Research Paper

Dissertation Intelligent Care System for Young Children

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ABSTRACT: With the rapid development of science and technology and the continuous improvement of people's living standards, the infant care system is also constantly upgrading. We have designed an advanced nursing system with STM32 as the core to better monitor the situation of children. Through the combination of cloud platform and mobile APP, the system uses a variety of sensors to monitor environmental information, infant posture, temperature and humidity, blood oxygen, heart rate and other key data in real time. This highly intelligent monitoring means not only improves the ability to grasp children in real time, but also provides all-round protection for children's safety and health.Data acquisition and transmission is also an important part of the system. Through the WIFI module, the monitored data is uploaded to the server and transmitted to the OneNET cloud platform in real time. On this cloud platform, users can view children's health indicators and the surrounding environment in real time through mobile APP or web pages anytime, anywhere. More importantly, the system also has the real-time alarm function of abnormal data to remind users of possible dangerous situations in time, so that the nursing work is more efficient and considerate.The cloud storage function of this system provides great convenience for parents and caregivers of young children. They can conveniently monitor their children's conditions remotely, avoiding time and space constraints, and at the same time saving a lot of costs and human resources. The upgrading of this care system not only improves the monitoring efficiency, but more importantly, it provides a smarter, more convenient and more reliable solution for families and the society to take care of their young children.

KEYWORDS: STM32; Internet of Things; Detection system; OneNET Cloud Platform

I.   INTRODUCTION

Currently, the global market for caregiver systems is large and in high demand. Due to the improvement of social living standards and technological progress, the market size of China's wearable monitor industry reached 5.15 billion yuan in 2017, and its size will continue to expand until 2019. As the market continues to grow, consumer demand for product quality is also increasing. Its system is gradually improved, integrated and multifunctional. With the continuous development of technology, new monitoring systems will soon appear.

In the initial stage, before 2010, the care system was mainly based on cable TV with the proposed physiological signal transmission circuits and thus integrated into a remote care system. Relying on the microprocessor as the hardware platform and software to detect signals and connect to the video acquisition equipment, local acquisition and local processing were realized. The processing capacity is weak, the processing efficiency is low, and the processing range is small. after 2010, the care system benefits from the development of the Internet of Things (IoT), and the combination of the IoT has realized a great leap[1]It can be oriented to the data collected by remote equipment to meet the demand of multi-user massive signal processing. Can be oriented to the data collected by remote devices, to meet the needs of multi-user massive signal processing, can be achieved by remote collection, cloud processing, with stronger processing capacity and higher efficiency, with low latency, high speed, large throughput advantages, and for the subsequent study of the more universal

and generalized expansion provides a possibility[2]。   So far, the nursing system has become more integrated, combining embedded, Android, sensor, Internet, Web server and other technologies to achieve the remote

security and nursing system of the Internet. The wearable monitor can detect and process in real time without affecting the life of the nursing object.

With the progress of science and technology and the improvement of people's living standards, the traditional way of kindergarten care has been unable to meet people's needs. This kind of nursing mode based on manual patrol can not monitor the situation of children in real time, and it is difficult to find abnormal situations in time. It also depends on the initiative of the caregivers, which is inefficient. Therefore, people's need for more meticulous and accurate care of children is increasingly urgent. In order to improve the shortcomings of traditional nursing methods, this paper proposes an intelligent kindergarten sleep nursing system to reduce the burden of nursing staff, reduce nursing risks and improve nursing efficiency. The system uses STM32 single chip microcomputer as the core to monitor children's sleep, crying, humidity, temperature, heart rate, breathing, etc. in real time through cameras and sensors, and provides the kindergarten UI control interface to achieve data transmission and monitoring[3]This allows caregivers to detect anomalies in a timely manner. This allows caregivers to detect abnormalities in a timely manner and understand changes in the user's cycle by comparing and analyzing the data collected. Parents or caregivers can also conveniently conduct real-time monitoring, thus reducing the pressure on caregivers, lowering the risk of caregiving, and making up for the shortcomings of traditional caregiving methods. This study provides a good foundation for the development of intelligent caregiving systems and has implications for the design of other caregiving systems.

