The Design of the Intelligent Health Information Collection Terminal Which is Based on the Embedded Technology

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Abstract. The paper introduces an Intelligent Terminal which is based on the embedded technology to address the low degree of integration and intelligence of the current Health Collection Information Terminal. The new terminal adopts the design of the structure and function integrating method to integrate six health parameter measuring functions in one suit, including Electrocardiogram(ECG), Respiratory Rate, Blood Oxygen, Body Temperature, Blood Pressure and Pulse), which is easy to carry. The additional interpersonal interfaces like storage, printer, monitor, communication and Radio Frequency Identification (RFID) enhance the new terminal’s intelligence degree. It could be widely applied in the situations of hospital, community, disaster relief and military.

Introduction

With the rapid progress of science and technology and people's living standards rising, people have gradually improved the requirement of medical care level. As a kind of health inspection equipment, the Health Information Collection Terminal is gradually applied to the community organizations of high-density population such as hospitals, clinics, schools and community. It can also be applied to the special Purpose like providing disaster relief and military.

The research of Health Information Collection Terminal in China has some bottlenecks and inadequate on technology and application. Firstly, the terminal has not high degree of integration. The connection between physiological parameter detection equipments and terminal is external. So it is not easy to carry. Secondly, it is lack of intelligence. Currently some of the terminals in China market adopt mobile phone. So these methods cause the communication lack of flexibility between the collection terminal and network server. Thirdly, the terminal can’t retrieval and storage the collected the health data on time, so it isn’t convenient for patient to understand their own condition.

For some design deficiencies of the Health Information Collection Terminal currently above-mentioned, we introduce a new design of Intelligent Health Information Collection Terminal which is based on the embedded technology. The innovation of this new terminal is mainly reflected in the high level of integration and high intelligence. Firstly the new terminal integrates the collection terminal and physiological parameter detection equipments to a multifunctional case. These parameters are ECG, Respiratory Rate, Blood Oxygen, Body Temperature, Blood Pressure and Pulse. Every collection module of parameters has its separate storage space. This Integrated approach makes the terminal easy to apply and carry. Secondly, the new terminal use the bluetooth and USB to achieve communication among device each other. It could enforce the flexibility of data interaction. Lastly, the new terminal integrates storage device, printer, tablet PC, RFED and communication module. It can not only display, store and print inspection results, but also achieve remote diagnostics.

Function Integrated Design of the Intelligent Collection Terminal

The Intelligent Health Information Collection Terminal which is based on the embedded technology can be divided into two major components by function: Embedded Workstation and Basic Physiological Signal Acquisition. The block diagram is in Figure 1.
The Function of Embedded Workstation

Embedded Workstation is the core component of Intelligent Health Information Collection Terminal. This component takes industrial computer main board as the control unit. The structure of Embedded Workstation is as follows:

(1) Human-Computer Interaction Unit: It’s actually the tablet PC. Embedded Workstation can display the friendly application interface by monitor. Doctor can also operate the equipment by touchscreen.

(2) Wireless Communication Module: This interface module is used to communicate to remote medical service. It could take the remote expert guidance to local that assists medical decision and achieve the diagnosis online.

(3) Integrated Application Peripherals: Embedded Workstation integrates printer, RFID, Storage. It could achieve the function of identification, storage and printing on data and image.

The function of Basic Physiological Signal Collection

Basic Physiological Signal Collection section contains ECG and respiratory rate measurement Integration module, Blood Oxygen measurement Integration module, Body Temperature measurement Integration module and Non-invasive Blood Pressure and Pulse Rate measurement Integration module.

ECG and Respiratory Rate Measurement Integration Module. ECG monitoring is an important means of diagnosing cardiovascular disease. The long record of dynamic ECG signal could improve the detection of ECG changes and reveal weak ECG change on state of supine. It could also acknowledge the relationship between these changes and Heart Rate, diary symptom, postural and so on. It provide important basis of medical diagnosis.

Respiratory rate analysis algorithm is based on ECG electrical axis analysis method. The method takes the orthogonal ECG lead. According to calculate the square of the orthogonal ECG lead wave group, we can calculate relative change of electrical axis and export breathing curve. The export breathing curve and the real breathing curve have a high correlation coefficient. So the real Respiratory rate could be calculated.

Blood Oxygen Measurement Integration Module. The Blood Oxygen Measurement of Intelligent Collection Terminal is mainly based on the degree that hematoglobulin and reduced hemoglobin absorb different wavelengths of light. Oxygen probe uses the two specific wavelengths of light to go through the upper part of finger, while silicon photovoltaic cell receives transmitted light and generates an electrical signal. Then the result could be gotten by calculating the ratio of AC and DC components of the two lights.

