An Home Health Care Box Adaptive for Different Scenarios

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Abstract—**Physiological signal monitoring is a key function in the application of home health care. In recent years, various devices for physiological signal monitoring in different environment were developed for assisting health care. However, monitoring alone can't fit the needs of many scenarios. As such, it is often that the patient requires some daily healthcare related interaction. It is also essential that a system not only monitors but also serves as an assistance to the patient, such as medicine taking reminder, home visiting arrangement, etc. for supporting the patient with interaction capabilities in daily care scenarios. Based on this consideration, this paper has presented a home health care box which provides health monitor and fits a variety of scenarios to achieve health management. In order for the home health box to be able to adapt for different scenarios, a message embedding mechanism is also presented in this paper.**

Keywords— **Home Health Care Box, Remote Health Care, Interactive Medical Scenario, Psychological Signal, Home Box**

I. Introduction

The utilization of telecommunication technology for medical diagnosis, treatment, and patient care is an attractive development in telemedicine [1]. Recent technological research has developed a broad range of telemedicine applications, such as tele-radiology [3]-[4], tele-consultation [5], and remote patient-monitoring [6]-[8] that are supported by computer networks and wireless communication. The world population is increasing in the percentage of elderly [9] and this has made patient-monitoring an attractive application because such services would enable early detection and diagnosis of pathological symptoms in elderly patients, who generally suffer from chronic diseases [10]. The applications of Patient-monitoring usually lacks interaction between the patient and service center. Now, monitoring alone no longer satisfies the users. Combining health management with monitoring is an emerging trend. Faced with a large number of physiological signals, we added a new function in the HCB to remind doctors concerning previous abnormal symptoms. Daily services such as reminders to take medicine, medicine delivery and healthy food delivery are useful. The ability to dialog with the service center, make an appointment with the hospital, and schedule the care visit plan, are all necessary functions.

Most monitoring applications[2],[6]-[8] do not allow remote access control from the service center. The HCB proposed by our study provides remote access control function to set up the HCB. In this way, it is easy to maintain the whole health care system and significantly reduce costs. The control message and other message are designed in EXtensible Markup Language (XML) in order to achieve uniformity of patient records with HL7 and other standards. ANSI/HL7 CDA R1.0-2000 is the first nationally certified XML-based standard for healthcare [11]. Specific embedded HCB design is a good choice in order to have a friendly interface and keep the cost down. In our study, a HCB adaptive for at least seven scenarios was proposed.

The paper was organized as the following: "Overall System" provide system overview. "The Design of Home Health Care Box" provide the software and hardware architecture. "Implementations" shows the implementation details. "Conclusions" concludes this paper.

II. Overall system

Figure 1 shows the overall system of the home health care platform. The service center could be considered as a message exchange center between patients and hospitals. The HCB and the service center have their own applications. The network of the system was designed in peer-to-peer. This means that the HCB plays both the roles of server and client at the same time. It sends physiological signals as a client role and also receives messages from the center as a server role. The signals and messages transmitted was designed in XML due to compatibility with HL7 used in the hospital information system. For our care center applications, a browser of physiological signals with a database was designed. The database in the service center is considered as a universal electrical patient record system. Health managers or doctors in the hospital view the physiological signals by a browser to access the remote database in the service center.

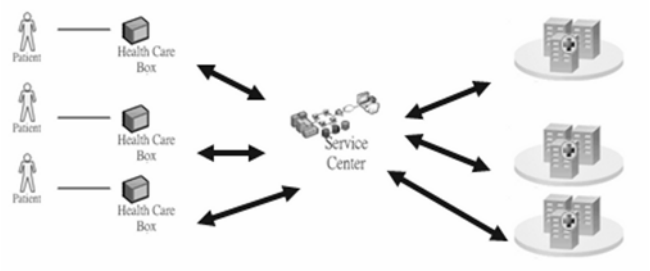

Fig. 1 The design of health care box

III. The Design of Health Care Box

A. Embedded system

Most of home health care applications use a Personal Computer (PC) or workstation as a terminal connected physiological device to receive and send physiological signals. In order to make the system friendly to the user, it was necessary to design the system based on its scenarios in an embedded system with proper hardware. In this way, not only is there increase in user friendliness but the cost of the hardware is lowered. The hardware specifically designed for the HCB is shown in figure 2. It consists of one LCD panel, eight signal lights, three buttons, a horn and a voice controller. Three buttons include an emergency rescue button, a "Yes" button and a "No" button. The horn is the voice output device. The loudness is controlled by a voice controller. Eight signal LEDs including the power LED, network LED, transmission LED, reception LED, and four ports LED indicating the presence of physiological device.