This paper mainly develops an intelligent sleep care system that can monitor children's physical condition, body temperature, heart rate, etc., and the surrounding environment in real time, and can timely alarm when abnormal conditions occur. The intelligent sleep care system for children designed in this paper mainly uses the STM32 single chip microcomputer with powerful functions, superior performance, rich resources on the chip and low power consumption as the main control chip, combined with the mature Internet of Things and sensor technology and other related knowledge, so that various functions of the care system can be fully realized. The main modules of this design include the main control chip STM32 MCU, data acquisition module, power module, WIFI wireless communication module, upper computer, etc. The main function is to display the physical characteristics of children's body temperature, heart rate, etc. in real time on the screen, and alarm for abnormal conditions; The web side and APP display information synchronously, and can view the situation of a week in history.

II. OVERALL DESIGN

The system is mainly composed of three functional modules: control module, cloud platform and user terminal. The control module takes STM32 as the main control chip and is equipped with a variety of detection sensors. These sensors include heart rate, temperature and humidity, posture, light, smoke, etc., which are used to collect the physiological characteristics of children and the surrounding environment and other information. The collected data is then transmitted to STM32 for processing, and at the same time, the OLED display module is driven to display the processing results. If there is an abnormal situation, the buzzer will automatically send an abnormal alarm to realize the real-time warning function. Then, a LAN is established under the same WIFI, and the router and the serial port of the wireless communication WIFI module ESP8266 are used for communication configuration, and the collected data is transmitted to the OneNET cloud platform[4]。

The cloud platform module is based on OneNET as the data forwarding and storage center, which can realize the storage of historical data and compare the data of children in a cycle. At the same time, when users visit OneNET cloud platform on mobile phones or computer clients, they can view the monitoring data displayed in real time on web pages and mobile apps.

III. HARDWARE DESIGN

The system hardware is mainly divided into four core modules, including the main control module, information acquisition module, OLED display module and WIFI communication module. Refer to Figure 2 for detailed hardware structure diagram. By using a variety of sensors, the system can collect the temperature, humidity, CO_2 concentration of the surrounding environment, as well as the temperature, heart rate, posture and other information of children in real time. When the collected data exceeds the preset threshold, the buzzer will give an alarm prompt and upload the data to the OneNET cloud platform through the ESP8266 Wi Fi module.

3.1 Master Control Module

The main control chip is the core component of the entire hardware structure. Its main task is to obtain the data information collected by each functional module, analyze it, and then transmit the data to the display screen. This is also the key to determine whether the system functions can be realized finally. Therefore, the selection of the main control chip is very important. According to the above description, the system needs to have good real-time performance and a certain number of communication interfaces, such as SPI, UART, etc.,

taking cost and various factors into consideration. It needs small size, low power consumption and low cost. So the system is built with STM32F103ZET6 single chip microcomputer.

The following is the schematic diagram of the STM32F103VCT6TR minimum system, which is used to enhance and improve the functions of the intelligent sleep care system for children. In addition to the common peripheral modules of the microprocessor, the design also adds the heart rate acquisition module, motion state detection module and WIFI wireless communication module to monitor the heart rate, motion state and realize the wireless transmission of information data with the cloud platform[5]。 The minimum system mainly includes the following contents: (1) power circuit; (2) Clock source circuit; (3) Reset circuit; (4) BOOT0 start circuit; (5) Debug the interface circuit.
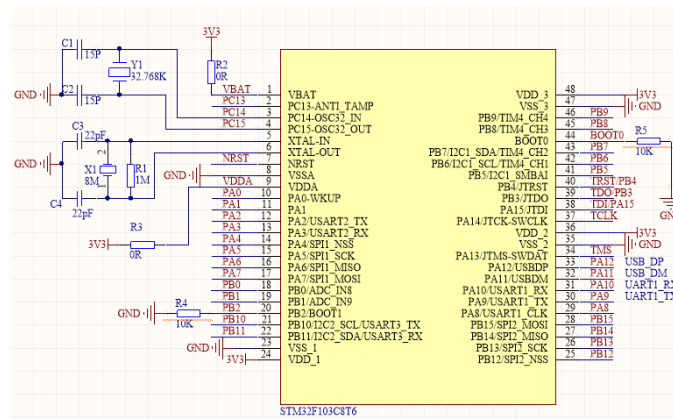

