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(54) **INTEGRATE CLIMATE CONTROL WITH RESPIRATORY MONITORING**

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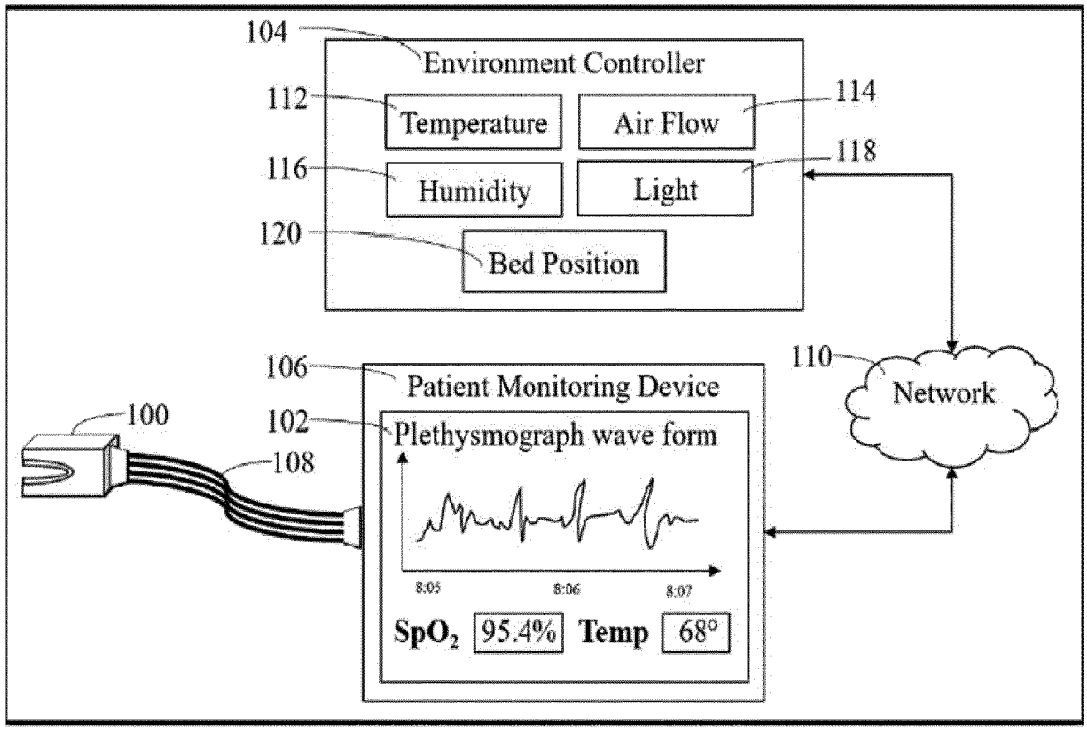
(57) **ABSTRACT**

A method for adjusting environmental parameters for patient condition monitoring comprising: inputting via a user interface a patient condition and other information relating to the patient; searching a database for environmental parameters and other information relating to the patient condition; determining environmental parameters to adjust based on the patient condition; defining oxygen saturation level threshold ranges corresponding to various sets of environmental parameters; measuring via a pulse oximeter a first oxygen saturation level of the patient under a first set of environmental parameters; adjusting the environmental parameters corresponding to the patient condition if the first oxygen saturation level lies outside the threshold ranges defined for the first set of environmental parameters; and measuring a second oxygen saturation level of the patient under the adjusted environmental parameters.



