



Original Research Article

Research and Development of Portable Health Monitor

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ABSTRACT

With the improvement of quality of life nowadays, the health requirements is also increased, the traditional health monitor has been unable to meet people's needs, in order to get real-time detection of physiological parameters, real-time understanding of the physical condition, miniature health monitor for strong research and development. This paper briefly introduces the characteristics of the traditional monitor and its research and development, and analyzes the research and development of the multi-parameter health monitor, and emphasizes the research of the body sign signal based on the volume pulse wave, and finally puts forward the research on the future portable health monitor, miniature monitor view, draw the portable health monitor will have a good development prospects.

KEYWORDS: portable physiological parameters volume pulse wave integrated sensing

1. Introduction

At present, the global population is facing aging, people's living standards have been improved, the demand for medical services in remote areas is also increasing, the patient's physiological parameters of real-time monitoring, these tangible factors are to promote the traditional medical changes, mobility and portability of medical electronic devices continue to develop.

China's report network published '2011-2015 China portable medical device industry market research and investment direction of the research report' [1] the use of national statistical data, the General Administration of Customs, survey data, business data collection and other databases. This paper analyzes the current situation of the portable medical device industry in China, analyzes the current situation of China's portable medical device industry market and introduces the market competition pattern of China's portable medical device market, and reports on the development of China's portable medical device industry. Analysis of the key business situation, the report also analyzes the development trend of China's portable medical device industry and investment strategy.

Domestic and foreign research on portable medical instruments have made some progress in different medical fields, for different medical and health care, different medical treatment related medical equipment, have gradually to the portable, simple, multi-functional, high accuracy of the trend. Especially in the health care monitoring, people want to the body's various physiological parameters of the same time, real-time monitoring, which is more conducive to people to keep abreast of their own physical defects and lesions in order to facilitate the timely treatment, especially for real-time monitoring elderly population health is particularly important.

For the development of portable health monitor, in the real-time monitoring, multi-parameter monitoring at the same time under the premise of ensuring the portable and the accuracy of the information. Domestic and foreign scholars in the portable medical equipment research also need to make greater efforts.

2. Commonly used human physiological parameters monitor the status of the study

2.1. Research on ECG monitor

In 1960, ECG was first used in patients, only ECG signals were monitored, called single-parameter monitors, with the advent of large-scale integrated ICs and microprocessors, as well as the constant inventions of new monitoring techniques the development of network technology, many ECG monitors can be composed of wireless or wired network

central monitoring system [2]. The use of ECG monitor real-time monitoring of the patient's condition, improve the quality of treatment and care, reduce the mortality of critically ill patients, improve the efficiency of care.

1957 American physicist Norman J. Holter invented the dynamic ECG machine [3], with the electronic technology, medical engineering and electrocardiogram diagnosis technology rapid development, according to the ECG recording, ECG monitoring system can be divided into two stages, the first stage cassette tape recording system, the second stage for the solid-state recording system.

At present, the ECG monitoring system at home and abroad is mainly solid state recording system, product types can be divided into three kinds [4-6]: the first for the Holter, Holter system by the storage recorder and playback instrument composed of two parts, the use of storage the recorder records the ECG data in the storage medium. After the recorder is set up and worn on the patient, the wearer's 24-hour ECG can be recorded and then returned to the hospital. The second is TTM (telephone transmission ECG monitoring system). The third is ECG real-time monitoring system, ECG real-time monitoring system is Holter and TTM lack of real-time monitoring function of an ECG monitoring system.

For conventional inpatients, ECG real-time monitoring operation is more convenient, and for patients without hospitalization, to achieve real-time dynamic monitoring, so far the basic cannot be achieved, to the implementation of the human body to monitor, it must have portable ECG monitor. Wei Long in the 'portable ECG monitor system design,' a paper mentioned the concept of portable ECG [7], based on this premise, Cheng Nan in the graduate project design using Samsung's ARM9 series S3C2440A processor , the use of ARM9 design to achieve a portable dynamic ECG monitor experiment, and the system to achieve low-power processing. Zhang Lingzhi based on MSP430 single-chip portable dynamic ECG monitor in the initial implementation of the portable ECG monitoring prototype. In portable medical equipment is very important point is low power consumption, the current study of the commonly used low-power processing methods are [8-10], first, the use of low-power devices; second, the use of gated clock method; third, reduce the clock frequency, these three methods have their own advantages and disadvantages.

