US 20180344219A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2018/0344219 A1

(43) Pub. Date: Dec. 6, 2018

CRONIN et al.

(54) MULTI COLOR PULSE OXIMETER

(71) Applicant: KONINKLIJKE PHILIPS N.V., EINDHOVEN (NL)

(72) Inventors: John CRONIN, BONITA SPRINGS, FL (US); Joseph BODKIN, FORT MEYERS, FL (US)

(21) Appl. No.: 15/761,465

(22) PCT Filed: Sep. 21, 2016

(86) PCT No.: PCT/EP2016/072340

§ 371 (c)(1),
(2) Date: Mar. 20, 2018

Related U.S. Application Data

(60) Provisional application No. 62/222,529, filed on Sep. 23, 2015.

(30) Foreign Application Priority Data

Mar. 18, 2016 (EP) 16161242.9

Publication Classification

(51) Int. Cl.

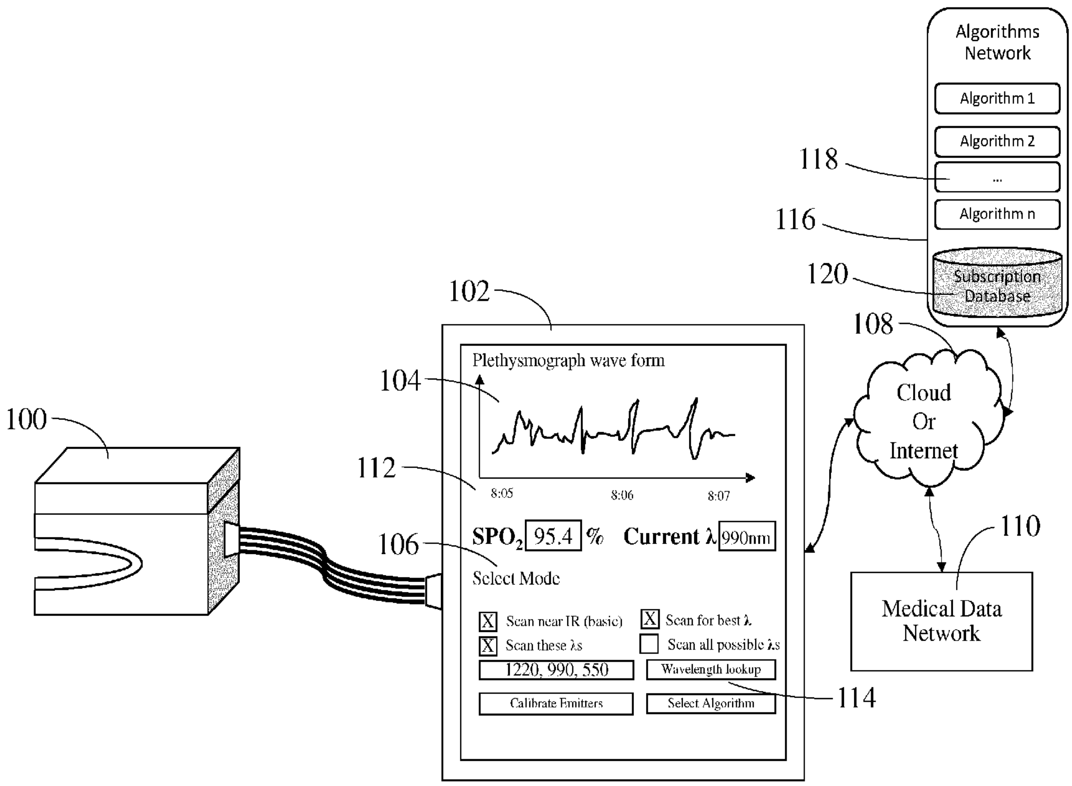
A61B 5/1495 (2006.01)
A61B 5/1455 (2006.01)
A61B 5/00 (2006.01)
G16H 50/30 (2006.01)
G16H 40/63 (2006.01)
G06F 17/30 (2006.01)

(52) U.S. Cl.

CPC *A61B 5/1495* (2013.01); *A61B 5/14552* (2013.01); *A61B 5/743* (2013.01); *A61B 5/7435* (2013.01); *A61B 2560/0271* (2013.01); *G16H 50/30* (2018.01); *G16H 40/63* (2018.01); *G06F 17/30864* (2013.01); *A61B 5/0022* (2013.01)

(57) ABSTRACT

Disclosed are systems and methods for measuring blood oxygen saturation via a multiwavelength pulse oximeter. The system comprises a multi-wavelength pulse oximeter with an LED array, a patient monitor connected to the multi-wavelength pulse oximeter, a medical data network for querying an at least one wavelength associated with a patient condition, an algorithm network for providing subscription based algorithms to process sensor data, and a user interface on the patient monitor for configuring a pulse oximeter's scanning mode, for querying the at least one wavelength associated with a patient condition, and for displaying a plethysmograph.



