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Research and Design of the Intelligent System of Care for the Elderly Based on the Internet of Things

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ABSTRACT

The design of the system for the care of the elderly is based on the technology of the Internet of things for the elderly with a specially designed powerful intelligent monitoring system, and a highly flexible, multi-protocol SOC nrf51822 as the processing unit, combined with peripheral equipment, including a gyroscope, acceleration meter, temperature, heart rate sensor, etc., The system gathers and analyzes the statistics of the sensor data, measuring the elderly person's body temperature, heart rate, amount of exercise, posture and other monitoring data. In case of an emergency, is can automatically call for help. The system has the advantages of convenience and ease of use, and provides a portable mobile monitoring station for the elderly.

Keywords: NRF51822, Automatically call for help, Posture.

1. SYSTEM OVERALL DESIGN

With the development of networking technology, wearable devices are gradually introduced into the medical field, and can provide a safeguard for people's physical and mental health. As contemporary college students should stand in the forefront of development, and grasp the most advanced knowledge of modern science and technology, for the benefit of society. The population of China has seen the emergence of the phenomenon of aging, with the number of elderly people in China reaching more than 200 million people by the end of 2015, according to statistics. Some of the elderly, because of their children going out to work， are left unattended or in understaffed nursing homes. It sometimes occurs that elderly people fall or die due to disease while no one discovers the cause of death. This technology based on the Internet of things for the care of the elderly care, can help to avoid a tragedy caused by no one finding an elderly person in time.

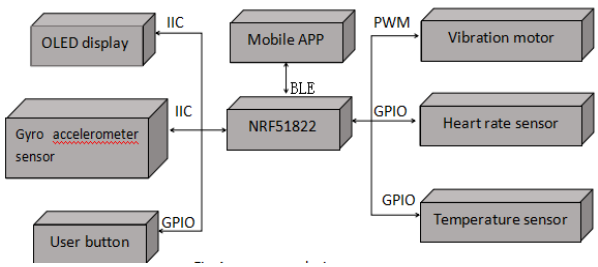

Figure1. System design

The system design, as shown in Figure 1, includes the main control NRF51822 which is responsible for the collection and transfer of data and user interaction. The mobile terminal APP uses low power Bluetooth and NRF51822 communication, and is responsible for sending text messages and emergency dialing functions. The OLED is responsible for the display of time, call reminders, SMS alerts and heart rate and body temperature values and other functions, combined with a vibration motor to remind the elderly users in a timely manner. The heart rate sensor and temperature sensor are respectively responsible for collecting the data of heart rate and body temperature of the elderly in a non-contact type. The gyro and acceleration sensors are responsible for real-time monitoring of the user's action status, which in the case of sudden fall can automatically notify the monitoring center or their families.

2. UNIT MODULE DESIGN

2.1 Attitude detection unit design

The design for attitude detection of the elderly person integrates the 3 axis MEMS gyroscope, 3-axis MEMS accelerometer and a can be telescopic digital motion processor DMP available in a IIC interface connected to a third-party digital sensor. Nrf51822 is the core of the control MPU6050 system and can directly control this working state and data acquisition. The data is collected by the MPU6050 processor and then goes through the BLE to send to the phone. The circuit structure for communication of the NRF51822 and MPU6050 through the IIC bus interface is

shown in Figure 2.

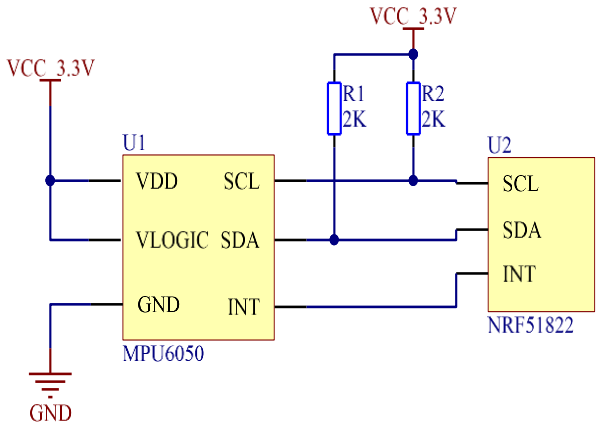

Figure 2. Hardware connection of MPU6050 and NRF51822

The MPU-6050 module from the point of view of data processing, uses many algorithms, such as the most common integral processing, Calman filter processing, comes with DMP processing. The design of the full use of the NRF51822 timer, uses integral processing. Within the range of the error requirement, the sum of discrete data can sometimes replace the integral data, and the design is based on this idea.