Figure 1: Minimum circuit diagram

3.2 Temperature sensors

DS18B20 single wire digital temperature sensor has small size, low cost, strong anti-interference ability, power failure protection function and wide measurement range. The temperature measurement principle is mainly based on the oscillation frequency change of the internal low temperature coefficient crystal oscillator and the high temperature coefficient crystal oscillator. The oscillation frequency of crystal oscillator with low temperature coefficient is less affected by temperature change, so it can stably generate pulse signal with fixed frequency; The oscillation frequency of crystal oscillator with high temperature coefficient fluctuates significantly with temperature. By combining these two crystal oscillators with the counter, we can accurately measure the temperature value, which is in line with this demand. Due to its many features and low price, DS18B20 is selected as the temperature acquisition module in this design.
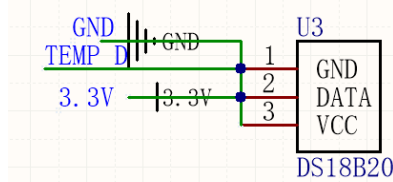

Figure 2: Schematic diagram of DS18B20

3.3 Ambient temperature and humidity sensors

DHT11 digital temperature and humidity sensor is selected as the environmental temperature and humidity sensor of the system, which has the characteristics of high reliability, excellent long-term stability, ultra small size and low power consumption. At the same time, he also has excellent ability in connection with other devices and data transmission. Because of the above characteristics and low price, this paper selects it as the environmental temperature and humidity sensor.

3.4 Heart rate sensors

MAX30102 sensor is selected as the sensor to detect the heart rate of children. The sensor is an integrated module of pulse oximeter and heart rate monitor biosensor, but only the heart rate acquisition function is used in this design. The MAX30102 uses a 1.8V power supply and an independent 5.0V power

supply for the internal LED, which are used in wearable devices for heart rate detection. MAX30102 measures tissue absorption of infrared light by emitting infrared light, and then calculates physiological parameters such as heart rate through built-in signal processing and algorithm processing[6]。
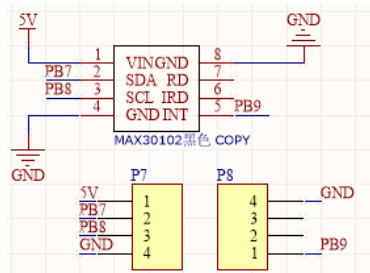
Figure 3: Schematic Diagram of MAX30102

3.5 Motion sensors

The MPU6050 is selected as the motion sensor. The MPU6050 is a 6-axis attitude sensor, which can measure the acceleration and angle parameters of the X, Y and Z axes of the chip itself. Through data fusion, the attitude angle can be obtained. The accelerometer has static stability, but not dynamic stability. Gyroscope means that the direction of the rotation axis of a rotating object will not be changed when it is not affected by external forces. Because the accelerometer has static stability and the gyroscope has dynamic stability, the characteristics of these two sensors are just complementary. Therefore, a stable attitude angle can be obtained through complementary filtering.
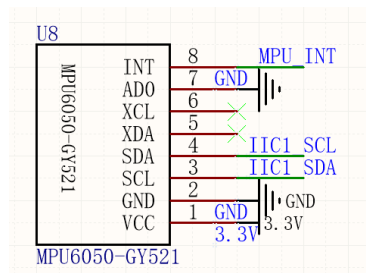
Figure 4: Schematic Diagram of MPU6050

