins, collect the temperature and humidity information through the temperature and humidity sensor, and at the same time display the temperature and humidity data on the OLED screen, and determine whether the temperature and humidity value is within the normal range. If the temperature and humidity value exceeds the set upper and lower thresholds, the buzzer alarms, and when the temperature value exceeds the set upper-temperature threshold, the drive fan is turned on to achieve the role of temperature regulation. The flowchart of the environment detection subsystem is shown in Figure 24.

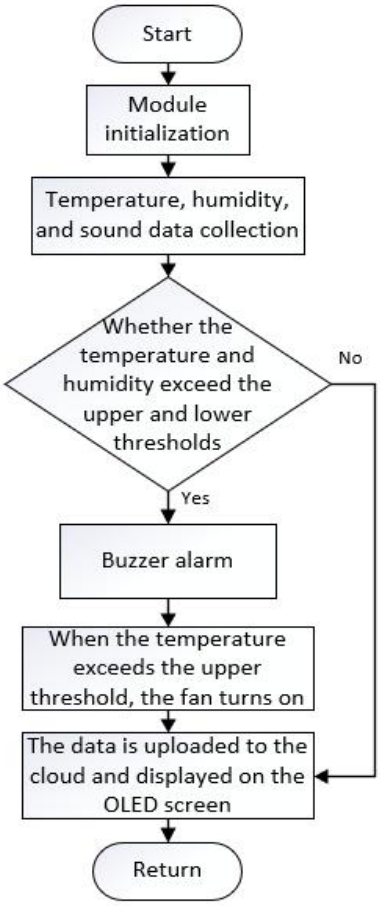

Figure 24 Environmental Detection Subsystem Program Flowchart

4.2 Infrared Access Detection Subsystem

According to the system function, after the system is powered on, the corresponding functional modules and their pins are initialized, and then infrared transmission and reception are to detect whether someone passes through, if someone passes through, the buzzer alarm, the state of in and out on the cloud platform is reversed, and if no one passes through then return to the detection of infrared in and out of the detection sub-system flowchart, as shown in Figure 25.

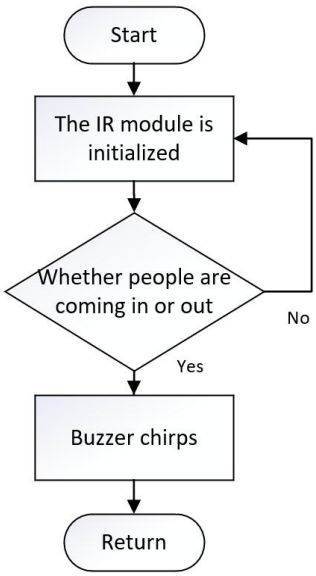

Figure 25 Infrared in/out Detection Subsystem Program Flow Chart

Secondly, after connecting the power supply to subsystem 2, the whole system is initialized and enters the corresponding subsystem program in order according to the instructions. The overall flowchart of the system is to

measure the signs of the elderly through the MAX30102 heart rate oximetry sensor, and if the signs of the elderly are not within the normal range, then drive the voice module to broadcast the message of “Abnormal Signs of the Elderly” and the collected signs will be uploaded to the cloud platform. The collected values will be uploaded to the cloud platform; then the MPU6050 sensor detects the posture of the old man to determine whether the old man falls, if the old man falls, then the GSM communication module to send a message to the cell phone “Old man falls”, if the old man does not feel comfortable, he can dial a phone number through the key module. If the old man feels uncomfortable, he can make a call through the key module. The main flow chart is shown in Figure 26.