2.2 Heart rate detection unit design

The design of the heart rate sensor using SON1303, to achieve the human heart and the heartbeat information extraction, as shown in Figure 3. The luminous 570nm wavelength green light has a higher rate of reflection compared to infrared light, thus providing a higher degree of measurement, and improves the S / N ratio characteristics. The reflection type photoelectric sensor has more freedom. Its application scope includes wearable electronic products and is new test method of pulse measurement, with an internal integrated high-tech nano coating light detection sensors. Its filters do not require a light source, reducing the rate of error caused by interference cause by any other source of light, and thus achieving high accuracy. After four operational amplifiers SON3130 and processing by square wave, it only needs to read the high and low level MCU in order to measure a heartbeat.

Because the signal is small, the SON1303 output analog needs an operational amplifier to enlarge it, The design of the SON3130 to amplifies the output signal level, and thus saving a large amount of calculation for signal acquisition and analysis.

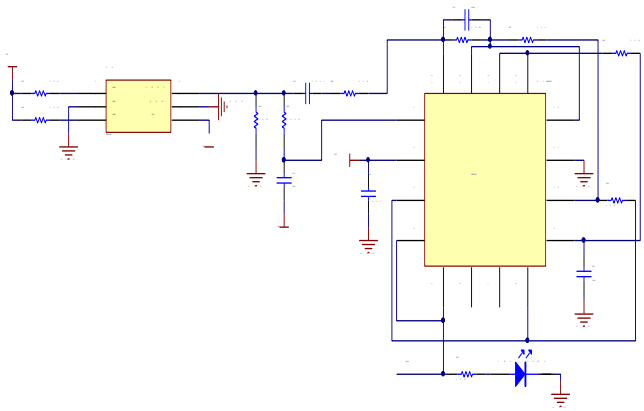

Figure 3. Circuit diagram of heart rate acquisition unit

2.3 Body temperature detection unit design

The SHT20 temperature sensor is the new generation of Sensirion temperature and humidity sensors and have been built according to the new smart standard, as shown in Figure 4. It is embedded in the flat no pin DFN package double bottom 3x3mm, with a height 1.1mm. Calibration of the sensor output signal standard is IIC format. The SHT20 is equipped with a new CMOSens chip design, an improved capacitive humidity sensing element and a standard energy gap temperature sensing element. Its performance has been greatly improved in measuring temperature accuracy over the last generation of sensor reliability (SHT1x). For example, a new generation of humidity sensor has been improved in order to make it more stable in a high humidity environment. It has very few peripheral circuits, and this convenient wiring reduces the volume. The hardware design is shown in Figure 4.

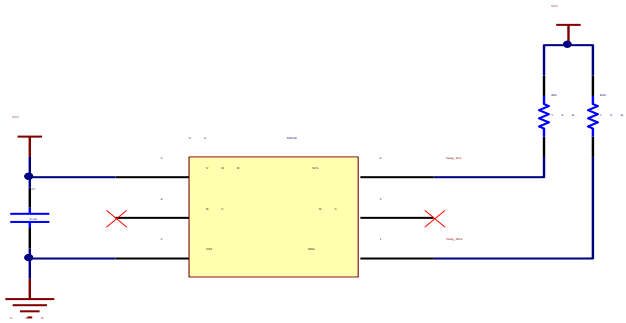

Figure 4. Design of the temperature measurement unit

2.4 Display unit design

This design is shown in Figure 5. The OLED (organic light emitting diode) liquid crystal display, has been widely used in mobile devices, and on televisions. The utility model has the advantages of fast response speed and light weight, as well as the following advantages:

1) The thickness can be less than 1 mm; with only the liquid crystal screen 1/3, the weight is relatively light.