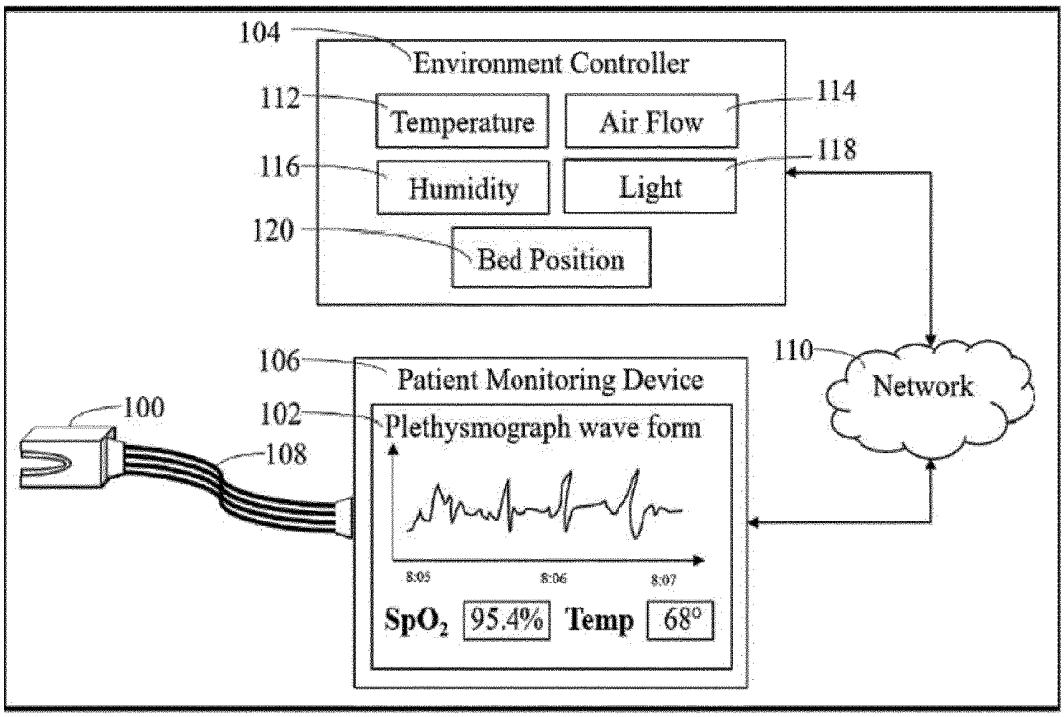

104
Environment Controller
112
Temperature
Air Flow
114
116
Humidity
Light
118
120
Bed Position
110
Network
106
Patient Monitoring Device
100
102
Plethysmograph wave form
108
8:05
8:06
8:07
SpO2
95.4%
Temp
68°