3.6 WIFI serial communication module

The ESP-01s in the ESP8266 series is used as the WiFi communication module of the system. ESP-01S is the smallest module in the ESP8266 series with relatively simplified functions. It is usually used in application scenarios with high requirements for space and cost. ESP-01S currently has three esp01s, one esp01 and three NRF24L01 modules. Through this module, the data captured by each sensor can be uploaded to the ONENET cloud platform to monitor and warn children's health. The ESP8266 WiFi module is an embedded wireless network control module with high cost performance and low power consumption. It supports concise and efficient AT instructions, is relatively small and has stable performance [7]. The module provides AP mode (wireless terminal access point mode), STA mode (wireless terminal mode) and mixed mode (the combination of the above two modes). In this system, the wireless terminal mode is used to connect to the factory's WiFi and establish a connection with the cloud platform to achieve data transmission and reception. ESP-01 requires a relatively clean 3.3V voltage, so it can be considered to use some voltage stabilizing ICs such as LD1117 AMS1117 to cooperate with filtering to build the power supply.

3.7 Power supply circuit design

Due to the characteristics of this system, it is impossible to connect the equipment for power supply at any time, and it must be powered independently. Therefore, during the whole hardware design process, the battery module needs to be used to power it. Considering that the voltage range supported by the whole hardware system does not exceed 3.6V, lithium battery is selected as the power supply. For 5V battery power supply, we selected ASM1117-3.3 model forward low voltage drop regulator to reduce 5V to 3.3V. It is internally integrated with a reference voltage source to provide a stable reference voltage. Through the feedback control circuit, the output voltage can be compared with the reference voltage of 3.3V, and the output voltage can be adjusted to stabilize at the specified value, namely 3.3V. To sum up, ASM1117-3.3 realizes stable

control of output voltage through reference voltage source, feedback control circuit, power transistor, differential amplifier and other components, so as to provide stable 3.3V voltage output for electronic equipment.

IV. SOFTWARE DESIGN

According to the overall structure diagram of the system, the software of the infant intelligent care system includes the main program of the system, the data acquisition module program, the communication program between the WIFI module and the OneNET cloud platform, and the user end mobile phone APP program.

4.1 Software development environment

The system uses Keil uVision5 as the main development platform. After the system is powered on, the STM32 development board and various functional modules are initialized first. At the same time, configure the transmission of ESP8266 to ensure the normal start of communication services. Then, the system starts to read the temperature and humidity, smoke, attitude and other values collected by each sensor module, and conduct necessary processing on these data. After processing, upload the data to the preset cloud platform through the ESP8266WiFi module. At the same time, users can access the cloud platform through the mobile terminal and view the changes of monitoring data in real time on the APP.

4.2 The overall flow of the system

After the system is powered on, first initialize the STM32 development board and various functional modules, configure the transmission of ESP-01S, and start the communication service. Then read the temperature, heart rate, posture and other values, and upload them to the ONENET cloud platform through the ESP-01S WiFi module after processing. At the same time, the user's mobile phone can access the cloud platform to display the monitoring data in real time on the APP or web page.

4.3 The main system program

The system software design is mainly divided into four parts: sensor acquisition module program, display module program, OneNET cloud platform configuration and user APP. Initialize each module, initialize the serial port 1 function, and set the baud rate to 9600; Then initialize the serial port 2 function and set the baud rate to 115200.

4.4 Data acquisition module program

The program design of the sensor acquisition module is mainly divided into two core parts, one is the sensor part responsible for collecting the environment and human body data, and the other is to realize the communication with the main control chip and the WiFi module esp8266. Through the use of built-in sensors and related technologies, the user's biological parameters and motion data can be collected in real time. Then, through data processing and algorithms, the original data is transformed into useful health information, providing users with functions such as health management and motion monitoring. In the aspect of data acquisition, the temperature and humidity data are mainly read by the MCU simulating the single bus protocol, and the concentration values such as CO are read by the ADC inside the MCU.