2) With solid state institutions, there is no liquid material, so the seismic performance is better, and can better withstand a fall.

3) There is very little visual angle problem; even from a very large angle, the picture is still not distorted;

4) Response time for the LCD screen is 1/1000; showing the motion picture does not have a drag phenomenon.

5) It is able to withstand ow temperatures, and still can display normally in minus 40 degree the liquid crystal display is unable to complete;

6) The manufacturing process is simple and the cost is low.

7) The luminous efficiency is higher, the energy consumption is lower than the liquid crystal display.

8) It can be carried out on different materials of the substrate, and the soft display can be made to bend.

OLED is controlled by the SH1106, where one LED makes a plane, without emitting light back onto itself could.

Its ultra-thinness is suitable for being a wearable device. Additionally, its electricity consumption is very efficient, if the user requires very low power consumption. The OLED display can be switched to a digital tube dynamic display. The human eye is unable to distinguish this difference, so it does not affect the user's experience, while solving the

elderly person's poor vision.

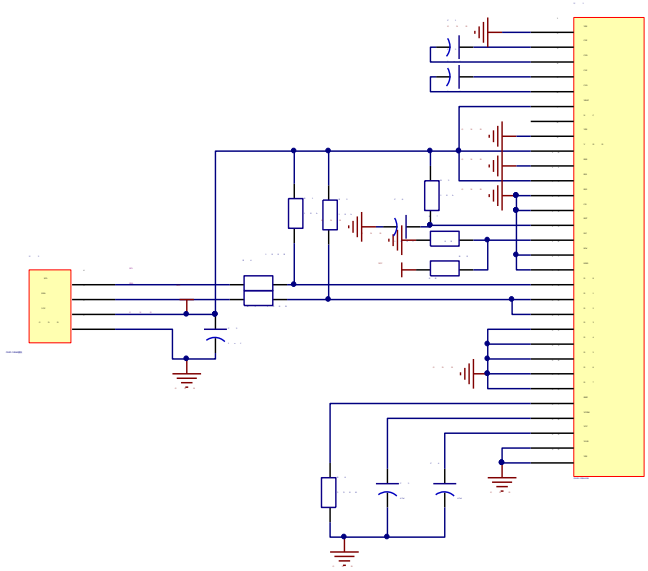

Figure 5. Design of display unit

2.5 Power unit design

The power supply design adopts LTC4055 as the power supply chip, as shown in Figure 6. It is a direct single lithium-ion battery that depends on a USB port for charging. It automatically switches between battery charging and discharging, and is capable of constant current and constant voltage. Heat feedback, maximizes the charging rate, with no risk of overheating. The current limit can be chosen of 100% or 20% (500mA/100mA). The operation of the Power Path TM ideal low power loss control diode with reverse current blocking, presets 4.2V charging voltage accuracy of 99.2%.This power supply is designed with a USB suspend mode, programmable timer and termination of charging current, soft start limits inrush current, thermistor input temperature qualified NTC charging. Small packages can also reduce the space.

4055 is a USB power manager and lithium ion battery charger designed to work in portable battery powered applications. This device manages and limits the total current through the USB operation and the battery in the use of charging. Depending on the state of the current selection pin (hpwr), the total input current can be limited to 100mA or 500mA. The drop in voltage from the USB power supply or battery USB peripherals are usually less than 100mV in 400mA and 20mV in 80mA. Other management features include an auto switch to battery when input is removed, surge current limit, reverse current blocking, and voltage protection and thermal shutdown. It also includes a full LTC4055 constant current lithium-ion battery linear charger. The floating voltage applied to the battery is typically kept within a strict tolerance of 0.8%, and the programmable charge current uses an external resistor for grounding. Full discharge of the battery automatically drops in the pro - 10% current, until the battery voltage of more than 2.8V. Total charge time is programmable with an external capacitor. When the battery drops below the voltage of the floating 100mV battery, automatic charging occurs, and the NTC thermistor input of rechargeable battery charging is monitored.