FIG. 1

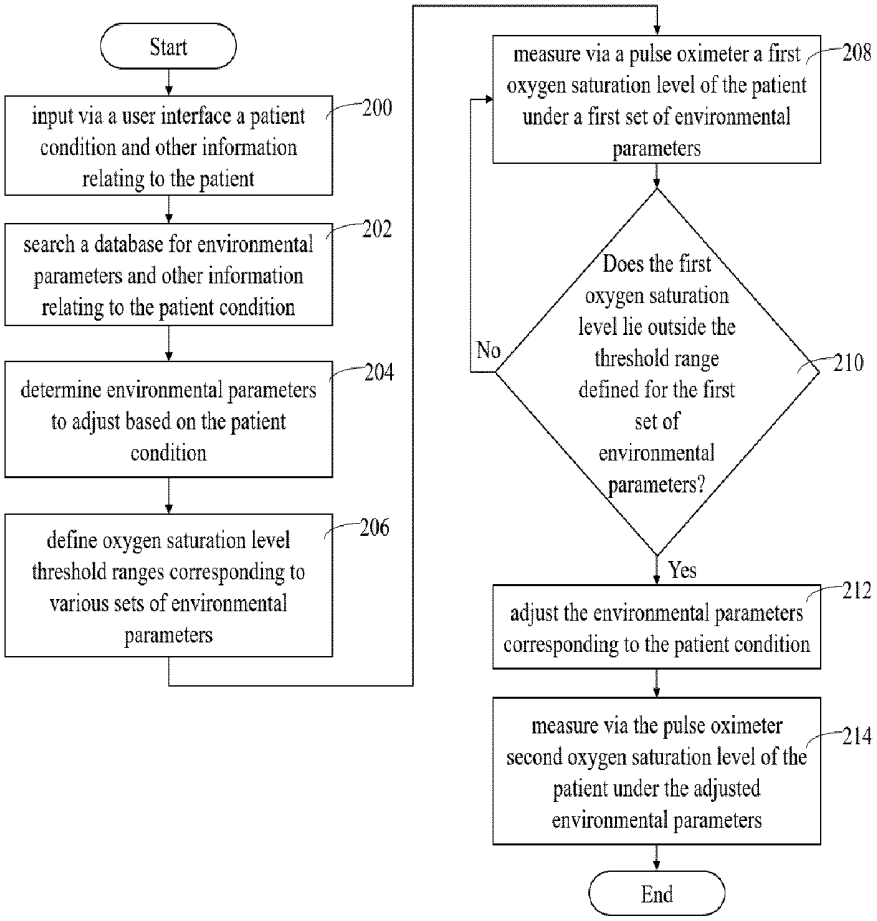

Start
input via a user interface a patient condition and other information relating to the patient
200
search a database for environmental parameters and other information relating to the patient condition
202
determine environmental parameters to adjust based on the patient condition
204
define oxygen saturation level threshold ranges corresponding to various sets of environmental parameters
206
measure via a pulse oximeter a first oxygen saturation level of the patient under a first set of environmental parameters
208
Does the first oxygen saturation level lie outside the threshold range defined for the first set of environmental parameters?
210
No
Yes
adjust the environmental parameters corresponding to the patient condition
212
measure via the pulse oximeter second oxygen saturation level of the patient under the adjusted environmental parameters
214
End

FIG. 2

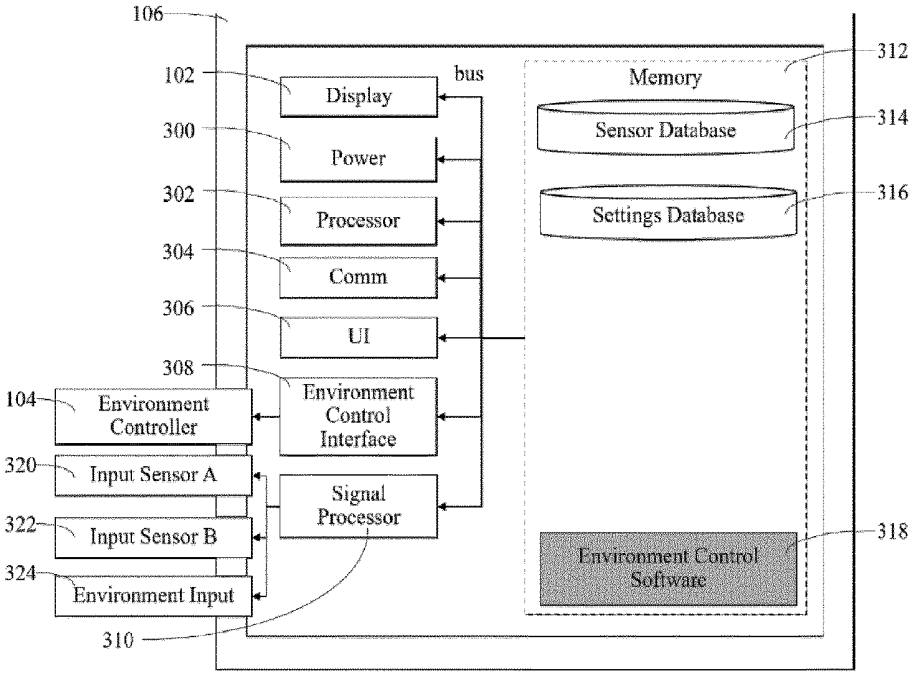

106
102
Display
bus
Memory
312
300
Power
Sensor Database
314
302
Processor
Settings Database
316
304
Comm
306
UI
308
Environment Control Interface
104
Environment Controller
320
Input Sensor A
Signal Processor
322
Input Sensor B
318
Environment Control Software
324
Environment Input
310

FIG. 3

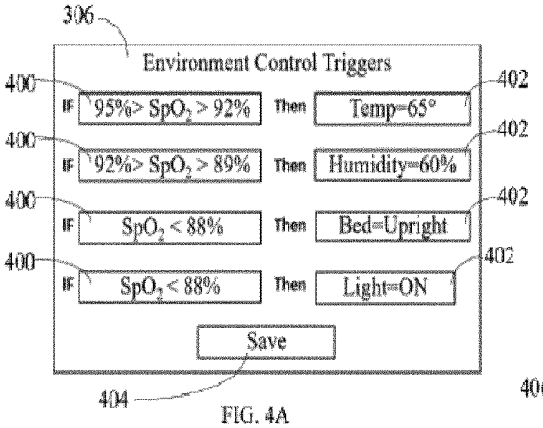

306
Environment Control Triggers
400
IF
95%> SpO2 > 92%
Then
Temp=65°
402
400
IF
92%> SpO2 > 89%
Then
Humidity=60%
402
400
IF
SpO2 < 88%
Then
Bed=Upright
402
400
IF
SpO2 < 88%
Then
Light=ON
402
Save
404