At present, the commonly used ECG signal detection is still using the traditional 3 lead or 12 lead mode, based on the current ECG monitoring, people have designed a wearable portable ECG monitor [11], Guo Jinsong research A wearable vest for wearable sensors and their measurement and transmission systems for moving nondestructive testing of vital life signals such as ECG and breathing, which can be used to achieve short-range data transmission via Bluetooth, making it the scope of application is limited.

The current development of portable ECG monitoring equipment, are not related to the remote transmission, there is no solution to the inconvenience caused by ECG line and some based on the 'portable' problem. The future of the ECG monitor will be toward the precise, comfortable, intelligent, network direction.

2.2. Blood pressure monitor research

Arterial blood pressure measurement has formed a complete set of measurement technology system, can be divided into two direct and indirect methods. Direct measurement of blood pressure results accurate, can be continuous, real-time measurements, but must be inserted through the skin catheter into the blood vessels, is a traumatic method. Indirect method is measured from the body surface of the corresponding pressure value, no need for cutting surgery, measurement is simple, widely used in clinical, the drawback is the measurement accuracy is low, it is difficult to accurately determine the heart and vein system pressure.

Wei Xiaojun in the '24h ambulatory blood pressure monitoring and left ventricular hypertrophy in the correlation and clinical significance of the study,' a paper that through the detection of dynamic blood pressure, analysis of dynamic blood pressure monitoring results can be found in the heart of the night systolic blood pressure, diastolic blood pressure , mean arterial pressure levels and left ventricular hypertrophy are closely related, non-dipper type of hypertension, dipper hypertrophy prone to left ventricular hypertrophy [13], this study shows that the detection of ambulatory blood pressure for some aspects of the disease is very good diagnosis. Traditional blood pressure meter so far or common bandage blood pressure meter, and the most advanced is the dynamic blood pressure monitor, is a used to monitor the dynamic, continuous blood pressure medical equipment, applied to the hospital is more convenient, but the volume is still relatively large, not easy to carry, and is still in the bandage under the premise of the principle of oscillating oscillations, charge and discharge quickly, low noise, the method achieved, but did not find a portable monitoring method. Therefore, many domestic and foreign scholars are committed to the study of blood pressure measurement, hope to further improve the principle, in the instrument to further improve the measurement accuracy and anti-interference ability, in the use of the traditional model to get rid of inflatable cuffs, the development of real-time, dynamic blood pressure measurement.

2.3. Blood glucose detector research

'The first, venous plasma glucose determination, with the body from the body to extract venous blood through biochemical monitoring analysis; second, the capillaries full of blood sugar,' the blood glucose monitoring method, measurement, the current most of the use of acupuncture blood test instrument that is commonly referred to as portable

blood glucose meter, take the whole blood glucose measurement of capillaries; third, noninvasive blood glucose monitoring, is not damage the body's skin under the conditions of measuring blood sugar concentration, electrochemical method and optical method; fourth, minimally invasive blood glucose monitoring, laser, near infrared spectroscopy; fifth, continuous blood glucose monitoring, continuous blood glucose monitor system is the core of blood glucose probe and recorder, usually in the patient's abdomen subcutaneous placement of a sensor.

Five blood glucose detection method of acupuncture blood collection monitor, non-invasive blood glucose detection is a promising direction of development, portable, does not mean that can only move easily, the future trend should be 'small', 'real', so now portable blood glucose meter cannot achieve the purpose of carrying. There are a number of companies in the United States committed to the development of non-invasive blood glucose tester, according to its working principle, can be divided into the following four categories [15]: first, the use of subcutaneous interstitial fluid sugar molecules, test blood glucose; the human body on the near infrared, infrared or far infrared spectral analysis, the extraction of blood glucose; third, the test of the body's radio frequency impedance, the extraction of blood glucose; fourth, according to diabetes, the higher the proportion of glycated protein in the blood, Eyeball test, get blood glucose. In order to achieve real-time dynamic detection, spectral analysis and eye testing is worth considering the direction. Currently only Cygnus Gluco Watch Biographer, using reverse ion electrophoresis, through the analysis of exudative body fluids, read the blood glucose level, the instrument can read out a 10min data, and continuous record 13h, 78 blood glucose the FDA has approved prescription for adult and child sales, and Europe has approved access to the market. Of course, in other noninvasive blood glucose testing also has some research, the domestic Zou Xiangyang, Liu Rong use of current-type biosensor-glucose oxidase electrode and STC single-chip STC12CA410AD micro-power portable fast blood glucose tester [16].

