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Near-IR Embedded in a Physiological Signal Monitoring System

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In this experimental study, we investigate the high frequency and power of near-infrared radiation embedded in impedance cardiography (ICG) with physiological signal monitoring using electrocardiographic (ECG) and pulse oximeter oxygen saturation (SpO2) sensors as well as sympathetic and parasympathetic activity analyses. This high-performance sensor system has three physiological sensing channels and a drive system. This monitoring system includes ECG, SpO2, and ICG sensors, processors, wireless communication modules, and power management modules. Compared with other portable products, physiological sensors can minimize cost and space. Power consumption and function/efficiency are all very sensitive. The sampling rate of the processor is 2500/s. The wireless communication module is a Wi-Fi communication system. The power management module supplies a continuous 5 V, 3 A power supply. A cardiovascular disease treatment drive system can supply a high frequency of operation based on the multichannel data fusion of the physiological monitoring module with a cloud artificial intelligence feedback information system with output voltage and power in the range from 0 to ±52 V. The frequency is 0.3–10 MHz. The physiological signal monitoring system can operate at a frequency of 3 MHz with a voltage amplitude of ±52 V.

1. Introduction

The physiological signal monitoring system includes four categories of sensors, processors, wireless communication modules, and power management modules. Compared with other portable products, physiological sensors can be said to be very strict in terms of cost, space, power consumption, and function/effectiveness. This demand is also reflected in the selection and consideration of key components. The best choice and configuration must be made within a very limited range, and at the same time, the performance must be improved as much as possible. When a patient is in a hospital bed, medical staff use information systems to detect the heartbeat, blood oxygen, and blood pressure to continuously monitor the patient's physiological condition.[(1–12)] In the past, sound, light, and other warning methods were used to alert medical staff that a patient may be experiencing an emergency. However, the false alarm rate of Internet of medical things (IMoT) devices is too high. Studies showed that 72–99% of alarms are false,

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which puts needless strain on nurses. In a technical analysis, some filtering mechanisms were used to assist in the past. However, if the graphics are too complicated, an accurate analysis cannot be performed. Therefore, by reducing the false alarm rate through artificial intelligence (AI), the measurement methods can be more detailed. With noninvasive detection and refinement, finger blood signal amplification, and image analysis, it is now also possible to judge the health index from the color of the blood. An LED device can be worn on the patient's finger to evaluate the color of the blood in the finger and then analyze the health level. The principle is to amplify the signal and analyze the blood oxygen concentration and other values after detecting the pulse, color, and data on blood flow in the finger with an LED light. However, during the measurement, if the finger is moved, false signals may be detected and a false alarm is issued.(13–18) Segmentation and edge computing of the heart rate warning system will become the focus of AI development with respect to cardiopulmonary function. After detailed analysis of an electrocardiogram (ECG), one can understand the conditions of arrhythmia (arrest) and ventricular fibrillation, and if there is a high risk of a life-threatening event, then the doctor must be notified. If there is bradycardia, tachycardia, or premature ventricular contraction (PVC), then the medical staff must pay more attention. Many AI systems analyze data in the cloud and then transmit the results to the organization. However, medical AI should be combined with edge computing technology to provide real-time detection and applications. The development of smart medical technology requires engineers and physicians to work together, and this also takes time.

In several modules of physiological monitoring systems, physiological sensors seem to only be responsible for the simple task of collecting body information, but they are the most varied and important ones in the research and development of portable systems. The quality of pure physiological signals that are collected directly affects subsequent processing and applications.(19–28) Generally speaking, the system power is supplied by an independent power system to eliminate unnecessary interference noise. In addition, a wireless connection is necessary, and it is also the most in need of a stabilizing mechanism. The microprocessor system provides an important computing environment related to the introduction of AI functions. Power management is a passive function, but to master the performance of the entire physiological signal system, a long battery life is definitely an important consideration for consumers. Regardless of the type of electronic product, the design involves the process of achieving the best performance in terms of cost and performance constraints. Portable products are particularly concerned with size and power consumption. Physiological signal monitoring systems are more strict in terms of space, power consumption, cost, and performance. Therefore, when selecting key components, regardless of how the end product is developed, the constant focus is on low power consumption, low cost, miniaturization, and high integration. Moreover, new products cannot significantly increase the cost or sacrifice durability due to improved performance. The highest goal is to develop physiological signal monitoring systems in the direction of overall improvement. This is also the greatest challenge faced by design engineers and research and development scientists. Sensors are one option, but considering the cost, size, power consumption, and other constraints, they can be adjusted through software or improvements in the hardware.

In addition, the processing power of the processor can be improved, so that the results of a calculation can be connected with cloud data to facilitate the execution of AI algorithms. Wireless connection capabilities are optimized to improve the judgment accuracy and decision-making quality. These processing steps must be completed without affecting the durability of the product. Effectively increasing the battery capacity is one possibility, but it does not need to significantly increase the cost.

The innovation in this study lies in the implementation of heart rate variability (HRV) analysis of combined symptoms of hemodialysis during the prevention of atrial fibrillation (AF). HRV is a useful tool for analyzing autonomic nerve activity in patients with AF.

Initially, differences in the control of pulmonary venous and atrial arrhythmias in hemodialysis patients were monitored. Initial HRV parameters of hemodialysis patients were recorded, and then fast Fourier transformation (FFT) was applied. Infrared (IR) light irradiation was used to observe the effect of improving autonomic nerve activity. The monitoring of HRV parameters in hemodialysis patients can significantly improve outcomes. The diagnosis and prevention of AF symptoms in early hemodialysis patients is very novel. This can help determine and prevent AF caused by pulmonary veins and atrial ectopic lesions. Hypertension and diabetes are known risk factors for AF.