FIG. 4A

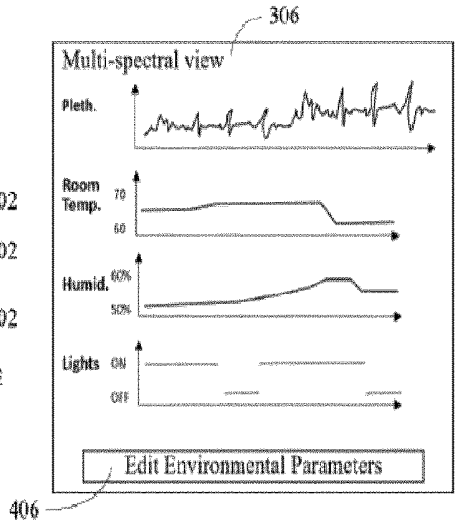

306
Multi-spectral view
Pleth.
Room Temp.
70
60
Humid.
60%
50%
Lights
ON
OFF
Edit Environmental Parameters
406

FIG. 4B

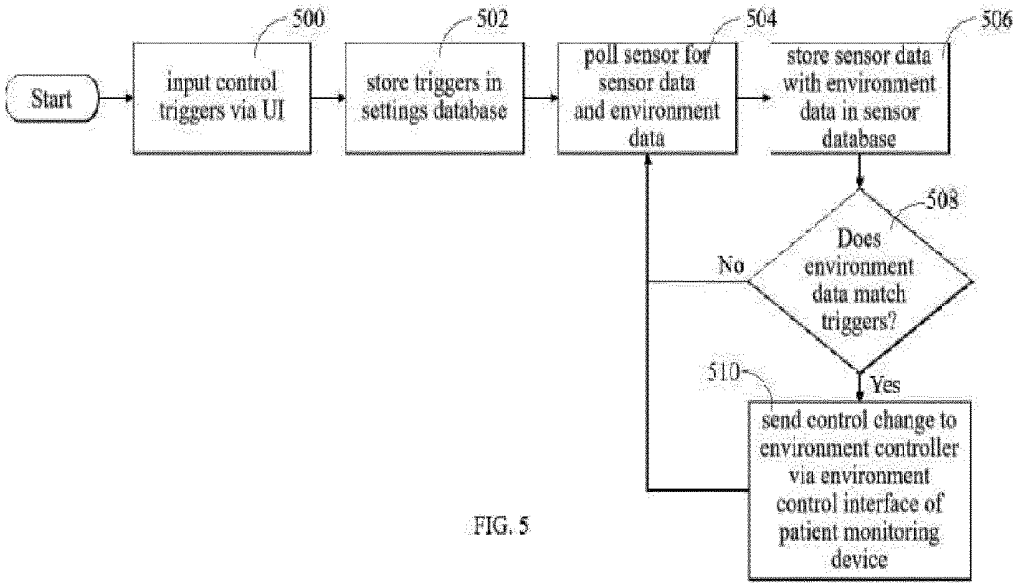

Start
input control triggers via UI
500
store triggers in settings database
502
poll sensor for sensor data and environment data
504
store sensor data with environment data in sensor database
506
Does environment data match triggers?
508
No
Yes
send control change to environment controller via environment control interface of patient monitoring device
510

FIG. 5

INTEGRATE CLIMATE CONTROL WITH RESPIRATORY MONITORING

BACKGROUND OF THE INVENTION

[0001] Pulse Oximetry is an effective non-invasive method for measuring SpO2. SpO2 level is a good indicator of the patient's respiratory condition. Examples of respiratory diseases that are monitored using pulse oximeters are chronic obstructive pulmonary disease (COPD), asthma, and sleep apnea. Some respiratory diseases, such as the diseases mentioned, are affected by environmental factors such as temperature, humidity, airflow rate, and illumination as well as the physical position of the patient such as bed height and bed angle.