2.4. Heart sound detector research

Heart sound is also an important indicator of medical diagnosis, through the heart sound signal analysis can diagnose the body of the heart of some diseases. For the heart sound detector research, also made some achievements, Ji'an proposed heart sound signal telemetry method [17], telemetry system by telemetry transmitter, telemetry receiver, notebook computer composed of three parts. Which telemetry transmitter from the large-capacity lithium battery-powered, small size, you can carry the same as the mobile phone. Through the chest electrode to detect the subject's ECG signal, through the wireless device will send the data sent to the host computer (notebook computer), the host through the operation of the heart sound telemetry system data detection program can be a long time to measure and store the subject's heart data, and shows the telemetry to the real-time heart sound map, heart change curve, heart rate curve, so that the telemetry effect can be controlled at any time heart sound signal detection process.

3. Multi-functional health monitor research status

In the late 1980s, with the rapid development of sensors and electronic technology, monitoring parameters increased, from the past a single parameter function for the development of multi-parameter monitoring [18].

The Unity Network Monitor is one of them. Through the Unity Network Monitor, it is possible to display the waveforms, data and other signals that can be monitored or telemetered at any time by the Unity Network Monitor at any time. At the same time, alarm, through the Unity network platform can be real-time display of all patient monitoring information and related alarm events [19], through the Unity network clinician can at any time, any monitor on the information or by any monitor called, so as to achieve the bed and the bed of information exchange. At the same time, multi-parameter monitor is the direction of miniaturization or large-scale multi-functional development, such as HP M3, Marquette's Eagle3000, with a touch screen space M90369 monitoring and wearing 24-hour blood pressure, ECG Instrument reflects the miniaturization of the instrument, and ECG telemetry system, the central monitor, remote monitoring system is to multi-functional, computing, storage capacity of the direction of development.

In order to realize the portable civilianization, the miniaturization direction is a very important development direction. Liu Haitao can improve the reliability and stability of the system by adopting the advanced hardware measurement module at home and abroad to develop the application system in the system integration mode [20] but also can greatly save the system development time, and can meet the different needs of users. Of course, this is a multi-module integrated development, so that although it can meet the current multi-parameter, portable monitoring, but still cannot achieve a high degree of integration, each module needs their own matching sensor, signal acquisition module, this is not fully realized. The trend of future development of multi-physiological parameter detection techniques may be [21], diversification of physiological signal parameters, configuration flexibility of signal modules, telemetry and wireless data transmission, OLEH system anesthesia online expert system, patient information integration, and finally to achieve a signal of a variety of data concept.

4. Conception of portable health monitor based on volumetric pulse wave

Photoelectric volume pulse wave method referred to as PPG, is by optoelectronic means in the living tissue to detect changes in blood volume of a noninvasive detection method, when a certain wavelength of the light beam to the fingertip skin surface when the beam will be transmitted or reflected by way of transmission to the photoelectric. In this process, the light intensity detected by the absorptive attenuator of the skin and blood by the fingertip skin is reduced, and the absorption of light from the skin and muscle tissue remains constant throughout the blood circulation, while the blood volume within the skin under the action of the heart was pulsatile changes, when the heart contraction of peripheral blood volume up to the largest amount of light absorption, the detection of light intensity minimum; and in the heart diastolic, just the opposite, the detected light intensity is the largest, so that the light receiver to receive the light intensity followed by pulsating changes, this light intensity change signal into electrical signals, you can get volume pulse blood flow changes.

It can be seen that the collected photo voltage pulse wave contains information that is very abundant in human blood pressure, blood flow, blood oxygen, brain oxygen, muscle oxygen, blood glucose microcirculation, peripheral vascular pulse rate, respiration rate and respiration capacity and other non-invasive detection has a very good application prospects.

The information detected by the PPG mainly consists of the following two components, one is the slowly changing DC component (DC) and the other is the AC component of the pulsating change, which contains the different information. Studies have shown that the characteristics of the PPG signal waveform should be determined by the cardiovascular state, and it will be subject to the detection of ambient temperature breathing posture exercise load and even some psychological factors such as anxiety and fear, of course, the age of people will be detected different have different results.