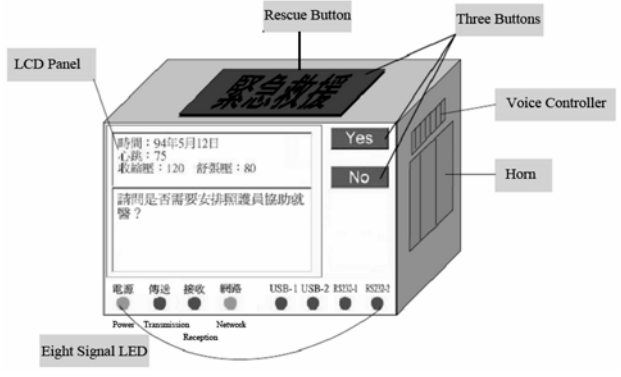

Fig. 2 The external design of the HCB.

B. The internal design of HCB

The internal design of the HCB is shown in Fig. 3. It consists of three levels which are: the application level, operation system level and hardware level. The application level consists of a user interface served by six units, including the main program, the message displaying and confirmation unit, acquisition unit, monitor and analysis unit, alarm unit, dialog unit, and remote access and data exchange unit. The physiological devices are connected into the HCB's serial port through RS232 transceivers. During each recording session, assigned a unique identifier, the program reads data from the serial port, converts it, and saves it into temporary files. This work is done by the acquisition unit. The monitor and analysis unit sends physiological signal via remote access and data exchange unit, analyzes the signals data and detect the device failure. If any signal abnormality is found, warning messages are sent to the alarm unit. The alarm unit is used to judge if there is an alarm, generate alarm messages, and output the messages to the LCD and send the messages to the service center. The dialog unit was designed to show the message in the LCD panel and receive input via the pushing of three buttons. The remote access and data exchange unit was designed to receive the messages from the service center and also package signals and messages in XML format to send to service center.

Operation system level consists of an operation system with several drivers. Linux is selected as the operation system inside of the HCB. Drives, including RS232, LAN and wireless LAN, sound system, USB, GPIO, and VGA, were installed. The corresponding hardware was also built up. GPIO handled the input/output. VGA controlled the LCD panel. Audio system displayed voice and controlled the loudness. LAN/WLAN transmitted and received data from internet. The hardware level was as described in section 1above and as shown in Fig. 3.

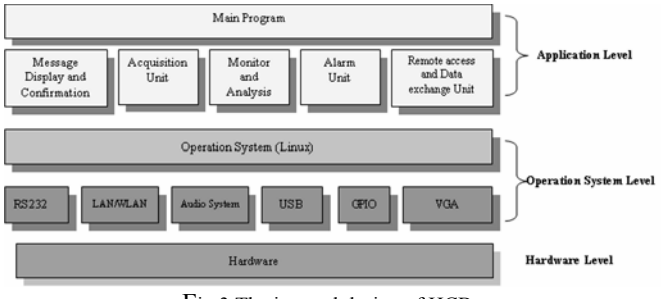

Fig.3 The internal design of HCB

IV. Scenarios

There are many scenarios designed for different services to the home box patient. They include monitoring by physiological signals, call-back for further diagnosis, care visitation, medicine taking follow-up, handling emergen-

cies, medicine delivery and healthy food delivery. Two scenarios will be illustrated here:

The scenario of monitoring by physiological signals is the basic service of home health care. The data flow is as follows:

1. There are different kinds of physiological devices connected to the HCB. The HCB acquires the physiological signals.
2. HCB sends physiological signals to the service center.
3. The doctor in the service center monitors the signals.

The second scenario illustrated is the "medicine taking reminder scenario". In order to control the sickness of patients, it is necessary to make sure that the patient takes medicine on time. The data flow is as follows and is represented as Fig. 4:

1. The service center reminds the patient to take the medicine on time via the HCB.
2. The patient follows the order to take the medicine and then presses the return message button.

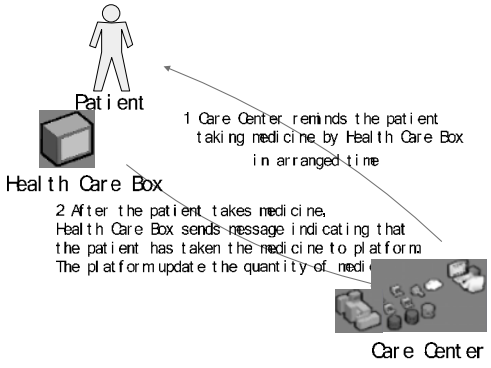

Fig. 4 Medicine taking reminder scenario

In this way, the doctor can understand if patients take medicine accurately. The user interface is illustrated in Fig. 5.