SUMMARY OF THE CLAIMED INVENTION

[0002] Embodiments of the present invention relates to systems and methods for adjusting environmental parameters for patient condition monitoring. The system according to some embodiments comprises a pulse oximeter for measuring an oxygen saturation level of a patient and an environment controller for adjusting the environmental parameters based on the patient condition.

[0003] The method according to some embodiments comprises inputting via a user interface a patient condition and other information relating to the patient. The pulse oximeter measures a first oxygen saturation level of the patient under a first set of environmental parameters. Then, the environment controller adjusts the environmental parameters corresponding to the patient condition if the first oxygen saturation level lies outside the threshold ranges corresponding to the first set of environmental parameters. Afterwards, the pulse oximeter measures a second oxygen saturation level of the patient under the adjusted environmental parameters.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] The accompanying drawings, which are included to provide a further understanding of the invention, are incorporated herein to illustrate embodiments of the invention. Along with the description, they also serve to explain the principle of the invention. In the drawings:

[0005] FIG. **1** illustrates a block diagram of a system for suggesting additional tests based on a patient's health status and medical records according to a preferred embodiment of the present invention.

[0006] FIG. **2** illustrates a flowchart of a method according to a preferred embodiment of the present invention.

[0007] FIG. **3** illustrates a block diagram of a patient monitoring device according to an embodiment of the present invention.

[0008] FIGS. **4**A and **4**B illustrate a user interface according to an embodiment of the present invention.

[0009] FIG. **5** illustrates a flowchart of the environment control software.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0010] Embodiments of the present invention relates to a method for adjusting environmental parameters for patient condition monitoring comprising: inputting via a user interface a patient condition and other information relating to the patient; searching a database for environmental parameters and other information relating to the patient condition; determining environmental parameters to adjust based on the patient condition; defining oxygen saturation level threshold ranges corresponding to various sets of environmental parameters; measuring via a pulse oximeter a first oxygen saturation level of the patient under a first set of environmental parameters; adjusting the environmental parameters corresponding to the patient condition if the first oxygen saturation level lies outside the threshold ranges defined for the first set of environmental parameters; and measuring a second oxygen saturation level of the patient under the adjusted environmental parameters.

[0011] Embodiments of the present invention also relates to a system for suggesting additional tests based on a patient's health status and medical records comprising: a pulse oximeter for measuring an oxygen saturation level of a patient; a display device with a user interface for inputting a patient condition and other information relating to the patient; an environment controller for adjusting the environmental parameters; and a patient monitoring device connected to the pulse oximeter, the display device, and the environment controller.

[0012] In a preferred embodiment of a system of the present invention as illustrated in FIG. **1**, a system for adjusting environmental parameters for patient condition monitoring comprises a pulse oximeter **100**, a display device with a user interface **102**, an environment controller **104**, and a patient monitoring device **106**. The pulse oximeter **100** is connected to the patient monitoring device **106** via a wire link **108** in the instant embodiment, although other connection means would also suffice, including wireless communications link such as Wi-Fi, Bluetooth, NFC, infrared, and other means appreciated by those skilled in the art. The patient monitoring device **106** is further connected to the environment controller **104** via a communications link **110**. The environment controller **104** is capable of controlling the temperature **112**, air flow **114**, humidity **116**, light **118**, and bed position **120** inside a room.

[0013] Preferably, the environment controller **104** sends control signals to different devices to adjust environmental parameters. Examples of environmental parameters are temperature **112**, humidity **116**, air flow/pressure **114**, illumination **118**, and bed position **120**. Examples of devices that control the environmental parameters include HVAC unit, humidifier, LED bulbs, and automatic bed. The transmission of control signals from the environment controller **104** may be accomplished physically via, for examples, a USB or wirelessly via, for example, Wi-Fi communications.

