The Design of Cardiovascular Disease Information Acquisition System

Bo LIU, Gang SHI* and Hu-yang LI

Industrial Control Network and Systems Department, Shenyang Institute of Automation, Chinese Academy of Sciences, Shenyang, China
Institutes for Robotics and Intelligent Manufacturing, Chinese Academy of Sciences, Shenyang, China

*Corresponding author

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Abstract. According to the chronic diseases’ characteristics of long course, high incidence and strong concealment, this paper designed a portable health information collection system, which can collect blood pressure, ECG, blood glucose and other health information related to cardiovascular risk factors in the high degree of portable with not to be restricted on the use scene, so as to facilitate the daily monitoring of patients in primary hospitals and families. Thus, the current situation of primary medical resources shortage can be alleviated and the purpose of health care and disease prevention can be achieved.

Introduction
With the improvement of people's living standard and the increase of work pressure, people's health concept has undergone profound changes, and health has gradually become the focus of people's attention. Chronic diseases have the characteristics of long course, high incidence and strong concealment. Once the prevention and treatment is insufficient, it will have a serious impact on the health and life of patients. At present, the management system of chronic diseases in China is relatively backward, and there is a lack of effective monitoring and intervention for the conditions of patients with chronic diseases outside the hospital, and the changes of patients' conditions cannot get effective feedback, which is an important reason for the occurrence of complications and complications of chronic diseases. The treatment of chronic diseases is a long-term process. Scientific management can not only play a positive role in the treatment of patients, enhance the treatment effect of patients and promote their recovery, but also reduce the incidence of complications, reduce the burden of patients and families, improve the quality of life of patients and alleviate the burden of society after the treatment of patients. Therefore, the risk assessment system of chronic diseases is particularly important.

At present, the medical equipment resources of primary hospitals in China are relatively backward, the professional level of primary medical staff is relatively low, and there is a lack of effective chronic disease management means, so residents cannot be evaluated for health and screened for chronic diseases. All patients with chronic diseases go to the central hospital for treatment, which leads to overcrowding in the central hospital, and outpatient doctors do not have enough time to give patients medical guidance on chronic diseases. Therefore, it is necessary to develop intelligent health terminals that meet the needs of primary medical care, and the terminals are equipped, so that the primary medical staff can evaluate, screen and follow up chronic disease patients under the guidance of the central hospital, so as to realize the decentralization of medical resources of the central hospital. At the same time, it helps the hospital to effectively monitor the patients with chronic diseases outside the hospital to prevent or delay the occurrence of complications.
Strategies and Significance of Cardiovascular Disease Risk Assessment

In recent years, the prevalence of cardiovascular diseases in China is still on the rise, and the mortality rate of cardiovascular diseases still ranks the first place, higher than that of tumors and other diseases. About 2 out of every 5 deaths are caused by cardiovascular diseases [1]. Cardiovascular disease is a serious threat to the health and life of the people, with high mortality and high disability rates. In the last 30 years, the number of cardiovascular deaths, morbidity, and prevalence of cardiovascular disease in the country has been increasing, and the age of onset is premature. Cardiovascular disease has become the most important public health problem in China.

Although the pathogenesis of cardiovascular disease remains to be studied, its main risk factors have been identified. A large number of studies have confirmed that hypertension, dyslipidemia, diabetes, heart disease, obesity, smoking, lack of physical activity and unhealthy eating habits are the main risk factors for cardiovascular diseases [2]. Many clinical trials and community integrated prevention and treatment studies at home and abroad have proved that intervention measures aimed at the major risk factors of cardiovascular disease that can be changed can reduce the level of cardiovascular risk factors and the incidence of cardiovascular disease in the community population.

Cardiovascular disease is the outcome of combined action of multiple risk factors, individual risk for cardiovascular disease not only depends on the level of a certain risk factors, also depends on the individual also has a number of risk factors for [3]. The interaction of multiple risk factors can lead to the significant increase of cardiovascular system damage caused by one factor due to the presence of other factors. Therefore, it is not enough to control single risk factors alone in the prevention and treatment of cardiovascular diseases, and we should also pay attention to the comprehensive assessment of the overall risk of cardiovascular diseases.