2. Materials and Methods

The multichannel transducer physiological signal monitoring system has a portable system design and wireless transmission technology to continuously monitor a patient's electrocardiogram (ECG), blood oxygen concentration (SpO2), and impedance cardiography (ICG). A patient's real-time physiological signals can be obtained through a display panel; at the same time, the physiological monitoring equipment can select channel signals to be observed according to different cardiovascular diseases.

2.1 ECG

An ECG captures the individual signal and observes the HRV. For hemodialysis patients, changes in the HRV before and after dialysis can be observed. Increasing morbidity and mortality due to kidney disease is a major global public health problem, and heart disease is the main cause of arrhythmia, or heart rhythm variation, in hemodialysis patients. HRV analysis is a method of measuring the degree of change in consecutive heartbeats. The blood pressure (BP) is a product of the cardiac output and peripheral vascular resistance relative to the total peripheral resistance (TPR) of the individual. The occurrence of hypotension during dialysis is naturally related to these two elements.

In fact, the normal heartbeat fluctuates due to regulation by the autonomic nervous system, and these fluctuations disappear due to the influence of the autonomic nervous system. During hemodialysis, systolic insufficiency, diastolic insufficiency, arrhythmias, pericardial effusion, myocardial damage, changes in blood volume, and changes in electrolytes exacerbate the reduction in cardiac output, resulting in a decrease in blood pressure. Therefore, when the variation disappears or is significantly reduced, a completely regular heart rate is produced without fluctuations. This heart rate is considered to be an abnormal manifestation of the cardiac autonomic nervous regulatory system. The purpose of observing HRV is to measure the regularity of the difference in the heart rate; it can provide a noninvasive way of measuring the balance of the autonomic nervous system. There are many factors that can cause it to change. In addition to age, gender, and ethnicity, other pathological factors such as myocardial infarction, diabetes, and heart failure can cause the HRV to decrease.

2.2 SpO2

The purpose of measuring the SpO2 is to detect the amount of oxygen in the blood. The measurement method requires the use of two single-wavelength lights: red light at 650–660 nm and IR light at 930–940 nm. The lights penetrate the skin tissues of the fingers, toes, and other body parts, and respond to oxygenated and non-oxygenated hemoglobin in the blood. The different characteristics of the light absorption of these two wavelengths cause different losses of light intensity. The optical receiver senses the distribution of different light intensities, couples the electrical signal, and then amplifies it.

ECG and photoplethysmography (PPG) have their own advantages and disadvantages, but they have complementary characteristics, which can provide more choices of cardiovascular information for users and doctors. In the future, with the development of home care and telemedicine technology, measurements from the fingers or the periphery of the body will make it easier to track diseases monitored during long-term care. In recent years, portable physiological monitoring signal systems have attracted considerable attention. Although measured physiological data are mainly based on daily exercise and sleep records, autonomous health management has become an extremely important requirement.

2.3 ICG

The TPR is calculated using the patient’s BP data and the change in systolic impedance from the electrical output measurement. The control system calculates the cardiac output as the product of the measured stroke output (calculated on the basis of the electrical output) and the heart rate.

(1) Cardiac function in hemodialysis patients: Under the influence of factors such as hypertension, coronary artery disease, and uremia, the myocardium becomes hypertrophic and rigid, leading to diastolic insufficiency. In addition, some patients have arrhythmias, ischemic heart disease, valvular heart disease, pericardial effusion caused by cardiac tamponade, restrictive cardiomyopathy, and so forth. Owing to the effects of these heart diseases, patients are particularly susceptible to loss of compensation and hypotension when dialysis dehydration causes a decrease in the systemic blood volume. Moreover, in dialysis, studies using positron tomography and cardiac ultrasound testing confirmed that regardless of whether it is dehydration during dialysis or combined with hypotension, it is sufficient to cause myocardial ischemia and damage. In addition to the lack of blood perfusion of

cardiomyocytes caused by hypotension, the increased plasma concentration after dehydration also contributes to shear stress on blood vessels.

(2) Changes in blood volume of hemodialysis patients: A 58-kg adult has a blood volume of about 4 L in a routine dialysis process, and the blood volume of the entire body is equivalent to twice the amount of plasma removed. However, studies confirmed that the removal of 3 kg of water during a 3-h dialysis process only reduces the body's plasma volume by 17%. The reason is that the water is refilled from the intracellular or interstitial tissues (plasma refilling) back into the blood vessels. The refill rate of plasma depends on the difference between the water level and osmotic pressure inside and outside the capillaries and is affected by sodium ions and the hematocrit, albumin, and glucose concentrations in the blood; therefore, those who use a low-sodium dialysate or have anemia or low plasma protein are all affected. Low-sodium dialysate is a predisposing factor for hypotension during dialysis. If the dialysis dehydration rate exceeds the plasma refill rate, the decrease in plasma volume leads to insufficient cardiac preload, which naturally causes hypotension.

With the ability to swap among multichannel signals, observation of detailed signals (detailed features within 1–5 s), and synchronous selection of multichannel data fusion of the physiological monitoring module with a cloud AI feedback system, the simultaneous selection of multiple physiological modules, such as ECG, SpO2, and ICG physiological sensor integration, can synchronously monitor the physiological status (Fig. 1). An ECG, SpO2, and ICG can simultaneously be collected and uploaded to cloud computing, and the analytical results stored. The ECG, SpO2, and ICG values are shown on the same system screen at the same time. The same time axis can be compared with the warning status of the next important parameter at the same time. Actually, with synchronized multichannel physiological sensing measurements, the system can zoom in to a certain time zone to calculate the impedance signal distribution in detail and estimate the area to compare symptoms.