[0014] FIG. **2** illustrates a preferred method of the present invention. A user such as a medical practitioner inputs via the display with a user interface **102** the patient condition and other information relating to the patient (step **200**). The inputted patient condition may include the disease and present status of the patient. For example, the medical practitioner inputs "chronic obstructive pulmonary disease (COPD)" in the field for the patient's disease in the user interface. Other information relating to the patient that may be inputted includes the patient's current medications, family history, and various patient information such as age, weight, and height. Next, the patient monitoring device **106** searches a database for environmental parameters and other information relating to the patient condition (step **202**). Based on the information that the patient has a COPD, search results from the database show that humidity and

temperature of a room and bed position affects the condition of the patient with COPD. Preferably, corresponding adjustment settings for the environmental parameters are also stored in the database. Afterwards, the patient monitoring device **106** determines environmental parameters to adjust based on the patient condition (step **204**). The patient monitoring device **106** makes a priority decision that the environmental parameters that should be adjusted are humidity and bed position. Optionally, the priority decision is done manually by a medical professional.

[0015] Following the determination of the environmental parameters to adjust based on the patient condition (step **204**), the patient monitoring device **106** defines oxygen saturation level threshold ranges corresponding to various sets of the environmental parameters (step **206**). Examples of the defined oxygen saturation level threshold ranges (OSLTR) corresponding to various sets of environmental parameters are 69%-92% OSLTR for humidity and greater than 88% OSLTR for bed position. Preferably, the oxygen saturation level threshold ranges corresponding to various sets of the environmental parameters are based on the search results previously done by the patient monitoring device **106** (step **202**). Alternatively, the oxygen saturation level threshold ranges corresponding to various sets of the environmental parameters are manually defined preferably by the medical practitioner via the display with the user interface **102**.

[0016] After defining the oxygen saturation level threshold ranges (step **206**), the pulse oximeter **100** measures a first oxygen saturation level of the patient under a first set of environmental parameters (step **208**). Preferably, the first set of environmental parameters is the current environmental parameters of a room where the patient is staying. These environmental parameters can be the current settings for the devices that control these parameters. For example, the current humidity setting of a humidifier is 77% while the current bed position setting of an automatic bed is 30 degrees. For these environmental parameters, the measured oxygen saturation level of the patient is 86%. Subsequently, the patient monitoring device **106** determines if the first oxygen saturation level lies outside the threshold ranges defined for the first set of environmental parameters (step **210**).

[0017] If the first oxygen saturation level does not lie outside the threshold ranges defined for the first set of environmental parameters, the pulse oximeter **100** continuously measures the oxygen saturation level of the patient under the first set of environmental parameters (step **208**). Otherwise, the environment controller **104** adjusts the environmental parameters corresponding to the present patient condition (step **212**). But if the measured oxygen saturation level in the previous example lies outside the threshold range for bed position, the patient monitoring device **106** then sends a control signal to the environment controller **104**. The environment controller **104** then forwards the control signal to the automatic bed to adjust the angle of the bed from 30 degrees to 20 degrees. Finally, the pulse oximeter **100** measures a second oxygen saturation level of the patient under the adjusted environmental parameters (step **214**). For example, the pulse oximeter **100** measures the oxygen saturation level of the patient lying on the bed that has just been adjusted to 20 degrees.

[0018] In another embodiment of the present invention, the determination of the environmental parameters to adjust (step **204**), as described in FIG. **2**, are also based on an outcome of a comparison between a measured oxygen saturation level and an oxygen saturation level threshold range.

[0019] In an exemplary embodiment of the present invention, a patient suffering from asthma is inside a hospital room at 90° F. and 78% humidity. Then, a medical practitioner inside the hospital room inputs in the user interface of the patient monitoring device **106** that the patient has an asthma. The patient monitoring device **106** searches a database for environmental parameters and other information relating to asthma. Search results show that temperature and humidity affects a patient suffering from an asthma. Also, the search results show that the optimum temperature and humidity for a person with asthma are 65° F.-75° F. and 35%-50%, respectively. Based on the search results, the patient monitoring device **106** determines that the temperature and the humidity of the room should be adjusted. The temperature and humidity are thus set with oxygen saturation level threshold ranges of 89%-92% and 88%-95%, respectively. Then, the pulse oximeter **100** measures the oxygen saturation level of the patient inside the room which is 87%. Subsequently, the patient monitoring device **106** determines that the measured oxygen saturation level lies outside the oxygen saturation level threshold ranges of temperature and humidity. Thereafter, the patient monitoring device **106** sends control signals to the environment controller **104**. The environment controller **104** then sends an instruction to an HVAC unit to adjust the temperature to 70° F. and the humidity to 50%. Finally, the pulse oximeter **100** measures the oxygen saturation level of the patient again.