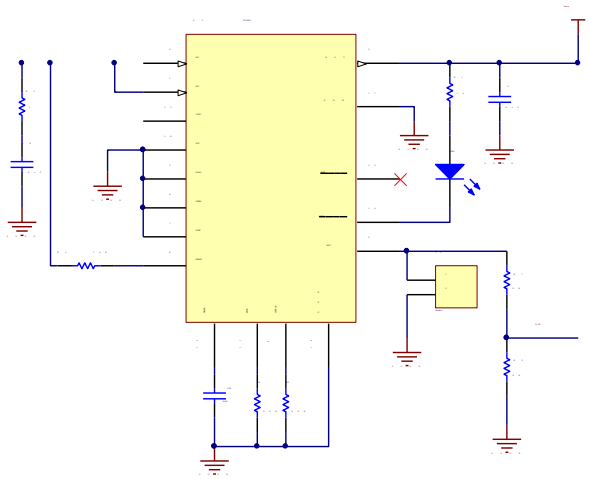

Figure 6. Design of power supply unit

IN1 and IN2 (pin 4 pin 1) refers to the input supply. Connected to the USB supply, are five buses, used as the main supply, and connected with the USB bus power supply to control the USB equipment. The input current is limited to 20% or 100% by determining the state of the HPWR pin as determined by the CLPROG pin. The charging current in the battery provided by the input is set to the current pro - program through the PROG pin and by the input limit current limit if the set is greater than the current limit. Connection resistance in the IN1 IN2 is less than 0.05.

WALL (pin 5) refers to the AC adapter current input. The pin is pulled above from 1 / 2 1V off and Disconnect charge - band supply path from 1 / 2 out. ACPR pins will also be pulled low, which indicates that an AC adapter is found. It requires 1 / 2 or out of the voltage to have a 100mV supply greater than the battery voltage to activate this feature.

SHDN input (pin 6) refers to a shutdown. This pin is pulled high. The entire disable process operates at low supply current mode. Power will disable all paths.

SUSP (pin 7) refers to the pause mode input. The top of the pin is pulled off from the 1 / 2 1.2V and will disable the charge and disconnect from the 1 / 2 power path up. The power supply current will be reduced to the USB standard mode. The battery's ideal diode function will remain active, as well as the battery's ability to charge. The output is less than 5V if the suspend mode will reset the charging timer in the pending mode. If it is kept larger than the battery voltage, such as when an AC adapter is present, the charging timer will not reset when the device is suspended. A weak drop current is internally applied to this pin to ensure that it has low power when the input is not externally driven.

HPWR (pin 8) refers to high power selection in controlling the amount of current drawn from the USB port. The logic on this pin will be limited to 100% of the current through the CLPROG pin on the charge and the 100% programming current through the PROG pin. A logic low pin current is limited to the 20% current, the CLPROG pin and a reduced battery charge current of 16% is done through the CLPROG programming. A weak pull down current inside the pin is used to ensure that it is low when the input voltage is not externally driven.

Because of this design it requires fast charging, so PROG CLPROG selects 100k resistance making the maximum charge current up to 500mA, and a shorter charging time. A state of full charging power prompts it to remind the user. The battery port access point's pressure resistance has real-

time monitoring of the battery voltage, and if the voltage is low, the OLED displays low voltage to remind the user to recharge the battery.

3. ANDRIOID APP DESIGN

This design uses the Android APP development software Esclipse to write the APP, and uses the language of the NRF51822. The Android operating system is a fully open platform, which is designed for the development of mobile device applications. Android is rapidly becoming the world's most popular mobile operating system, and through the support of multiple markets, providing developers with unparalleled ways to make their mobile applications generate revenue.

4. SOFTWARE DESIGN

4.1 Software flow chart

As shown in Figure 7 after the start of the program, the equipment runs automatically. It first connects to the phone, and then automatically collects data, such as the user's heart rate, temperature, user's quantity and type of motion, judging whether the temperature falls below or exceeds the set value, in which case it will immediately notify other mobile phones to send text messages to the guardian or monitoring center. The SMS, and the electrical equipment vibration reminds the user if his/her hearing is not good. Furthermore, OLED will display the time and the amount of exercise per day, and may users at night to do more exercise in order to prevent muscle atrophy. The device also has a distress alarm function, by pressing a button, and the user can send text messages (also can be set to the telephone dial-up function) to the guardian or care center. This function can also be set to the telephone dial-up function.