3. Results

By synchronously selecting the multichannel physiological monitoring module with a cloud AI feedback system and method, multichannel clinical physiological signals can be synchronized, including the simultaneous capture of ECG, SpO2, and ICG. The high-frequency

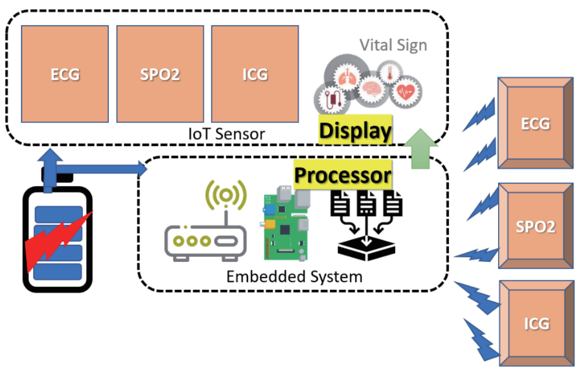


Fig. 1. (Color online) Physiological signal monitoring system.

and high-voltage power drive system is shown in Fig. 2. The drive system in this research can output voltage and power in the range from 0 to ±52 V according to information from this system. The frequency is 0.3–10 MHz. As shown in Fig. 3, it can operate at a frequency of 3 MHz and a voltage amplitude of ±52 V.

3.1 High-frequency and high-voltage power drive system

Information from the multichannel physiological monitoring module with a cloud AI feedback system can be used to process and treat heart disease cases, including AF disease. AF is a type of abnormal function of the rhythm signal generated by the heart, causing the heartbeat to be irregular and often too fast.

On average, one in every 100 persons in the general population suffers from AF. As one's age increases, the susceptibility to this disease becomes higher. Four in every 100 persons over 60 years of age suffer from this disease, and one in every 10 persons over 80 years of age suffers from the disease.

This study was based on monitoring the signals from the ECG channel to observe the responses of the sympathetic and parasympathetic nervous systems. This process provides a

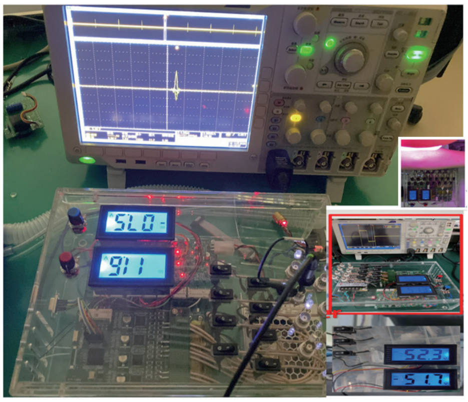


Fig. 2. (Color online) High-frequency and high-voltage power drive system.

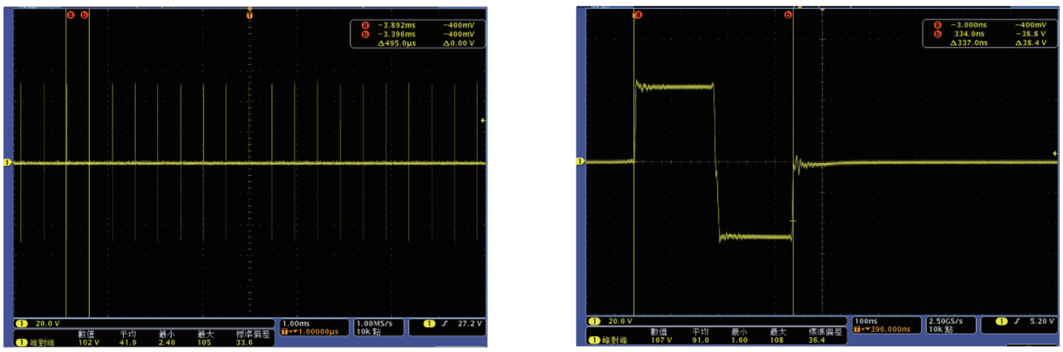


Fig. 3. (Color online) High-voltage pulse waveform output of high-frequency and high-voltage power drive system.

clinical reference for determining the symptoms of AF and assists in further clinical setting of the parameters and operating specifications of the treatment system. One of the functions of the high-frequency and high-voltage power drive system is to output short pulses to drive the near-IR (NIR) light source irradiation system. The purpose of this NIR light source irradiation system is to respond to the sympathetic and parasympathetic nervous systems after irradiation, as shown in Figs. 2 and 3.

3.2 Multichannel data fusion physiological monitoring system

A physiological signal monitoring instrument is used to observe a patient's heart rhythm or blood oxygen in clinical practice. If the measured physiological signal value is not within a reasonable range, it will immediately sound an alarm, and the nursing station is notified to initiate first aid or provide medication. It is impossible to predict the possible status of a patient in advance or observe the previous physical status of a patient.

