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Design of Home-Based Elderly Health Care System

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ABSTRACT

In this paper, we designed a home-based elderly care system, which consists of three parts: Equipment for Health detection, Monitoring cloud and Mobile user terminal. Combining intelligent sensing technology, GPRS wireless communication, Ethernet TCP / IP protocol and MySQL version of the analytical database, the system can fully get the physical healthy condition of the elderly at home and provide professional medical and personalized services with the software and hardware working together.

1. INTRODUCTION

The current situation of aging population is severe, and the aging population is showing an explosive growth trend. By 2020, China has ushered in unprecedented severe pressure about how to provide for the aged, and smart retirement has begun to rise to the national strategic level. The traditional way of providing for the elderly has been weakened, and the elderly group is more dependent on medical services and health care. Among them, home care for the elderly is more in line with the traditional concept of the Chinese people. With the increase of age, the probability of sudden emergency to the elderly living alone at home increases frequently. Home care should not only be invested in economy and time, but also in technology.

In existing home care solutions, functions such as emergency call for help and indoor temperature and humidity measurement have been set. But problems such as lack of real-time monitoring, limited community medical service projects, lagging information communication and insufficient service power supply still exist [1]. With the continuous advancement of artificial intelligence technology, integrated circuit technology, and wireless communication technology, detection and communication systems have been greatly developed, and wireless-based pension systems have received increasing public attention.

Therefore, it is of great practical significance to build a comprehensive care system based on prevention and diagnosis. In order to solve the above corresponding problems, we established a multifunctional comprehensive elderly health care system based on the combination of intelligent sensing, GPRS communication, MySQL database and a cloud server. We use modern technology to protect the elderly's health and achieve remote monitoring, reduce the pressure of home care, and promote the long-term stagnation of the old-age care industry.

2. SYSTEM STRUCTURE

2.1 Overall structure

The overall structure of the system is divided into three parts of equipment for health detection, monitoring cloud and mobile user terminals (see Figure 1).

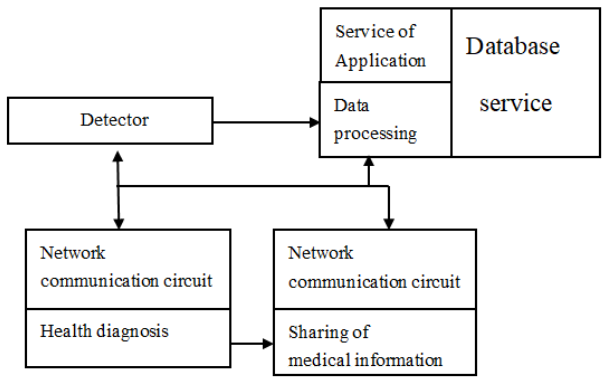

Figure 1. Schematic diagram of system structure

The equipment for detection collects the user's physical signs data such as ECG, heart rate, pulse rate, blood pressure, blood oxygen, body temperature according to the prescribed medical protocol. It consists of sensor acquisition circuit, wireless communication module, controller, data transmission unit. The monitoring cloud is mainly composed of data units, communication units, and positioning units. First, according to the long-term physical data of the elderly, predict the health status of the elderly in the vertical direction and a large number of horizontal directions, and form a health report. The second is to connect with the family Wi-Fi to realize the position linkage and abnormal reminder of the elderly; the third is to connect with the community, hospital and other terminals to realize auxiliary functions such as the establishment of medical and personal medical files. The mobile user terminal is the output layer of the system so that

family members or doctors can directly obtain information about the elderly, including detection data, health reports, early warning signals, location information, etc. It can also perform operations such as emergency medical treatment, appointment registration, and medical record upload.

2.2 Health data collection

2.2.1 Controller selection

The central control management module of the detection equipment implements the basic situation control function. Based on the basic signal query program, the module executes the signal query method and calls the signal management control commands to complete the response, and then returns the processing result to make other modules act accordingly [2]. Controller uses TI's MSP430F149 as the core chip, which is a control center for information interaction, to complete the power supply control and information management between the modules. The chip can implement a variety of low power consumption modes, which is convenient for portable measurement applications. Equipped with a powerful 16-bit RISC CPU, 16-bit registers, and a constant generator to help maximize coding efficiency, the numerically controlled oscillator DCO can wake up from low-power mode to active mode in less than 6μs, which greatly improves the operating speed of the device [3]. Figure 2 shows sensor circuit overall structure and the Figure 3 shows the functional block diagram of the MSP430F149 chip:

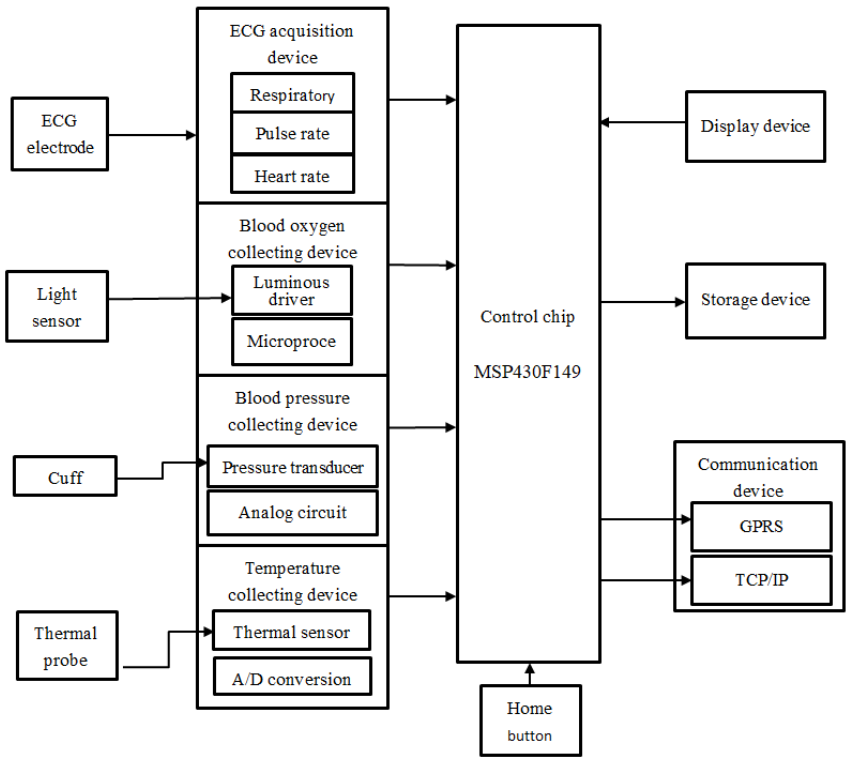

Figure 2. Sensor circuit overall structure

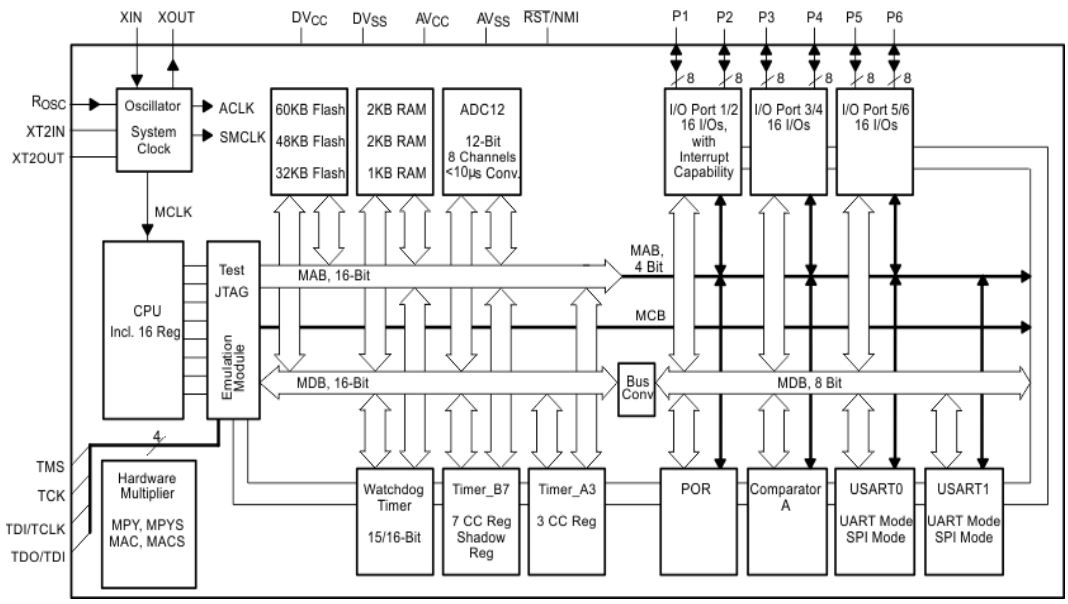

Figure 3. MSP430F149 chip functional block diagram

2.2.2 Sensor module design

ECG measurement uses conductive materials that can be in close contact with the skin. The electrodes are thin sheets and silicone electrodes. Since the ECG signal is very weak which is only μA and mA. Besides, the anti-interference ability is extremely poor. In the case of ensuring the quality of ECG signal acquisition, in order to reduce the impact of environmental noise on ECG waveform as much as possible to expand its Using range, we use a preamplifier for the module circuit. In addition, the electrode uses active electrodes, which improves the signal quality while avoiding the pre-processing required for the original measurement. Considering the problem of power frequency interference, the Module measuring circuit principle is shown in Figure 4 [4]:

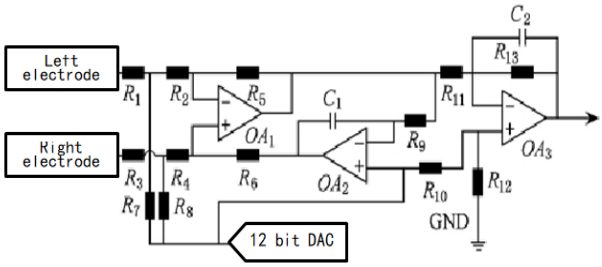

Figure 4. Circuit diagram of ECG signal measurement

The blood oxygen measurement uses finger-type photoelectric sensors. During the measurement, the sensor sleeve is attached to the finger, and the LED light-emitting tube emits red light with a wavelength of 660 nm and near-infrared light at 940 nm. The light transmission intensity through the tissue is distinguished by the photosensitive sensor. According to the periodic changes of HbO_2 and Hb concentration in the detected arterial blood flow, the components it collects are amplified by photocurrent conversion. It could obtain a pulse wave composed of most of the DC component and a smaller pulsating component, from which the hemoglobin concentration and blood oxygen saturation are calculated. The measuring circuit diagram is shown in Figure 5:

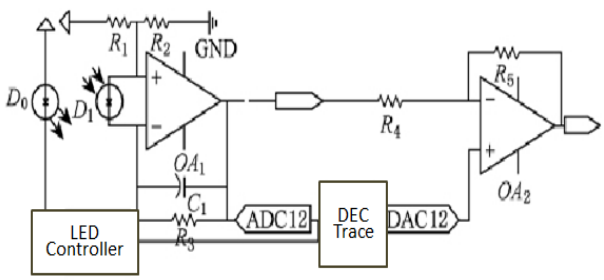

Figure 5. Circuit diagram of blood oxygen signal measurement

Body temperature detection is achieved by measuring the resistance of the metal foil in close contact with the skin, using the AD7783 integrated chip, which is a 24-bit ad acquisition chip, with two 200μA integrated current sources. It could also integrate programmable amplifiers and digital filters. The body surface temperature can be obtained by processing the signals obtained from the electrode pads. In addition, by collecting the ambient temperature as compensation temperature, the output through the serial port can be conveniently connected with the controller or the detection part. The measuring circuit is shown in Figure 6:

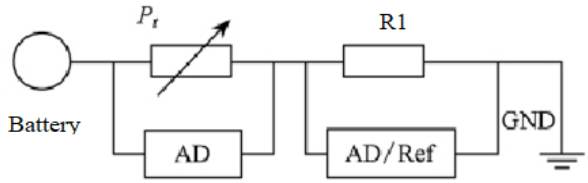

Figure 6. Circuit diagram of body temperature signal measurement

The blood pressure is detected by constant pressure current source, pressure sensor, amplifier circuit and other components. The air pressure in the cuff is adjusted by controlling the output of the air pump. The sensor adopts BP300, has a Wheatstone bridge structure inside, and the measurement accuracy can reach 0.6mmHg. The internal itself contains signal op amp and signal adjustment functions, which can directly transmit the blood pressure signal of 0.2 ~ 3.9V (Corresponds to 0 ~ 300mmHg) to the A / D converter microprocessor input port [5]. The module finds the peak value obtained by sampling, and determines the parameter corresponding to this peak value, that is, the position in the sampled array. After analysis and calculation, the transient time position of the systolic and diastolic blood pressure is determined, and the blood pressure value is obtained blood pressure results which is based on the calculated systolic and diastolic (Figure 7).