Design of Portable Health Information Acquisition System

Blood Pressure

The blood pressure detection scheme of this system is based on the wave method, without the interference by artificial subjective factors, strong repeatability, and colleagues has the objectivity and accuracy, is widely used with the electronic blood pressure measurement scheme, the basic principle is as follows: through the cuff of blocked arteries blood flow, and then gradually deflated test under different pressure, the pressure caused by the blood vessel wall collision vibration to determine the blood pressure, through the sensor to collect data, analyze the pulse wave generated by blood flow turbulence envelope, combined with the cuff pressure under different time, determine the specific systolic and diastolic blood pressure values.

The composition of the blood pressure detection module is shown in the figure below, mainly including the following contents: sleeve belt, rubber vent valve, capacitive sensor, ring oscillation circuit, air pump, air valve, air pump drive circuit, air valve drive circuit, microprocessor, memory.

![Figure 1. The block diagram of blood pressure detection module.](image_url)

The microprocessor connects the pressurized air pump through the pump driving circuit, sends out PWM control signal to the pump driving circuit, and switches the pressurized air pump by adjusting
the duty cycle ratio of PWM signal. The pressurized air pump is connected to the sleeve belt through the trachea for filling air into the air bag to increase the pressure on the measuring part. The ring oscillating circuit converts the pressure signal of the sleeve belt into the electrical pulse signal with real-time frequency change, and inputs the signal into the timer interface of the microprocessor to complete the conversion from pressure signal to digital signal. The microprocessor extracts the pulse wave signal from the sleeve belt pressure curve through butterworth bandpass filter, forms the pulse wave envelope line through double gaussian fitting, finds out the inflection point of the envelope line, obtains the corresponding frequency value at the inflection point, and calculates the blood pressure value according to the mapping relation between the stored pressure and frequency. The microprocessor connects the solenoid air release valve through the valve driving circuit, sends out control signal to the valve driving circuit, and the control valve driving circuit switches the solenoid air release valve: The electromagnetic relief valve is connected to the sleeve belt through the air pipe to discharge air from the air bag after the measurement.

ECG

ECG signals are low-frequency and weak physiological signals. ECG on the surface of the body is generally only 0.05 ~ 5mV, with the frequency between 0.05 ~ 100Hz and the energy mainly concentrated around 17Hz. This system USES high input impedance instrument amplifier INA326 and high precision operational amplifier 0PA2335 to form a two-stage amplifier circuit, which amplifies ECG signal 200 times for acquisition. Noise will inevitably be introduced in the acquisition process. The noise of normal ECG signals can be divided into three categories: power-frequency interference noise, baseline drift noise and electromyography interference noise.

Power frequency interference noise in the process of collecting data is common, mainly by the power supply network and related equipment, the space electromagnetic interference generated domestic mains fixed frequency 50 HZ, as can be seen from the sinusoidal signal and harmonic wave, the amplitude is small and is characterized by the regularity of low-temperature wave ECG, is essentially a random process, but easy to cover up the ECG, which is tiny twist, affect the diagnosis. The amplitude of these power frequency interference is generally 0~0.4mV, approximately accounting for about 1%~40% of the normal R wave peak value.

Baseline drift noise is the biggest interference that affects the detection results of ECG signals. The noise generally refers to the contact of electrodes, impedance changes caused by slight movement of human body and low-frequency interference signals caused by the respiration of the measured person. Its shape is similar to a sinusoidal approximate curve with slow change, which is mainly manifested as amplitude modulation of ecg signal and produces the effect of signal jitter. The frequency distribution of baseline drift noise is 0.05-5HZ, and the energy is mainly concentrated in 0.1-0.2HZ, which is very close to the frequency components of ST segment and Q wave of ECG signal. Moreover, ST segment and Q wave are of great clinical significance, which requires careful treatment of such noise, otherwise, the accuracy of judgment will be greatly reduced.

Electromyographic interference noise is mV level interference noise caused by the contraction and relaxation of human muscles. Its frequency range is very wide. It is a kind of high frequency interference similar to gaussian white noise. Electromyographic interference noise can easily cover up the details of the original ecg, making the local ecg signals vague or even distorted, which brings difficulty to subsequent identification and diagnosis.