The adopted structure is divided into the synchronous selection of the multichannel physiological monitoring module with a cloud AI feedback system and method, which synchronizes multichannel clinical physiological signals and the multichannel physiological monitoring module cloud AI feedback system, including the synchronous capture of ECG, SpO2, and ICG, and extends the physiological sensor system. (1) The SpO2 physiological sensor can be integrated to monitor the physiological state and simultaneously collect the ECG and SpO2 and upload the analytical results to cloud computing for storage. (2) The blood oxygen concentration (SpO2) physiological sensor can be integrated to monitor the physiological state, simultaneously collect the ECG and ICG values, and upload the analysis results to cloud computing for storage. The results are fed back to the treatment equipment, and the hemodialysis equipment immediately stops operating. (3) The ICG sensor can be integrated to monitor the physiological state and simultaneously collect the ECG and impedance value and upload the analytical results to cloud computing for storage. The system can zoom in to a certain time zone to calculate the cardiac output value. This threshold is the average value of the monitored cardiac output for half a year. If it is lower than the average threshold, a warning message is issued. If the value is 90%, the first aid mechanism will immediately be activated on the basis of feedback data. (4) It can integrate the physiological sensors of select ECG, SpO2, and ICG values, monitor the physiological state, and collect the ECG, SpO2, and ICG values at the same time after uploading the analysis results to cloud computing for storage. The ECG, SpO2, and ICG values are simultaneously displayed on the same system screen. The same time axis can be compared with the warning status of the next important parameter at the same time. (5) In the actual synchronized multichannel physiological sensing measurement, the system can zoom to in a certain time zone to calculate the impedance signal distribution in detail. According to the monitoring needs of different ethnic groups, the multichannel physiological monitoring module cloud AI feedback system is simultaneously selected, and the physiological signal channel of a particular ethnic group is selected for operation for subsequent prevention, treatment, and care applications. The multichannel data fusion of the physiological monitoring module with a cloud AI for feedback on clinical treatment is shown in Fig. 4.

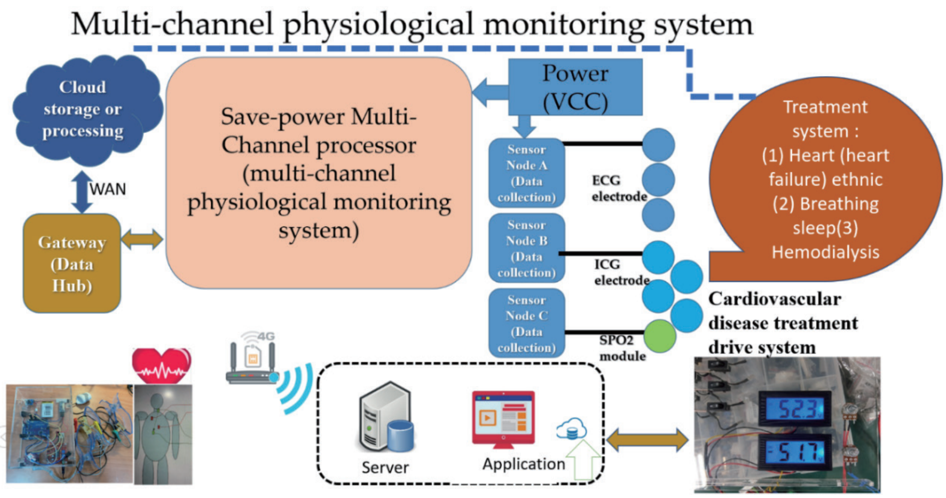


Fig. 4. (Color online) Multichannel data fusion of physiological monitoring module through cloud artificial intelligence for feedback on clinical treatment.

Synchronous multichannel clinical physiological signals from the synchronous selection of multichannel data fusion of the physiological monitoring module with a cloud AI feedback system include the synchronous capture of ECG, SpO2, and ICG, thus extending any physiological sense detector system. The way the feedback mechanism is applied to treatment is as follows. (1) For patients with heart heart failure, with feedback treatment system reference, ECG channel monitoring signal results are used to judge AF symptoms, to help determine further clinical treatment system parameters and operating specifications settings. (2) For patients with breathing and sleep disorders, changes in blood oxygen value (SpO2) are used as the basis for altering the pressure of the respirator. (3) For hemodialysis patients, the body impedance reaching the average value of the case after dialysis is the basis for stopping dialysis.

3.2.1 Multichannel physiological monitoring system of multiple fields

According to patients in different regions, the synchronous selection of the multichannel data fusion of the physiological monitoring module through a cloud AI feedback system in multiple fields can integrate patient data. Results of the previous treatments of hemodialysis patients and physiological signal feedback are used as parameters for the current treatment. After calculating and analyzing the enormous amount of data of physiological signals, whether or not the autonomic nerve function of the patient is normal can be judged. From changes in the low-frequency (LF)/high-frequency (HF) values before and after hemodialysis, physical health indicators can be analyzed and predicted. Common indicators for frequency domain analysis include low frequency, high frequency, and the low frequency/high frequency ratio (LF/HF ratio). The LF/HF ratio mainly reflects the index of the balance between the sympathetic nerve and the parasympathetic nerve (sympathy–vagal balance).

The sensor node collects data and sends it to the gateway through the transmission interface. After the gateway collects the data, it is uploaded to the cloud for storage (database) or processing. Continuously retrieved data and continuously embedded data in the device are copied to the cloud, regardless of the size of the data. After the data are written to the gateway device, the device uploads the data to the cloud. This system collects physiological data of different patients in multiple fields at the same time. After collecting data according to field 1, field 2, field 3, to field N, this system provides a reference for the treatment information of patients in the corresponding field as shown in Fig. 5.