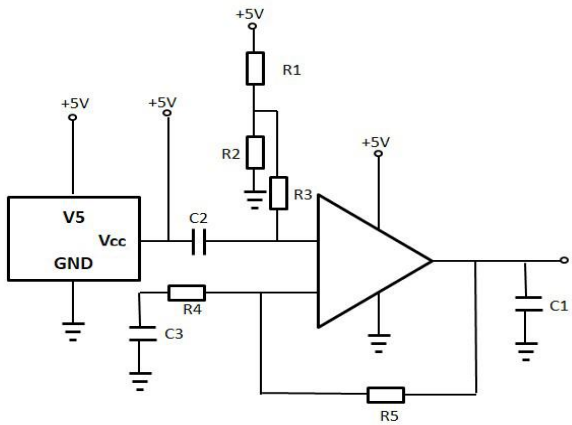

Figure 7. Circuit diagram of blood pressure signal measurement

2.2.3 Data communication

This system utilizes the advantages of "high speed" and "real time online" of GPRS technology to realize data renewal. GPRS allows users to send and receive data in end-to-end packet transfer mode without using network resources in circuit conversion mode and provide an efficient, low-cost wireless packet data services [6]. Embedded GPRS communication module is mainly composed of TCP / IP-embedded MCU, GPRS module, SIM card holder, external interface and data expansion memory. The mobile SIM card enables GPRS to communicate directly with the Internet

through the TCP / IP protocol. With the wireless communication module of 4G-LTE and the scanning control module of the chip as the core of the design, a new off-line control system structure based on ARM + 4G is realized, which is matched with PC software based on TCP/IP network communication protocol [7]. The module displays the network connection status through two LED lights, including conflict detection, connection status detection, data transceiver detection, and duplex communication mode. The transceiver sends query control instructions through the control node and uploads the output signals of each sensor to the remote server. The mobile terminal communicates with the database on the cloud server through the TCP / IP protocol, and then the Web service calls the database resource to implement the information exchange [8] (Figure 8).

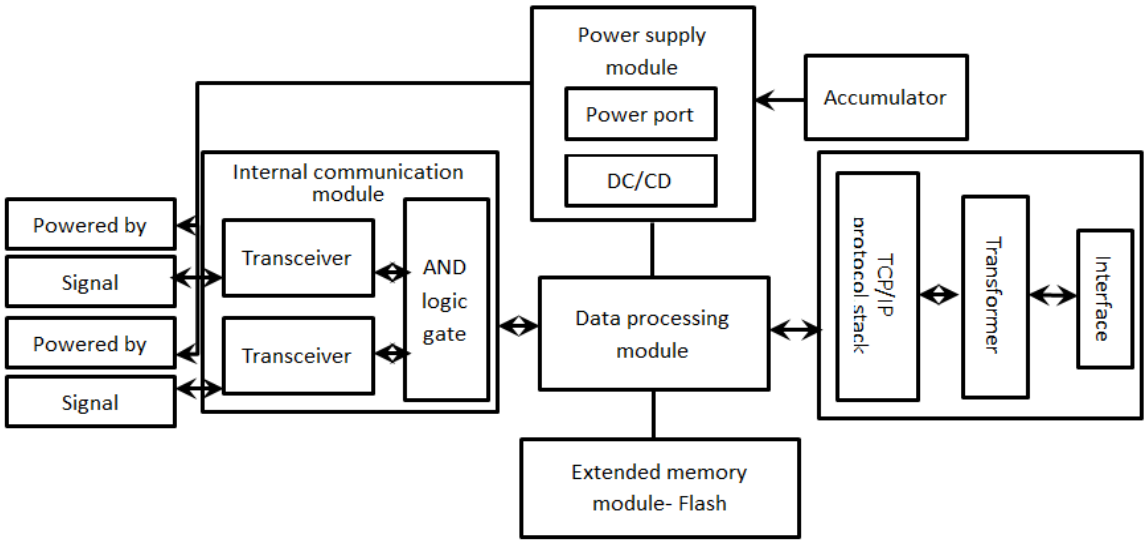

Figure 8. Bus communication and power supply module

3. POWER SUPPLY AND DISPALY MODULE

The detector is powered by a removable polymer lithium ion rechargeable battery, which has the advantages of operating voltage range and no memory effect. In order to save the power consumption of the system as much as possible and reduce the unnecessary energy loss, we use the power management module to control the enable terminal of each module chip to realize the accurate control of the energy consumption of each module. When the power management circuit detects that the system is in standby low power mode, it pulls down the enable side of the power output bus to save energy. Display part with LCD screen, whose cost is low and programming is relatively simple. The interface provided on MSP430F149 can be connected to LCD directly [9].

