Design of Health Care for Elderly Living Alone Based on ZigBee

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Abstract: Now the society has stepped into the aging stage, because of the rapid pace of life in cities and hollowing out of villages, a considerable number of older adults living alone. The health of the older adults living alone becomes a concern for their children. The aim of this study is to provide a health monitoring program that does not interfere with the life of the elderly. Research data show that the biggest threat to the health of the elderly is falls and cardiovascular attacks. The design uses wireless wearable technology to monitor the motion status and ECG signals of the elderly. PC is used as data storage and transmission center and has the ability of simple data processing. The experimental results show that the design can transmit the acceleration signal and ECG signal to the personal computer through wireless mode, and the processed data can meet the needs of professional medical staff.

1. Introduction
Health care for the elderly living alone in the aging society has attracted people's attention. Research data show that the biggest threat to health of people over 65 is heart disease. The odds of falling over 60 years old were eighteen percent, which resulted in 1.3% of the fracture, and the data showed that the odds of falling over age also increased. In this paper, wireless technology is used to collect health information, and home computer is used as data center. After processing, data can be used as the basis for medical personnel.

2. System Design
The purpose of this design is to realize the daily dynamic monitoring of the indoor environment of a specific group. On the basis of the research of current wireless technology, this design selects ZigBee technology to collect health monitoring information after considering equipment volume, power consumption, communication rate and distance, cost and convenience of wireless networking. Wireless monitoring nodes are designed to be wearable and each node monitors a kind of health information. The receiving node receives data and sends it to PC, and the computer sends the data to the remote data center through the network after the data is simply processed. The design is shown in Fig1.
3. Nodes Design

(1) ECG Monitoring Node

The node is designed as a vest, and electrodes fixed in clothing are used to collect ECG signals. The signal processing circuit amplifies the signal by about 100 times, and the amplified signal passes through the high-low pass filter, voltage lifting circuit and ADC, and finally the digital signal is transmitted to the receiving node by wireless way. The amplifying and filtering parts are implemented by an operational amplifier. ADC and wireless transmission are implemented by CC2430 microcontroller. The chip is built in ADC module and ZigBee protocol. The design of ECG monitoring node is shown in fig. 2.

(2) Fall Monitoring Node

The fall monitoring is realized by collecting the acceleration information of the elder. The node is designed as a waistband style and the acceleration sensor is fixed in the middle of the back waist. The design can not only protect the privacy of the elderly, but also monitor the movement information of the elderly in real time, and the abnormal motion information can be monitored by setting the acceleration threshold reasonably. The acceleration sensor is MMA7260Q, which has low power consumption, simple peripheral circuit, adjustable sensitivity and flexible power supply. The ADC and data transmission are implemented by CC2430. The acceleration monitoring node is shown in Fig. 3.

(3) Emergency Alarm Node

The node is designed as a wrist strap, which can realize active alarm and is realized by the CC2430. The active alarm can be realized by the CC2430 configuration button, and can be used for emergency affairs alarm.

(4) Receiving Node

The main function of the node is to collect data and send the data to the personal computer by USB, and the node has the buzzer and display part. It can observe the monitoring node network and simple alarm. The receiving node is shown in Fig. 4.
4. Experimental Result

(1) Wireless Networking Test
Firstly, power up the receiving node and establish a network. Secondly, power up the data acquisition node and join the network. Finally, communication rate testing. The wireless network networking and communication rate testing is shown in Fig.5. The 7561 represents the average number of bytes received per second, and 1134070 indicates the total number of bytes received. It can be seen that the data transmission capability of the wireless network is adequate for wireless health monitoring.

(2) Data Acquisition and Processing
After completing the software and hardware design, we collect the ECG signal and walk acceleration signal through the experiment wireless networking function. The personal computer receives data, and the data is processed as shown in the figure. Original data and low-pass filtered data are as shown in the Fig.6.

After the original data recovery, the original data is obviously disturbed. The data after simple low pass filtering is more readable, and can clearly see the various group waves of the ECG signal and the acceleration and deceleration of walking. This data can be used as a basis for judging professional medical staff.

The Z axis represents the forward direction, the Y axis represents the vertical direction, and the X
axis indicates the left and right directions. It is shown in Fig.7.

\begin{align*}
Z\text{-axis} \\
Y\text{-axis} \\
X\text{-axis}
\end{align*}

Fig.7 motion acceleration signal

After the ECG signal processing, this design attempts to detect the R wave of ECG signal and judge the heart rate of the ward. In this design, four point difference method is used to judge R-wave through first-order difference. $x(n)$ represents the original ECG signal sequence, $y(n)$ is the first-order difference of $x(n)$. The four point difference formula is as follows.

$$y(i) = \frac{1}{8} (x(i + 2) + 2 \times x(i + 1) - 2 \times x(i - 1) - x(i - 2))$$

In this experiment, 20 Hz low-pass filter is applied to the ECG signal first, and then the R wave of ECG signal is detected according to the difference algorithm. The results are shown in Fig.8.

\begin{align*}
\text{QRS detection}
\end{align*}

Fig.8 QRS detection

5. Conclusion

The experimental results show that this design can collect the health data of the elderly on the premise of protecting the privacy of the elderly. The processed data can reproduce ECG and acceleration information. These curves can be used as a basis for professional judgment and can also be used to study the alarm. Subsequent design can be further studied in the direction of alarm judgement, 4G data transmission and mobile APP alarm.

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Reference
[1] Huang Yi, Tong Xiaoguang. Analysis of the current situation of population aging in China [J]. Chinese Journal of Gerontology. 2012,32 (21): 4853-4855.
[2] Yu pulin, Wang Jianye. Current situation and Prospect of geriatrics [J]. Chinese Journal of Practical Internal Medicine.2011 (04): 244-246.
[3] Huang Chengli, Pang Lihua. Analysis of the impact of aging population on the allocation of medical resources [J]. Population and Development.2011,17 (02): 33-39.
[4] Yu Pulin, Tan Zhaohui, Wu Di, et al. Investigation on the incidence of falls in urban community elderly in Beijing. Chinese Journal of Geriatrics [J], 2006,25 (4): 305-308.