3.2.2 Simultaneous selection of multichannel physiological monitoring module operation interface

Monitoring data collected by front-line field equipment are returned to the central cloud database for data storage, and the multichannel data fusion of the physiological monitoring module with a cloud AI feedback system and method are synchronously selected, multichannel clinical physiological signals are synchronized, and multichannel physiological monitoring is synchronized by the modular cloud AI feedback system, including the simultaneous capture of ECG, SpO2, and ICG, and the extension of any physiological sensor system. The image of the multichannel physiological monitoring module operation interface is synchronously selected as shown in Fig. 6. The physiological information table contains the file name, file size, command (delete file), selection, and other commands that belong to the patient's case.

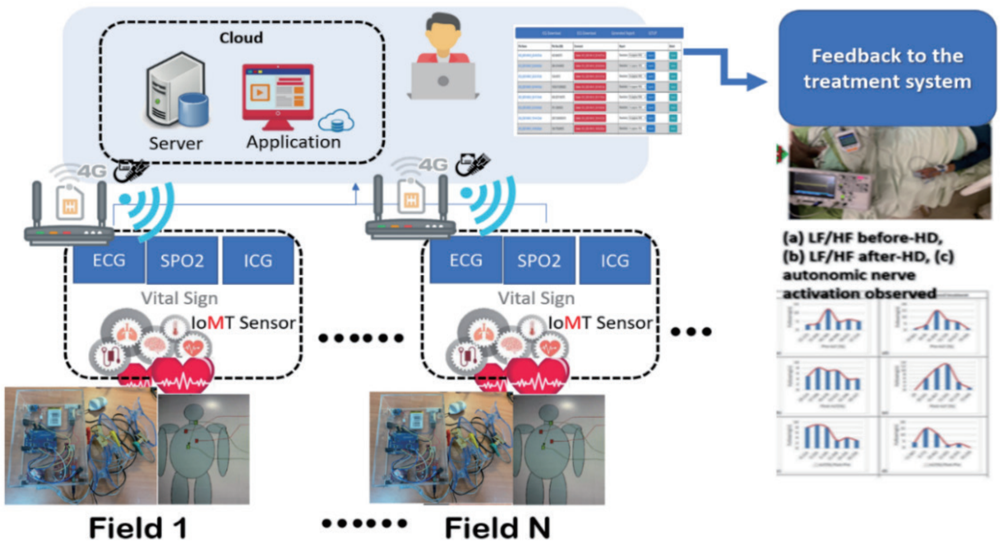
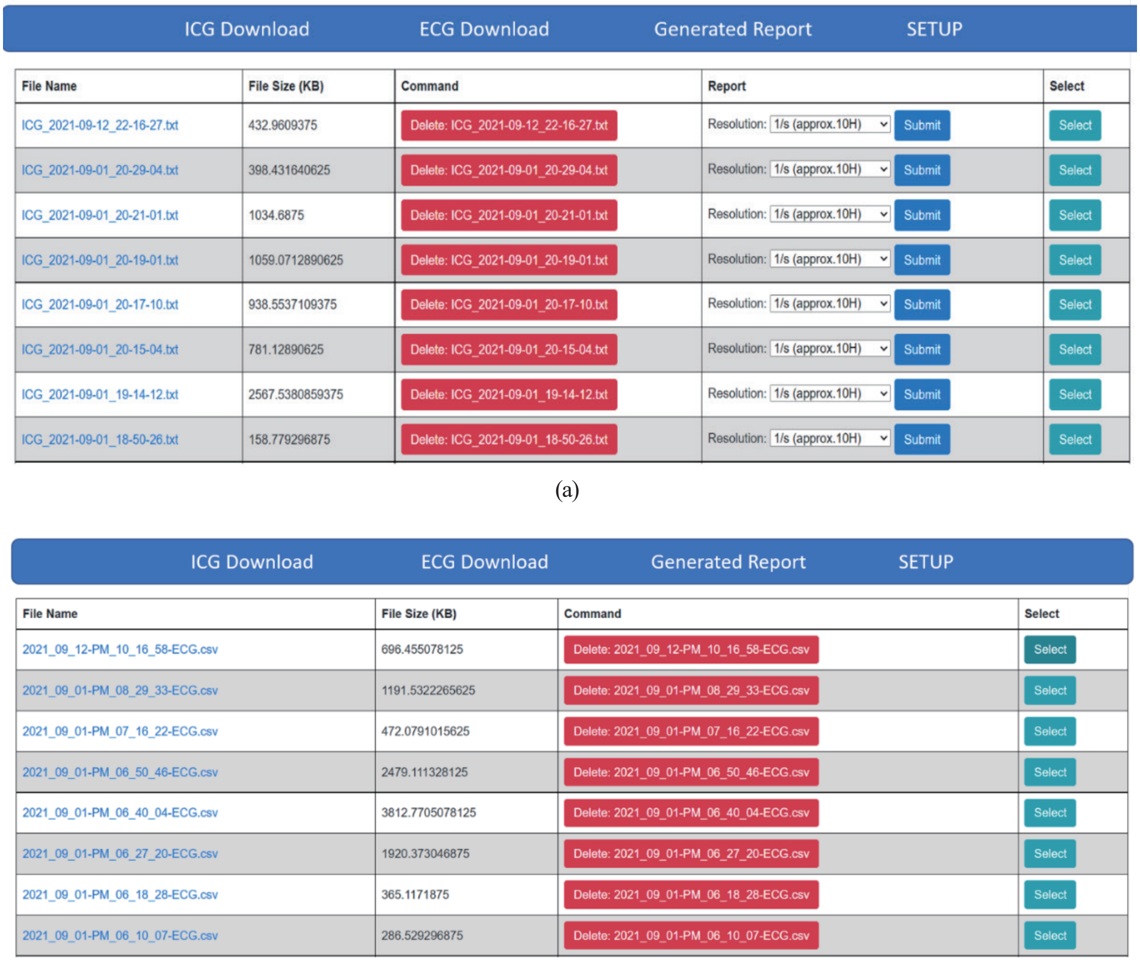


Fig. 5. (Color online) Several-field multichannel physiological monitoring system.