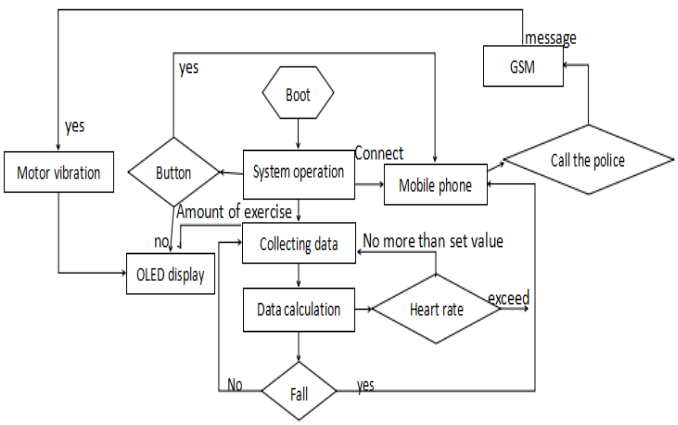

Figure 7. Software flow char

4.2 Generic access specification in Bluetooth protocol GAP

Generic Access Profile Generic (GAP) ensures that different Bluetooth products can discover each other and establish a connection.

GAP defines how Bluetooth devices are found and built to connect with other devices. It deals with some general patterns of operations, such as query, naming, and search, and some security issues, while also dealing with some of the connected businesses such as link establishment, channel and connection establishment.

GAP provides some general running tasks. As a result, it is mandatory requirement and serves as the basis for all other Bluetooth applications.

GAP is the basis for all other configuration files, which defines a common method for establishing base band links between Bluetooth devices. In addition, GAP also defines the following:

⑴The function must be implemented in all Bluetooth devices

⑵Common steps for finding and linking devices

⑶Basic user interface terms

GAP ensures a high degree of interoperability between applications and devices, and allows developers to make use of existing definitions that are more likely to define a new configuration file. GAP processing is not connected between the two devices found and establishes the connection process.

This configuration file defines a number of generic operations that are available for reference to the GAP configuration file, as well as the implementation of multiple configuration files for the device to use. GAP ensures that two Bluetooth devices can exchange information via Bluetooth technology to find the application that supports each other. Bluetooth devices that do not meet any other Bluetooth profile must be in compliance with the GAP to ensure basic interoperability. The configuration GAP code is as follows:

```
Static void gap_params_init(void)
  {
uint32_t err_code;
ble_gap_conn_params_t gap_conn_params;
ble_gap_conn_sec_mode_t sec_mode;
BLE_GAP_CONN_SEC_MODE_SET_OPEN(&sec_mod
e);
   err_code=sd_ble_gap_device_name_set,
     APP_ERROR_CHECK(err_code);
  memset(&gap_conn_params,0,sizeof(gap_conn_params));
gap_conn_params.min_conn_interval=MIN_CONN_INTE
RVAL;
gap_conn_params.max_conn_interval=MAX_CONN_INT
ERVAL;
gap_conn_params.slave_latency=    SLAVE_LATENCY;
gap_conn_params.conn_sup_timeout=CONN_SUP_TIMEO
UT; err_code=sd_ble_gap_ppcp_set(&gap_conn_params);
APP_ERROR_CHECK(err_code);
}
```

This code sets the connection security mode, and sets the connection interval.

5. CONCLUDING REMARKS

In this paper, the design and research of a wearable monitoring system for the elderly. The accuracy of heart rate measurement is as high as 99%, and the measurement of body temperature is accurate to 0.1 degrees Celsius. The monitoring is non-contact type, providing the user with a comfortable experience. Motion does not affect its accuracy, and attitude detection is also very accurate. During the monitoring, detecting the probability of a fall also has very high accuracy. The results show that the equipment has a significant effect on elderly people who live alone, and it can greatly reduce the accident rate of elderly people living alone.

ACKNOWLEDGEMENT

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