4.5 Communication program between ESP8266 and OneNET cloud platform

ESP8266 can communicate with OneNET cloud platform through HTTP protocol or MQTT protocol. Based on the needs of this design, MQTT protocol is required to communicate with the cloud platform.

First, configure an MQTT client on the ESP8266, and use the device ID and API Key to connect to the OneNET MQTT server. Next, write code on ESP8266, and use MQTT protocol to publish data to OneNET platform or subscribe to OneNET platform data. The code needs to include ESP8266WiFi library (for connecting to Wi Fi network) and PubSubClient library (for sending data through MQTT protocol). When sending data using the MQTT protocol, you need to connect to the MQTT server provided by OneNET, and use the device ID and API Key for authentication. Then, publish the data to the specified topic. MQTT client configuration, including the server connected to OneNET and the publish or subscribe operation of subscription topic or publish topic data.

After careful comparison, this design scheme decided to implement data communication between WiFi module and OneNET cloud platform based on MQTT protocol. MQTT protocol is an Internet of Things communication protocol based on publish/subscribe mode. It is simple to implement, supports quality of service (QoS), simplifies messages, and is based on TCP/IP. It can also view and obtain human health monitoring data in real time. After completing the WiFi connection configuration, that is, setting the parameters for connecting to the WiFi network on the WiFi module, including SSID and password, we further integrate the MQTT client

to achieve data publishing and subscription. Then, send the AT command to set the working mode to realize the connection with the OneNET cloud platform.

4.6 APP

Android Studio platform is used for mobile APP development. Android is an open source software operating system based on Linux kernel, which can display layout independently, has data storage management function, supports multi task processing and wireless sharing function. And Android is widely used in smart phones, wearable smart devices and other types of smart devices, and is a very popular mobile operating system. The mobile APP of this system is a data terminal, which can display the detected content in real time on the APP, and can satisfy parents or caregivers to view various data remotely.

V.   EXPERIMENRAL VALIDATION

5.1 Hardware component debugging

First of all, we need to test each module independently to ensure that there are no physical problems, so as to avoid short circuits, broken circuits and so on in the subsequent assembly process. After completing the testing of each individual module, they will be assembled and connected to the power supply to check whether the system can start normally. If everything is normal, then you can proceed to the next step of hardware and software debugging.

Figure 5: Some of the components

After the program is compiled correctly, use the ST Link download cable to write the program into the bracelet hardware. Once the program is burned, connect the 3.7V lithium battery to power the bracelet. After the power is turned on, you will be able to see the display of body status, heart rate, temperature and other information on the OLED display.
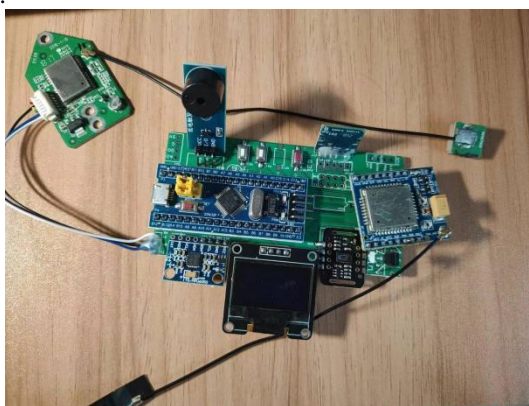
Figure 6: Physical map

Due to the large number of modules, only the heart rate and movement status in the data acquisition module are tested this time. According to the figure, after the equipment is powered on, the heart rate sensor is close to the wrist to collect complete heart rate data information. Once the data collection is completed, the OLED screen will display the heart rate data. If it is not displayed, it may not be in the detection range because the distance between the wrist and the sensor is too far. Or the hardware failure is caused by poor welding.

5.2 OneNET Cloud Platform Debugging

Use the simulator or actual equipment. This time, use the actual equipment to ensure that the equipment can correctly connect to the OneNET cloud platform, test the equipment to send data to the cloud platform, and ensure that the data transmission is successful and can be displayed in the cloud.