ICG Download ECG Download Generated Report SETUP

File Name	File Size (KB)	Command	Report	Select
ICG_2021-09-12_22-16-27.txt	432.9609375	Delete: ICG_2021-09-12_22-16-27.txt	Resolution: 1/s (approx.10H) Submit	Select
ICG_2021-09-01_20-29-04.txt	398.431640625	Delete: ICG_2021-09-01_20-29-04.txt	Resolution: 1/s (approx.10H) Submit	Select
ICG_2021-09-01_20-21-01.txt	1034.6875	Delete: ICG_2021-09-01_20-21-01.txt	Resolution: 1/s (approx.10H) Submit	Select
ICG_2021-09-01_20-19-01.txt	1059.0712890625	Delete: ICG_2021-09-01_20-19-01.txt	Resolution: 1/s (approx.10H) Submit	Select
ICG_2021-09-01_20-17-10.txt	938.5537109375	Delete: ICG_2021-09-01_20-17-10.txt	Resolution: 1/s (approx.10H) Submit	Select
ICG_2021-09-01_20-15-04.txt	781.12890625	Delete: ICG_2021-09-01_20-15-04.txt	Resolution: 1/s (approx.10H) Submit	Select
ICG_2021-09-01_19-14-12.txt	2567.5380859375	Delete: ICG_2021-09-01_19-14-12.txt	Resolution: 1/s (approx.10H) Submit	Select
ICG_2021-09-01_18-50-26.txt	158.779296875	Delete: ICG_2021-09-01_18-50-26.txt	Resolution: 1/s (approx.10H) Submit	Select

(a)

ICG Download ECG Download Generated Report SETUP

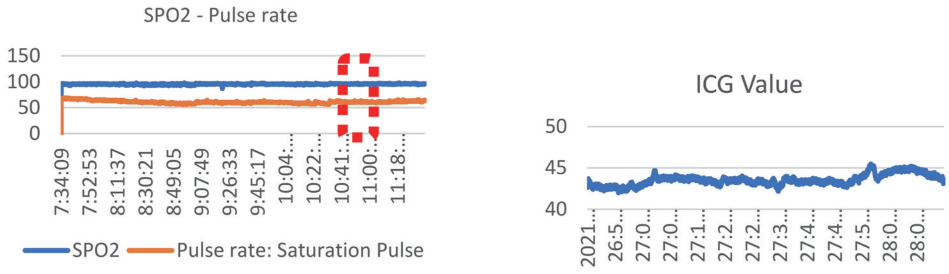
File Name	File Size (KB)	Command	Select
2021_09_12-PM_10_16_58-ECG.csv	696.455078125	Delete: 2021_09_12-PM_10_16_58-ECG.csv	Select
2021_09_01-PM_08_29_33-ECG.csv	1191.5322265625	Delete: 2021_09_01-PM_08_29_33-ECG.csv	Select
2021_09_01-PM_07_16_22-ECG.csv	472.0791015625	Delete: 2021_09_01-PM_07_16_22-ECG.csv	Select
2021_09_01-PM_06_50_46-ECG.csv	2479.111328125	Delete: 2021_09_01-PM_06_50_46-ECG.csv	Select
2021_09_01-PM_06_40_04-ECG.csv	3812.7705078125	Delete: 2021_09_01-PM_06_40_04-ECG.csv	Select
2021_09_01-PM_06_27_20-ECG.csv	1920.373046875	Delete: 2021_09_01-PM_06_27_20-ECG.csv	Select
2021_09_01-PM_06_18_28-ECG.csv	365.1171875	Delete: 2021_09_01-PM_06_18_28-ECG.csv	Select
2021_09_01-PM_06_10_07-ECG.csv	286.529296875	Delete: 2021_09_01-PM_06_10_07-ECG.csv	Select

(b)

Fig. 6. (Color online) This system operation guide contains four project data operations: ICG Download, ECG Download, Generated Report, and Setup. (a) Body impedance (ICG) channel selected: capture the current data on the patient. (b) Heart rhythm signal (ECG) channel selected: Retrieve the current data on the patient.

Figure 7 shows observed changes in a patient's SpO2–pulse rate for a long time as a reference for the treatment system. The physiological monitoring module with a cloud AI feedback system calculates whether the heart beat output of the patient is normal.

This system operation guide contains four project data operations: "ICG Download", "ECG Download", "Generated Report", and "Setup". In a different field, physiological information of the patient is selected. Real-time feedback and AI calculations, predictions, and assistance in treatment are provided. ICG and ECG values are plotted along a time axis as shown in Fig. 8. In a table of physiological information, the corresponding characteristic signal is drawn on the same time axis. The interface can be zoomed in to deeply observe the physiological information of abnormal details, including the HRV signal, the amount of body water, and the analysis of the corresponding combined symptoms at the same time.



(a) (b)

Fig. 7. (Color online) SpO2–pulse rate–ICG synchronized multichannel physiological monitoring module. (a) Physiological signal channel integration selected: plot of the characteristics of the current combination after 4 h of monitoring the distribution of SpO2–pulse rate. (b) The physiological monitoring module can be used for artificial intelligence calculation, judgment, and treatment parameters.