[0020] FIG. **3** illustrates another preferred embodiment of the patient monitoring device **106**. The patient monitoring device **106** comprises a display **102**, a power module **300**, a processor **302**, a communications module **304**, a user interface **306**, an environment control interface **308**, a signal processor **310**, and a memory **312**. The memory **312** comprises a sensor database **314** and a settings database **316** and an environment control software **318** is stored in the memory **312**. The signal processor **310** processes inputted data from the input sensor A **320**, input sensor B **322**, and environment input **324**. The environment control interface **308** sends control signal to environment controller **104**.

[0021] FIG. **4**A illustrates an exemplary interface **306** for inputting environment control triggers in accordance with some embodiments. Condition fields **400** serve to allow user inputs for oxygen saturation level threshold ranges. On the other hand, response fields **402** serve to allow user inputs for the environmental parameters and any necessary environmental parameter value adjustments. The patient monitoring device **106** saves these inputs when button **404** is pressed by the user (e.g., medical practitioner). FIG. **4**B illustrates an exemplary interface **306** for displaying plethysmograph waveform and environmental parameter data in accordance with some embodiments of the present invention. The environmental parameters data displayed on interface **306** are displayed in graphical form versus time. Pressing button **406** allows the user to edit environmental parameters.

[0022] FIG. **5** illustrates the process of the environment control software **318** in accordance in some embodiment of the present invention. The user such as a medical practitioner inputs control triggers via user interface **306** described in FIG. **4**A (step **500**). The control triggers are the oxygen saturation level threshold ranges. Subsequently, the patient monitoring device **106** stores these triggers in the settings

database **316** (step **502**). After, the input sensor A **320**, input sensor B **322**, and environment input **324** are polled to check if sensor data and environment data are available (step **504**). When sensor data and environment data are available, these data are stored by the patient monitoring device **106** in the sensor database **314** (step **506**). Then, the patient monitoring device **106** checks if the environment data is consistent with the corresponding triggers (step **508**). If the environment data does not match the corresponding triggers, the patient monitoring device **106** polls the input sensor A **320**, input sensor B **322**, and environment input **324** for sensor data and environment data (step **504**). Alternatively, if the environment data match the corresponding triggers (falls within the oxygen saturation level threshold range), the patient monitoring device **106** sends control change signal to environment controller **104** via the environment control interface **308** (step **510**). Finally, the patient monitoring device **106** polls again the input sensor A **320**, input sensor B **322**, and environment input **324** for sensor data and environment data (step **504**).

[0023] As shown in FIG. **1**, display **102** displays the plethysmograph waveform and SpO2 level collected by pulse oximeter **100**. The temperature of the room is also displayed in the display **102**. In another aspect of the invention, the patient monitoring device **106** and environment controller **104** are connected directly to each other via a physical link such as a USB connection.

[0024] The pulse oximeter **100** is preferably a portable pulse oximeter device worn on a patient's finger and adapted to measure the oxygen saturation level of the patient. The patient monitoring device **106** is preferably a stand-alone device connected to the display **102**—which may be a laptop computer, a desktop computer, a mobile phone, a tablet computer, or a PDA. In another embodiment of the invention, the patient monitoring device **106** may reside within the display **102**.

[0025] In accordance with the various embodiments of the present invention, the memory **312** may include high-speed random access memory or non-volatile memory such as magnetic disk storage devices, optical storage devices, or flash memory. Memory **312** may also store software instructions for facilitating processes, features and applications of the system disclosed in the invention. The communications module **304** may include any transmitter or receiver used for Wi-Fi, Bluetooth, infrared, NFC, radio frequency, cellular communication, visible light communication, Li-Fi, WiMax, ZigBee, fiber optic and other forms of wireless communication devices. Alternatively, the communications module **304** is a physical channel such as a USB cable or other wired forms of communication.

[0026] The present invention is not intended to be restricted to the several exemplary embodiments of the invention described above. Other variations that may be envisioned by those skilled in the art are intended to fall within the disclosure.