5.3 Physical commissioning

Using the ESP8266 WiFi module, we will upload the real-time monitored human health data to the OneNET cloud platform. Users can view the current data conditions in real time through the web page or mobile terminal. If a certain data is abnormal compared with the safe value, the system will provide a corresponding prompt. At the same time, the user can also click the "Historical Monitoring Data" button to view the monitoring information of the last week, which is helpful to discover the abnormal situation of children in time. The joint test can be carried out only after the power on hardware of the bracelet is tested correctly. After downloading the corresponding APP in the mobile phone, you need to open the mobile phone WIFI, enter the APP interface, click Scan, and then you can directly enter the main interface of the application. On the main interface, you will see the information corresponding to the data displayed on the display screen, including body temperature, heart rate and body state.

When the switch is turned on, the function modules are initialized, and the words "initializing" appear on the display screen. During the networking process, the WIFI module signal light will flash.

After initialization, OLED displays the heart rate and temperature. Since the measurement has not started yet, the display temperature is the ambient temperature and the heart rate is 0.
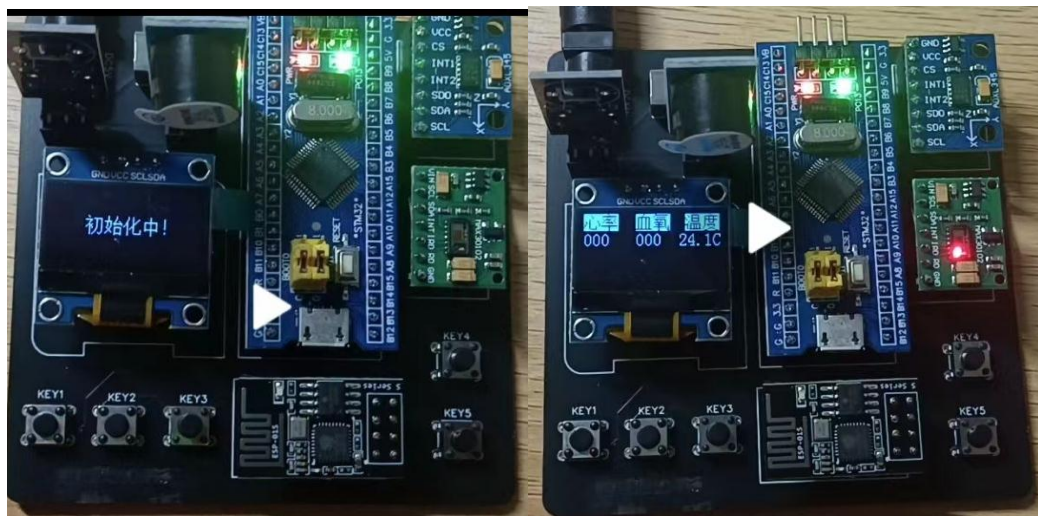

Figure 7: Initialization and completion of initialization

Put your wrist near the data acquisition module, the display shows the current results, you can see that all the normal display, but due to the high temperature of the device chirps, the cloud platform also shows the prompts for children abnormal. Then pick up the device to simulate the movement of children, you can see the display prompts children to move words. Put the device down again, and after a period of time, it prompts the word "asleep". Due to the individual differences, each child can not be generalized, but also added a button to adjust the heart rate, blood oxygen and body temperature alarm threshold.

Figure 8: Toddler Move and Toddler Has Fallen Asleep and Changed Thresholds

VI.　SUMMARY

The kindergarten intelligent sleep care system uses a variety of sensors to monitor children themselves and the surrounding environment in an all-round way. The system takes STM32 microprocessor as the core to process and analyze the data collected by the sensor efficiently. Then, through the WiFi module, the system can

upload the real-time monitoring data to the OneNET cloud platform to realize the centralized storage and management of data. The cloud platform module stores historical data, and can view the health status and activity information of children. The terminal system can view the monitoring data in real time and alarm for abnormal conditions.

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