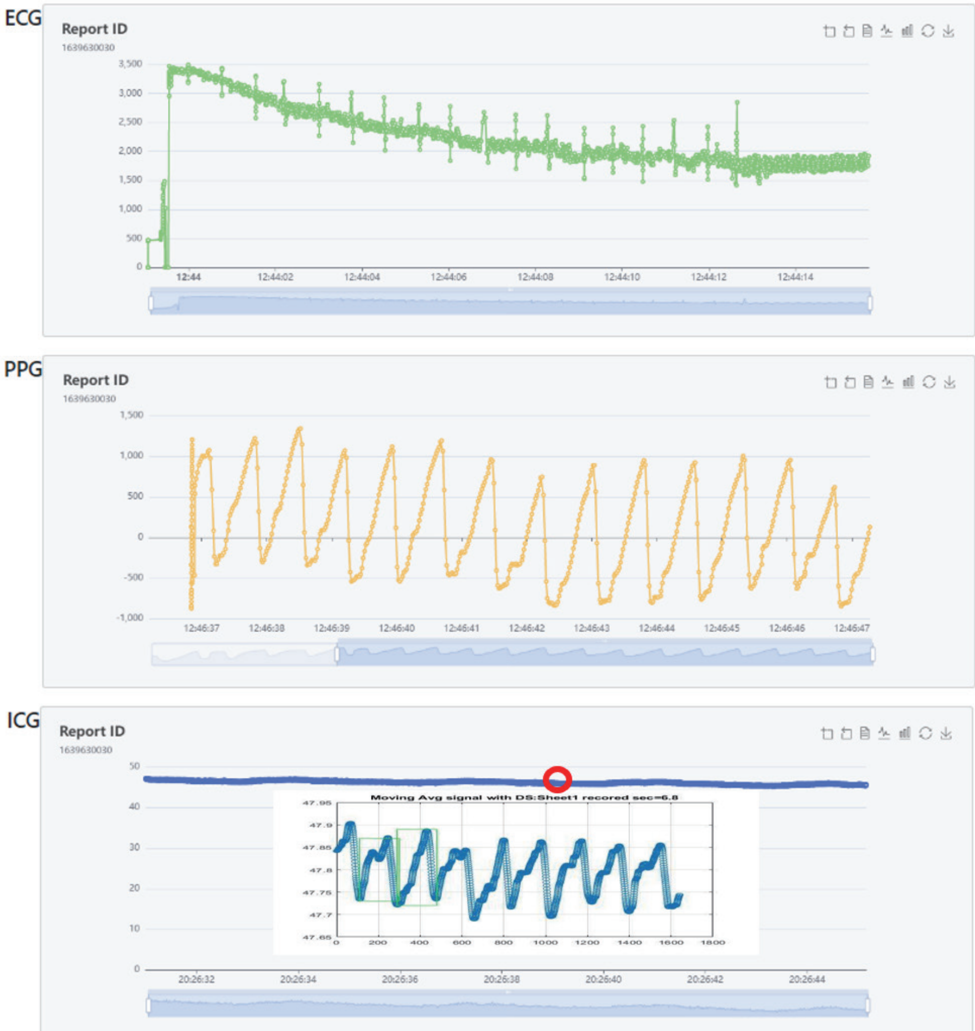


Fig. 8. (Color online) Synchronously integrated ECG, SpO2 (PPG), and ICG synchronization selection and characteristic curve from multichannel physiological monitoring.

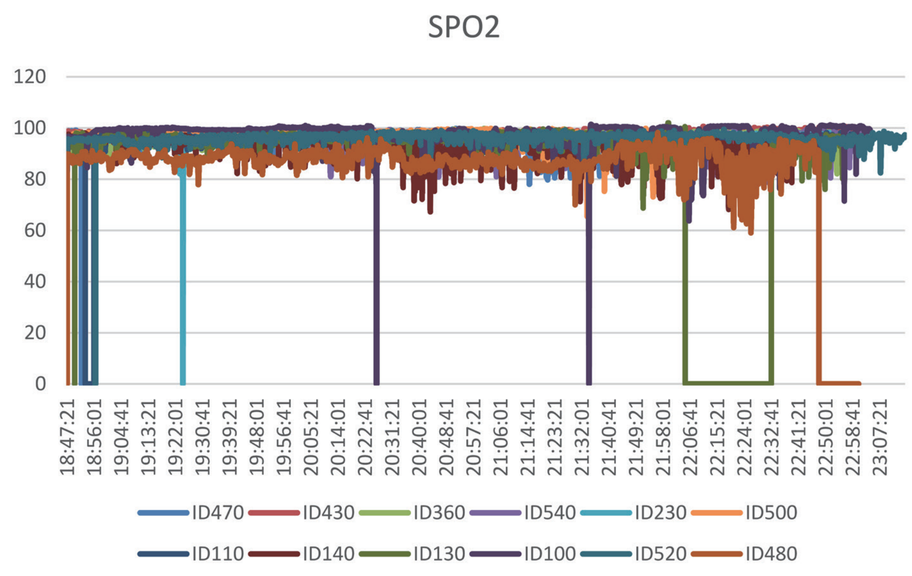
For the heart (AF disease, heart failure) patients: Abnormal functioning of the heart that produces rhythm signals can cause the heartbeat to be irregular and often too fast, or the heartbeat blood output to be abnormal. The cloud AI feedback system can treat heart disease cases, including AF disease.

For patients with difficulty breathing and sleeping: The multichannel physiological monitoring module cloud AI feedback system synchronously selects the size of the impedance curve area, and changes in the HRV and SpO2 are used as the basis for setting the pressure of the respirator.