The filtering method of this system includes hardware filtering and software filtering. Hardware filtering methods include shielding, grounding, power supply isolation and other measures. Due to the limited simplification degree of hardware circuit and its own electromagnetic interference, hardware filtering alone cannot completely solve the problem of noise interference. Software filtering takes the filtered waveform and SNR as the evaluation criteria. In signal processing, it is hoped that the processed signal can contain as little noise as possible. Therefore, the higher the SNR is, the better the waveform meets the requirements.
The wavelet threshold algorithm analyzes the actual signal according to the type of threshold and
the threshold selection rules. Because the signal noise of the signal to be processed is relatively small,
Stein unbiased risk threshold selection rules of heuristic method are adopted to determine the
threshold. After the actual verification, it is found that soft threshold is automatically selected. The
wavelet threshold processing effect for ECG is shown in the figure below. The "burr" in the signal is
well filtered, indicating that the interference of power frequency noise and electromyography noise in
the signal has a good filtering effect. The ECG signal morphology after treatment has not changed
much compared with that before treatment, which is acceptable. However, in the process of
comparison with the original ECG signal, it can still be clearly seen that the processed signal has the
same trend with it, indicating that the problem of baseline drift interference has not been well solved.
Therefore, there are some problems with the wavelet threshold de-noising algorithm.

Wavelet packet algorithm is a kind of processing method which can divide the signal in detail and
reconstruct the low frequency component and high frequency component after filtering and
combining. Based on the decomposition layer number of 6, the frequency band of the signal is
controlled by adding and deleting nodes of the wavelet packet tree, so that the reconstructed ECG
signal can be obtained more accurately. As shown in the figure below, in the problem of baseline drift
interference, the processing effect of wavelet packet algorithm is significantly better than that of
wavelet threshold algorithm, and the ECG signal waveform after processing does not change much.
However, in terms of the filtering of electromyographic noise interference, the advantages of wavelet
packet algorithm are not fully exerted. The fundamental reason is that multi-resolution analysis
cannot solve the separation problem when noise interference and useful signal frequency are
consistent. Therefore, "burrs" can be seen in the signals processed by wavelet packet algorithm.
Therefore, the wavelet packet algorithm alone cannot achieve good processing results.

In summary, the final de-noising scheme is selected as the improved algorithm based on wavelet
packet in this paper. The improved algorithm combines multi-resolution analysis (careful) ability to
signal decomposition and the signal to the correlation (remove different categories of threshold value
signal) the advantages of the wavelet packet algorithm combined with wavelet threshold method,
form a kind of can not only remove the low frequency noise and baseline drift and can remove most of
fixed frequency power frequency interference and noise frequency distribution is wider
myoelectricity interference noise wavelet packet algorithm. As can be seen from the figure below, the
processed waveform is the closest to the standard ECG waveform in both signal morphology and
signal details.

Figure 2. Rendering of based on the improved algorithm of wavelet packet processing ECG waveform.

Glucose

Glucose is catalyzed by glucose oxidase to produce gluconic acid and release hydrogen peroxide.
Hydrogen peroxide releases oxygen in the presence of peroxidase and chromogenic receptor, which
oxidizes the pigment to red quinone compounds. The production of red quinone compounds is proportional to the glucose content.

The biochemical detection module adopts the photochemical method. The most important feature of the structure is that the incident excitation light is perpendicular to the fluorescence detection direction, so as to avoid the interference of the incident light. The module mainly consists of light source and its power supply, excitation wavelength selection device, sample room, emission wavelength selection device, detector, output and control module.

![Block diagram of glucose detection module](image)

**Figure 3.** The block diagram of glucose detection module.

In the light source part, monitoring photocell is introduced to monitor the change of light source and reflected light intensity at the same time, which is similar to the dual-beam method in common spectrophotometer. The light power measured by the monitoring photoelectricity is taken as 0, and the light power obtained by the light emitted by the light source reflected by the reagent strip is taken as F, and the value obtained by dividing the two is taken as the reflectivity. Its height is only related to the content, and is not affected by the light intensity fluctuation of the light source. The color changes generated by the reaction between the reagent area and blood glucose and lipid components in the blood are detected. The depth of the color block makes its reflectivity different under the irradiation of monochromatic light, and the content of blood glucose and lipid components can be determined according to the gradient of reflectivity.

**Summary**

This paper designed a portable health information collection system, which can collect blood pressure, ECG, blood glucose and other health information related to cardiovascular risk factors, so as to facilitate the daily monitoring of patients in primary hospitals and families, which helps clinicians to develop individualized comprehensive treatment strategies for multiple risk factors, thus minimizing the overall risk of cardiovascular disease.

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