4. DATABASE DESIGN

The database is mainly used to obtain data from the detection device, and draw a line chart through graphics and other classes in Java's SWING, to generate a detection report and push medical advice. And then, a thread is specifically responsible for receiving information, including detection from the device side Data, positioning signals, medical record information and appointment information from the mobile terminal. When the information is received, the relevant data will be transferred to the buffer and notified to the main thread to complete the database update. This function can be implemented by using the listen method in Socket [10]. In the design process, we use part of the modeling language, and then design the system database structure according to the data table. For ease of use, the system uses Alibaba server as a cloud server, and uses Pagoda Linux and MySQL databases as technical management, to exert the data analysis and mining capabilities of the database. Finally, it implements signal transmission by deploying code on the server. It can help to establish a stable and efficient program architecture and restrict normative access behavior. On the basis of the general framework, the advantages of Spring and Hibernate frameworks are fully utilized to improve data processing efficiency, enhance the monitoring effect, and improve the system hierarchy.

5. DESIGN OF USER TERMINAL

The user software layer can be represented by the management layer and the technical layer. Logical interfaces related to modules such as central control management, health management, call management, and home management are realized through the management layer. The design of the user end is divided into two parts: the PC system and the APP. System APP side development is based on the Android platform, through flexible application program groups to enhance the display and interaction of application programs, the PC side uses Java development design. This system uses java to develop and design the Android client. The subsystems include the elderly terminal, family terminal, and medical care terminal. The elderly terminal can perform health testing, emergency help, appointments, Fall alarm, sleep monitoring, etc. After the family sends the request, the processing result is returned

after processing by the basic server, data server and other components. After filtering by the firewall, switch and other components, the user accesses the Internet to obtain, and then can perform video linkage, data viewing, medical record uploading, appointment consultation, etc. The medical care terminal can perform medication reminders, information query, voice intercom, etc. (The process is shown in Figure 9). According to the users' habits, different functional frameworks are built, to protect the safety of the elderly and avoid risks efficiently and timely.

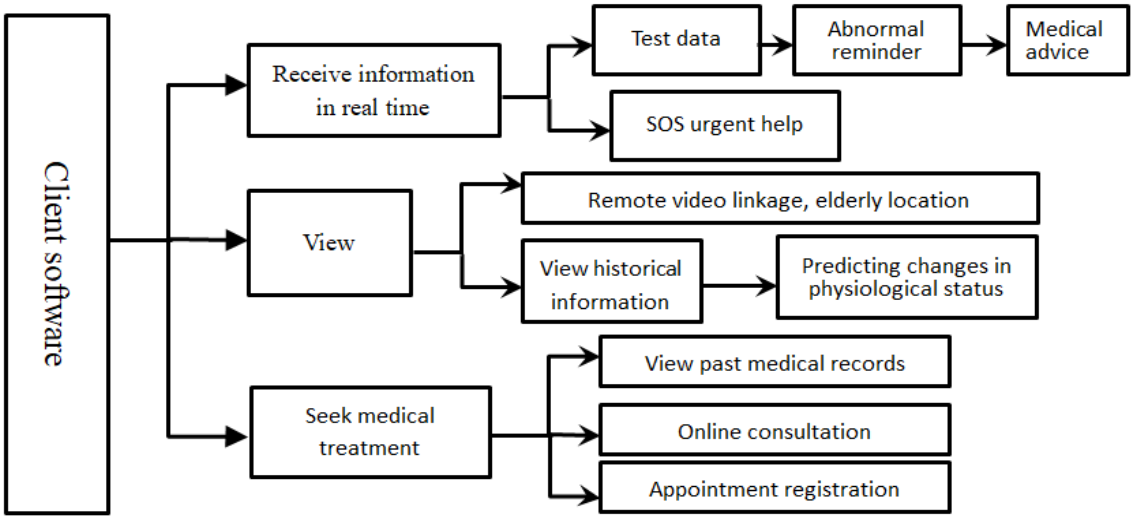

Figure 9. Flow chart of client software

6. CONCLUSIONS

In the paper, we build a comprehensive and diversified Home-based elderly care platform using a cloud server, supported by smart sensor technology, GPRS wireless communication technology, Ethernet TCP / IP protocol, etc. Combined with the multi-party supervision of the children and institution, it provides smarter and personalized services for the elderly with multiple considerations of the health and safety of the elderly. In the later stage of the project, the system will be committed to building a comprehensive, diverse, easy to use, high-quality home-care brand, building a relatively complete intelligent pension mechanism, improving the efficiency of pension services, and upgrading the pension model. With the rapid development of network technology and big data technology, this system will make corresponding update, keeping pace with the pace of The Times. It is believed that the home-based elderly care system will definitely produce huge social and economic benefits in the near future.

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