Fig. 5 Reminder of medicine taking.

Fig. 6 shows an example of the dialog message written in XML. Three kinds of data were written in the XML format used in the HCB. The first is the dialog messages used in the scenarios as shown in Fig. 6.

```
<?xml version="1.0" encoding="Big5" ?>
<Messages>
    <Header>
        <FileName>M2005-05-23-11-25-27.001.xml</FileName>
        <CertificateID>XLXIDDU</CertificateID> // 是跟 Box 或跟 User 綁
        <SenderID>Server9124</SenderID>
        <SenderIP>140.114.87.5</SenderIP>
        <ReceiverID>Box940141</ReceiverID>
        <ReceiverIP>192.168.1.150</ReceiverIP>
    </Header>
    <Message>
        <SequenceID>Box940141-20050523112527</SequenceID>
        <ReferenceID>20050523112527</ReferenceID> // 同一秒的狀況最後二位由 00-99 依序編號
        <Level>normal</Level>
        <Label>D2</Label>
        <Content>
            <Text>詢問是否需要陪病人員陪同就診？</Text>
            <WaveFileName>sample.wav</WaveFileName>
            <WaveReplay>5</WaveReplay>
            <WaveInterval>3</WaveInterval>
            <TextDisplayTime>60</TextDisplayTime>
            <FontSize>5</FontSize>
        </Content>
    <Message>
    <Message>
        . . .
```

Fig. 6 An example of dialog message in XML format

The second is the message used for remote set up of the HCB from the service center as shown in figure 7. It shows examples of a set-up message from the service center in XML format. Figure 7(a) shows an order to set up the thresholds of physiological signals which are used as the criteria to send warning messages to the service center. Figure 7(b) shows that the service center sends a configuration set-up message to the HCB to set up the network, devices and associated configurations. XML was also used in the server's applications for the data exchange between service center and hospital information system. MS SQL Server 7.0 was used as the database server.

```
<Name> Mr. Lee </Name>
<ID>E123012085</ID>
<CertificateID>XLXIDDU</CertificateID>
<TransmissionModel>Model1</TransmissionModel>
<TransmissionPeriod>3</TransmissionPeriod>
<HigherBPHighThreshold>400.3</HigherBPHighThreshold>
<HigherBPLowThreshold>20.3</HigherBPLowThreshold>
<LowerBPHighThreshold>300.5</LowerBPHighThreshold>
<LowerBPLowThreshold>10.5</LowerBPLowThreshold>
<PulseHighThreshold>250</PulseHighThreshold>
```

(a)

```
<?xml version="1.0" encoding="Big5"?>
<Config>
<network>
<ServerDomain-
Name>www.carecenter.com.tw</ServerDomainName>
<ServerIP>140.114.87.5</ServerIP>
<BoxIP>192.168.1.150</BoxIP>
<Interval>1800</Interval>
</network>
<device>
<RS232-1>Simens Servo 300</RS232-1>
<RS232-2>Heaven P3</RS232-2>
</device>
<message>
<NormalRetry>5</NormalRetry>
<NormalInterval>5.0</NormalInterval>
<EmergencyRetry>50</EmergencyRetry>
<EmergencyInterval>3</EmergencyInterval>
```

(b)

Fig. 7 Examples of set-up messages in XML format (a) set up the thresholds of physiological signals, (b) set up network's, devices' and associated configuration.

V. Implementation

The supported physiological devices included Simens Servo 300 ventilator with 9600 baud rate and Ostar blood pressure monitor with 4800 baud rate. The HCB's applications were written in C++ programming language compiled by GCC in the environment of Linux with version Red Hat 8. The resolution of the LCD panel is 800 x 600 pixels. Fig. 5 shows an example of it.

VI. Conclusions

In this study, we propose an enactive home health care with a home box adaptive for various scenarios. A home health care box is designed to fit the requirement of different scenarios and also follow the principle of user-friendliness. It is used at home to send physiological signals and also provides the interaction between the patient and the service center. The interactions are mostly executed automatically, such as medicine reminding, medicine and food delivery.. The HCB has the advantage of providing ease of management. The HCB can be set up remotely, which facilitates reduction of labor. Messages in XML are compatible with the standard HL7 used in the hospital information system. For this reason, it is easy exchange patient data between the service center and hospitals.

Acknowledgment

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