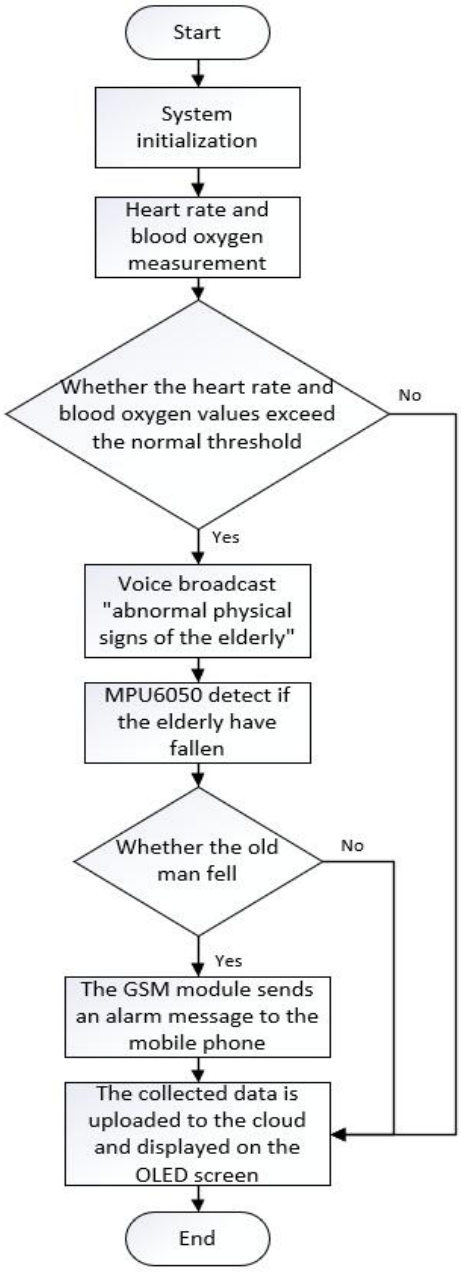

Figure 26 STM32 Main Program 2 Flowchart

4.3 GSM Communication Subsystem

According to the functional requirements of the system, insert the SIM card, after the system is powered on, the system is initialized, and the corresponding functional modules and pins are initialized, and then press the key 1 to receive the signal through the built-in antenna of the GSM module [6], and then demodulate the received signal to convert the analog signal into a digital signal, and the demodulated digital signal will be further processed and decoded to extract the voice, SMS and other information, the GSM module can send the processed data to other devices or servers, send the voice data to the cell phone user, and finally convert the processed digital signal to radio wave through the built-in radio transmitter to realize the functions of telephone call, sending SMS, etc. The program flow chart of the GSM communication subsystem is shown in Figure 27.

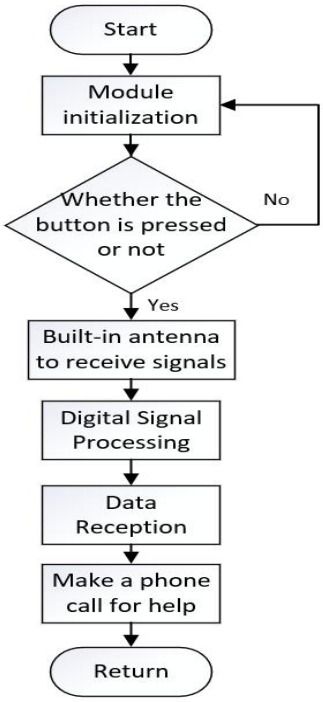

Figure 27 GSM Communication Subsystem Program Flowchart

4.4 Elderly Signs Detection Subsystem

According to the functional requirements of the system, the corresponding modules and pins are initialized first, and then MAX30102 heart rate and the blood oxygen sensor are used to collect the signs data of the elderly, and the heart rate and blood oxygen data are displayed on the OLED screen at the same time, and then the collected data are uploaded to the AliCloud platform through the WiFi module, so that the data can be viewed in real-time, and it can determine whether the signs value is within the normal range. If the value is out of the normal range, it will drive the voice module to broadcast “The old man's physical signs are abnormal”. The program flowchart of the elderly sign detection subsystem is shown in Figure 28.