At home and abroad have been on the volume of pulse wave conducted a number of columns of research, volume pulse wave has also been applied to some areas. In his doctoral thesis, the influence of the baseline drift on the measurement of the time domain index is based on the compensation of the volumetric pulse wave based on the wavelet analysis and the 30-domain value selection method. [22] And the mean pressure, diastolic blood pressure and systolic blood pressure of the heart were analyzed by means of oscillometry and volumetric pulse wave. He also studied the design of arterial endothelial dysfunction based on photo voltage pulse wave, which is valuable for the study, diagnosis and evaluation of subclinical arterial disease [23]. Luo Zhichang compared the relationship between pulse pressure and volume pulse blood flow. The information about the total pulse current is given by the microcirculation model, where the DC component gives information about the total pulse flow, and the pulsation component synchronized with the heart rate is related to the microcirculation [24]. The results of this study are new cardiovascular blood flow parameters of noninvasive detection and monitoring equipment will have a good application prospects. Wang Haitao uses the SAX description method to discretize the volumetric pulse waves into symbolic sequences, the number of letters of the symbolic sequence forming the word, and then comparing the distance between the words at the local and the whole, and the distance is compared with the set threshold The pulse wave is divided into normal and interfering segments [25], and this method can also be applied to other signals.

However, most of the researches on PPG at home and abroad are mainly focused on the analysis of test methods and experimental results. There is little research on the information characteristics that may be included in the volume of blood flow, and there is no problem of PPG signal for a more in-depth theoretical analysis.

PPG has been applied to a variety of clinical applications are: 1. Human body blood oxygen state measurement; 2. Peripheral blood circulation function test; 3. Blood pressure pulse rate and other blood flow parameters of non-invasive detection; 4. microcirculation in the study of the application; 5. PPG estimated respiratory capacity, 1992 Lindberg et al proposed the application of PPG can monitor the respiratory rate and heart rate in the PPG signal power spectrum contains a significant difference between heart rate and heart rate.

5. Conclusions

Traditional medical equipment is larger, the function is relatively simple, for the ordinary people in terms of their own physical health to have a good understanding, in addition to the traditional signs of disease to be used to judge other than the other way. Although the hospital's examination can be a good physical examination of the body, but very convenient, and expensive. Now the social aging is serious, the health management of the elderly groups is a big problem, with the progress of society, not only the elderly, but also everyone in society will have high demands on their own body, so portable Integration, to carry, to real-time monitoring of the body's physiological parameters of the instrument will have a great market.

Traditional medical equipment is basically limited to large hospitals can be used, the location is relatively fixed, the general small and medium-sized clinics cannot be equipped with appropriate medical equipment. The traditional single

indicator of the accuracy of the detector is indeed very high, which requires the development of portable equipment in the process, cannot be blind, to be accurate testing shall prevail.

As mentioned above, there are already multi-parameter monitors in the society. The principle of the current multi-parameter monitor is basically to refine and reduce the large-scale equipment, and then block together, the detection of the probe are separated the source of signal is basically the same as the large equipment.

The idea of a new generation of portable medical devices has the following:

1) The unity of information sources. Should be excavated, seeking a characteristic signal from the human body, the signal can reflect all aspects of the body's physiological parameters, such as the previously mentioned volume pulse wave, the signal can reflect the body's many signs, including blood pressure, blood flow, Blood oxygen, cerebral oxygen, muscle oxygen, blood glucose, microcirculation, peripheral vascular pulse rate, respiratory rate and respiratory capacity, only one signal can contain many signs of the human body, which can make the instrument simple.

2) Integration of multi-signal-based sensors. Human physiological parameters of the signal is very complex, many, in the detection if you can avoid the trouble of multi-sensor, will greatly promote the development of portable instruments. For example, the current temperature and humidity sensor, is the temperature and humidity of the two sensors together for data processing, simplifying the traditional temperature and humidity detection. Detection of the human body signal is the same, you can talk about the detection of human lung tone, heart sounds, ECG and other associated sensors together.

3) To create new physiological parameters indicators. To find this indicator, hope that through this indicator can be found in many aspects of the human physiological condition, of course, this indicator is not reflected in the other existing indicators, the need to seek a new route, as in the absence of ECG, found ECG.

4) Physiological parameters in determining the accuracy of human health. At present, the data available for portable testing equipment, because of its large equipment and the data obtained from a certain access, of course, as the existing medical and health standards, perhaps this is an inadequate, but can change this situation. Using the method of medical statistics to separate the characteristics of the signal, based on medical statistical methods of signal analysis, the accuracy rate is quite high.

5) Centralized processing of data calculations. If the detection device has the function of communication with the cloud computing center, then the detection device only need to simply deal with the data, and then the data online to the cloud processing center for data processing, so that the computing power of the device greatly reduced, it may reduce the CPU frequency of the device, which may reduce the power consumption of the device.

Finally, with the development of society, with the progress of science and technology, the upgrading of processing technology in the development of portable medical equipment will be possible to miniaturization, implantation of human physiological parameters of the test.

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