For hemodialysis patients: The multichannel physiological monitoring module cloud AI feedback system determines when the body impedance reaches the average value of the case after dialysis as the basis for stopping the dialysis, and then sends a "stop dialysis" signal.

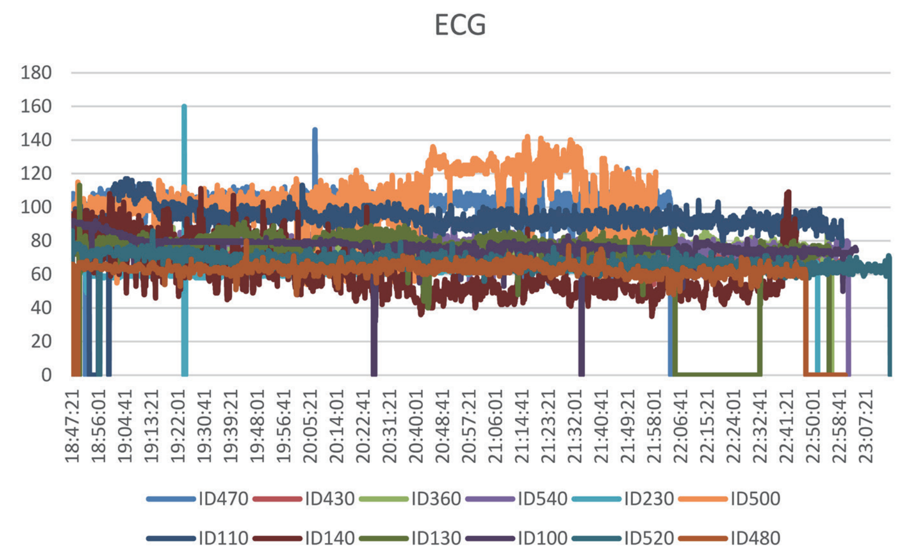
According to the monitoring needs of different ethnic groups, the multichannel physiological monitoring module cloud AI feedback system is simultaneously selected, the physiological signal channel of this ethnic group is selected, and the cloud AI feedback system is used for subsequent prevention, treatment, and care applications. The calculation method of the synchronous selection of this system is not limited to the simultaneous collection of ECGs, SpO2, and ICG, but also includes physiological values that can be calculated at any time, and executes cloud computing to apply AI to predict, judge, and make decisions. According to the monitoring needs of different ethnic groups, this system simultaneously selects the physiological signal channel of this ethnic group for operation for subsequent prevention, treatment, and care applications.

The blood oxygen and heart rate were measured [Figs. 9(a) and 9(b)], and variations of physiological signals were observed during radiation therapy. HRV signals were analyzed for sympathetic and parasympathetic nervous system responses during the procedure. It included the difference in curve distributions before radiation therapy (Pre-nLF: sympathetic nerve



(a)

Fig. 9. (Color online) (a) Measurement of blood oxygen in patients and (b) measurement of heart rate.



(b)

Fig. 9. (Continued) (Color online) (a) Measurement of blood oxygen in patients and (b) measurement of heart rate.

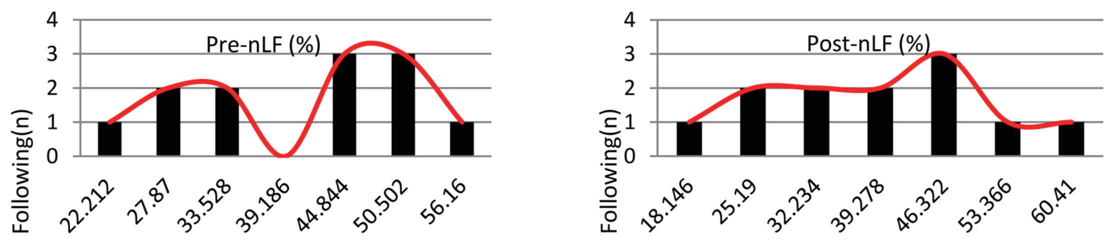


Fig. 10. (Color online) Sympathetic/parasympathetic balance indicator (a) before and (b) after radiation therapy.

reflection index) and after radiation therapy (Post-nLF) [Figs. 10(a) and 10(b)]. The result is clearly a normal distribution. This indicates that the response of physiological signals after irradiation treatment is an index representing the balance of sympathetic and parasympathetic nerve activities. Observation of the regulatory function of sympathetic nerves is possible, and it is helpful for symptom observation after follow-up surgical treatment.

4. Conclusions

In this research, we demonstrated high-frequency power and near-infrared radiation embedded in ICG with physiological signal monitoring by ECG and SpO2 sensors, which satisfied the multitask selection multichannel physiological signal monitoring sensor drive system. This system not only completes vertical integration, synchronous multichannel clinical physiological signals, and synchronous selection of multichannel data fusion of the physiological monitoring module through a cloud AI feedback system, but also completes horizontal integration, integrating multiple field monitoring data into one AI process, and displays the results on a screen. It is used for subsequent prevention, treatment, and care applications. Because multichannel case physiological information is collected, after AI calculations, we can obtain reference materials for the treatment of heart disease symptoms. This system includes high-frequency and high-voltage power drive systems, and the design and manufacture of an ultrasonic ablation drive system. As another clinical application, the treatment system is a radio frequency electric ablation system. In the future, it will not only be used to continuously monitor a patient's ECG, SpO2, and ICG, but also the increase in grip strength (EMG), body temperature, and BP, with NIR imaging. Through the display panel, the patient's real-time physiological signals can be obtained.

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