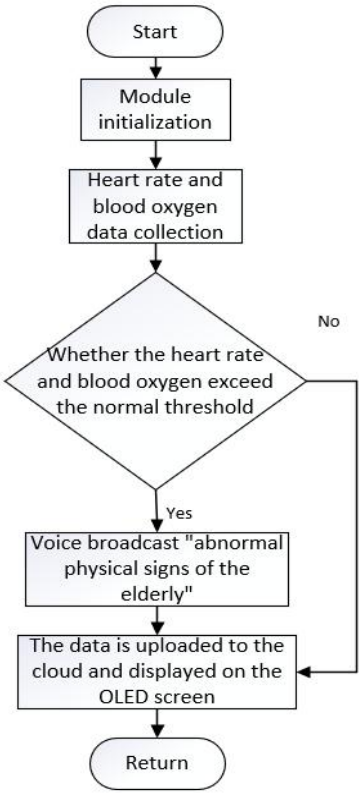

Figure 28 Flowchart of the Program of the Subsystem for Detecting Signs of the Elderly

4.5 MPU6050 Fall Detection Subsystem

According to the functional requirements of the system, the corresponding modules and pins are initialized first, and then the three-axis accelerometer can detect the acceleration in three directions at the same time, and the gyroscope [7] detects the rotational motion of the object, which can help to determine the attitude and direction of the object, and through the built-in Kalman filtering algorithm to process the data from the gyroscope and the accelerometer to determine whether the old man has fallen down or not, and if the old man falls, the GSM communication module will be driven to send the message "Old man falls" to the mobile phone. If the old man falls, it drives the GSM communication module to send the message "Old man falls" to the cell phone. The program flow chart of the MPU6050 fall detection subsystem is shown in Figure 29.

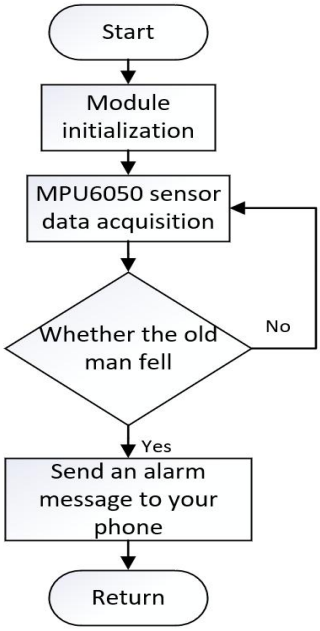

Figure 29 MPU6050 Fall Detection Subsystem Program Flowchart

5 CONCLUDING REMARKS

This paper designs a smart nursing home system based on the purpose of research and application, focusing on alleviating the existing problems such as the increasing trend of population aging, the mismatch between supply and demand of traditional institutionalized elderly care, and inefficient resource allocation [8], etc. This design innovates the use of low-cost materials to create a safe and comfortable smart elderly care environment and greatly reduces the waste of resources and duplication of inputs. However, this design still has some limitations, and there is still a certain gap with the practicality, but still hope that this design provides some ideas for the application of smart aging, and helps the senior care service industry to high-quality development. Meanwhile, the next research direction of this paper will focus on further optimizing the degree of intelligence of the system, monitoring the elderly's physical characteristics data more finely, improving the user experience to a greater extent, and exploring a more efficient and sustainable resource utilization model.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

[1] LIU Xiaoxu, Lv Zhihua, HE Runhua. Intelligent system design of nursing home based on narrowband internet of things. Modern Information Technology, 2024, 8(02): 154-157.
[2] LIANG Taohua, ZHOU Jiang, XIAO Guannan. Design and realization of temperature and humidity meter based on DHT11. Electronic Fabrication, 2024, 32(15): 88-90.
[3] Zhao JC. Research on health detection system based on multifunctional sensors. Qingdao University, 2022.
[4] ZHU Min, XIN Yiyang, ZHAO Yangguang, et al. Fall alarm system for the elderly based on STM32 microcontroller control. University Physics Experiment, 2023, 36(05): 72-76.

[5] LI Ningning, WU Xingyu, LI Youxue, et al. Design and realization of human body alarm based on wireless communication. Technology and Innovation, 2024(23): 46-48.
[6] SHI Yongkang, LIU Tao, LIU Chen. Design of home burglar alarm system based on GSM SMS. Wireless Interconnection Technology, 2024, 21(18): 73-75.
[7] Du Peng. A low-power attitude and depth measurement device based on six-axis sensor MPU6050. Naval Electronics Engineering, 2022, 42(06): 168-170.
[8] Tian ZP. Research on Technology Application Enabling M Nursing Home Smart Elderly Service. Shanxi University of Finance and Economics, 2024.