1. A system for adjusting environmental parameters for patient condition monitoring, the system comprising:

a pulse oximeter for measuring an oxygen saturation level of a patient;

a patient monitoring device connected to the pulse oximeter and a communications link, the patient monitoring device comprising:

a display device having a user interface for inputting one or more environment parameters;

a power module,

a processor,

a communications module,

an environment control interface,

a signal processor that processes data input from: one or more input sensors for acquiring sensor data, an environment input for acquiring an environment data, or both, and

a memory including a sensor database, a settings database, and an environment control software, and

an environment controller connected to the communications link, the environment controller adjusting the one or more environmental parameters;

wherein the user interface provides one or more condition fields that enable a user to input one or more oxygen saturation level threshold ranges, and one or more response fields that enable the user to input the environmental parameters or an adjustment to the environmental parameters.

2. The system of claim **1**, wherein the environment controller sends one or more control signals to one or more devices that control the environment parameters.

3. The system of claim **2**, wherein the one or more environmental parameters is selected from a temperature, a humidity, an air flow, an illumination, a bed position, and a combination thereof.

4. The system of claim **2**, wherein the one or more devices that control the environmental parameters is selected from an HVAC unit, a humidifier, an LED bulb, an automatic bed, and a combination thereof.

5. The system of claim **2**, wherein the one or more control signals are sent physically, wirelessly, or both.

6. (canceled)

7. (canceled)

8. The system of claim **1**, wherein the user interface displays a plethysmograph waveform and the environmental parameters.

9. The system of claim **1**, wherein execution of the environmental control software by the processor:

receives the one or more oxygen saturation level threshold ranges;

stores the one or more oxygen saturation level threshold ranges in the settings data base;

polls the input sensors and the environment input for availability of the sensor data and the environment data;

stores the sensor data and the environment data in the sensor database;

compares the stored environment data with the one or more oxygen saturation level threshold ranges; and

sends a control change signal to the environment controller when the stored environment data falls within the one or more oxygen saturation level threshold ranges.

10. A method for adjusting environmental parameters for patient condition monitoring, the method comprising:

inputting, via one or more user inputs on a user interface, a patient condition and other information relating to the patient;

searching a database for environmental parameters and other information relating to the patient condition;

determining environmental parameters to adjust based on the patient condition;

defining oxygen saturation level threshold ranges corresponding to various sets of environmental parameters;

measuring via a pulse oximeter a first oxygen saturation level of the patient under a first set of environmental parameters;

adjusting the environmental parameters corresponding to the patient condition if the first oxygen saturation level lies outside the threshold ranges defined for the first set of environmental parameters; and

measuring a second oxygen saturation level of the patient under the adjusted environmental parameters.

* * * * *

专利名称(译)	将气候控制与呼吸监测相结合		
公开(公告)号	US20180272103A1	公开(公告)日	2018-09-27
申请号	US15/761473	申请日	2016-09-26
[标]申请(专利权)人(译)	皇家飞利浦电子股份有限公司		
申请(专利权)人(译)	皇家飞利浦N.V.		
当前申请(专利权)人(译)	皇家飞利浦N.V.		
[标]发明人	CRONIN JOHN E CRONIN SETH MELVIN		
发明人	CRONIN, JOHN E. CRONIN, SETH MELVIN		
IPC分类号	A61M21/02 A61B5/1455 A61B5/00 A61G7/018 F24F11/88		
CPC分类号	A61M21/02 A61B5/14551 A61B5/7425 A61G7/018 F24F11/88 A61M2021/0044 A61M2021/0066 A61M2205/3561 A61M2205/3303 A61M2205/502 A61M2205/52 A61M2230/205 A61B5/002 A61B5/02 A61B5/0205 A61B5/4815 A61M2205/3584 A61M2205/3592 A61M2230/005		
优先权	2016161280 2016-03-18 EP 62/232167 2015-09-24 US		
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摘要(译)

一种用于调整患者状况监测的环境参数的方法，包括：通过用户界面输入患者状况和与患者有关的其他信息;在数据库中搜索环境参数和与患者状况有关的其他信息;确定环境参数以根据患者状况进行调整;定义对应于各种环境参数组的氧饱和度阈值范围;通过脉搏血氧计测量第一组环境参数下患者的第一氧饱和度水平;如果第一氧饱和度水平位于为第一组环境参数定义的阈值范围之外，则调整对应于患者状况的环境参数;并在调整的环境参数下测量患者的第二氧饱和度。