Body Temperature Measurement Integration Module. It is very important to keep the Body Temperature stable. The change of Body Temperature can also cause disease. So the Body Temperature measurement is an effective method of detecting and preventing disease. The measurement module is based on thermistor detection method to get the Body Temperature. The circuit of measurement is Wheatstone electric bridge whose one bridge arm is added the thermistor.
The result could be gotten by measuring the unbalanced output of electric bridge. The least-squares fitting algorithm should be taken to fit and correct the characteristic curve.

**Non-invasive Blood Pressure and Pulse Rate Measurement Integration Module.** Non-invasive Blood Pressure measurement of Intelligent Collection Terminal mainly uses oscillography method to achieve the precision measurement. Inflatable cuff is used to block arterial blood flow. During the process of slow blowing off, detection is from the vibration wave of vessel wall and finds out the intrinsic relationship between envelope of vibration wave and arterial pressure. Then the measurement result of Blood Pressure is gotten. In addition, patient status alarm and system status alarm should be added to monitor measurement state. As oscillometric measuring time could not be too long, we also design the function of blood pressure cuff quickly blowing off and Cuff overvoltage protecting to keep the patient safety during measurement.

As pulse wave signal is in a very small proportion on mixed-signal during measuring the Pulse Rate, the output of instrumentation amplifier can’t be leaded to SCM AD converter module for sampling directly. The frequency range of static pressure is 0~0.5Hz which likes DC and The frequency range of pulse wave is 1~30Hz like periodic signal. Passing high-pass filter, static pressure can be filtrated. Then obtained pulse wave signal is weak and contains some High-frequency interference. It should be amplified low-pass filtrated and finally be leaded to SCM AD converter module for sampling.

**Integrated Structure Design of the Intelligent Collection Terminal**

Considering the shortcoming of low integration about traditional collection terminal, we integrate the Embedded Workstation and Basic Physiological Signal Collection device into a multi-function case. Its shell adopts high strength synthetic plastics. So it has high hardness, waterproof, impact resistance, corrosion resistance, wear resistance, high temperature resistance, light weight and other characteristics. The exterior of the case is in Figure 2.

We design and layout the interior of Intelligent Health Collection Terminal case reasonably. RFID, printer, keyboard, monitor and other human interface device is embedded into panel of the case interior. So it is convenient for doctor to operate. Six health Parameters measurement device have separate storage space in case that is easy to inspect. The embedded electric control part is under the panel. It can keep the entire tidy. The quality of the case interior adopts ergonomic principles. So the load’s distribution evenly and make the case easy to carry.

![Figure 2. The case of Intelligent Health Information Collection Terminal](image)

**The Function Text of Health Data Collection Terminal**

To verify the detection accuracy of Intelligent Health Collection Terminal, we randomly selected one hundred of different age which is from 6 to 70 and different gender to measure the health parameter. We apply the measurement result of the standard health parameter measurement device as the standard reference data at the same time. We also choose a multi-parameter monitor which is researched by Adecon Company in Shenzhen to compare with our terminal. The accuracy of measurement result is in Table 1.
<table>
<thead>
<tr>
<th>Text parameter</th>
<th>Adecon DK-8000</th>
<th>Intelligent Health Collection Terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood Pressure</td>
<td>±5mmHg</td>
<td>±4mmHg</td>
</tr>
<tr>
<td>ECG</td>
<td>±1%</td>
<td>±0.85%</td>
</tr>
<tr>
<td>Body temperature</td>
<td>±0.1°C</td>
<td>±0.06°C</td>
</tr>
<tr>
<td>Respiratory Rate</td>
<td>±3bpm</td>
<td>±2bpm</td>
</tr>
<tr>
<td>Blood Oxygen</td>
<td>±2%</td>
<td>±1.3%</td>
</tr>
<tr>
<td>Pulse</td>
<td>±2BrPM</td>
<td>±2BrPM</td>
</tr>
</tbody>
</table>

According to test result in block1, every health parameters’ accuracy is more accurate and meets the standard requirement. Every measurement result can detail present to the doctor and the text data can be stored and printed timely. The health collection data can also report to the remote medical server.

**Conclusions**

The paper presents an Intelligent Health Information Collection Terminal which is based on the embedded technology. The terminal adopts the design concept of embedded structure and integrates the measurement module, monitor, storage, printer and communication module into a high-strength synthetic plastic case. It not only overcomes the shortages of terminal on market currently which are single function, low degree integration and non portable, but also enhances the degree of intelligence. The new terminal could provide ECG, Respiratory Rate, Blood Oxygen, Body Temperature, Blood Pressure and Pulse check of physiological parameters. According to the test , every integration module runs normally, and every function is able to meet the standard accuracy requirements. The terminal could also realize remote data communication and diagnostics online. The design goal of high integration and intelligence has been achieved.

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