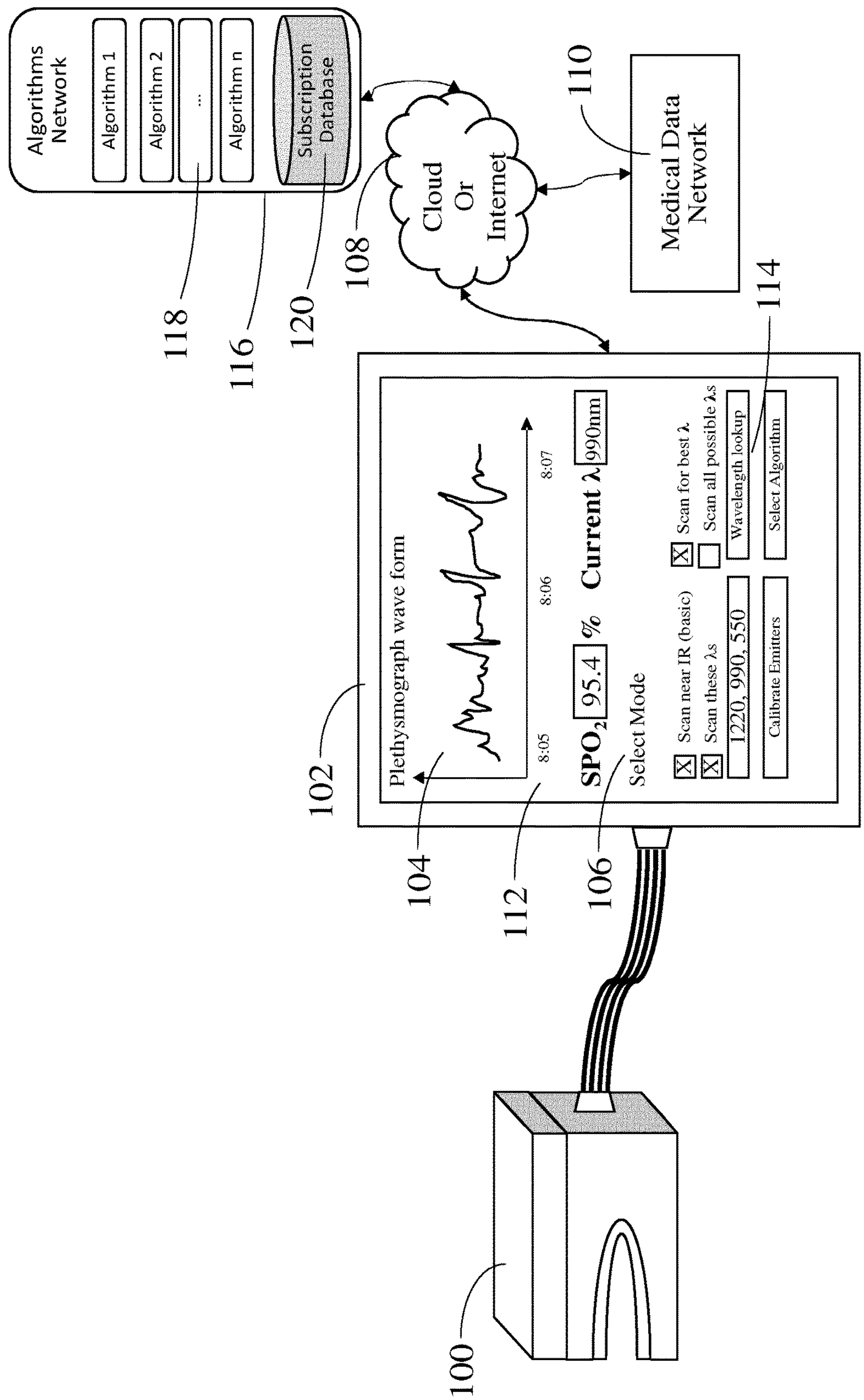

Algorithms Network
Algorithm 1
Algorithm 2
...
Algorithm n
Subscription Database
118
116
120
108
Cloud Or Internet
110
Medical Data Network
114
Plethysmograph wave form
8:05
8:06
8:07
SPO2 95.4 %
Current λ 990nm
Select Mode
Scan near IR (basic)
Scan these λs
1220, 990, 550
Calibrate Emitters
Scan for best λ
Scan all possible λs
Wavelength lookup
Select Algorithm
102
104
112
106
100

FIG. 1

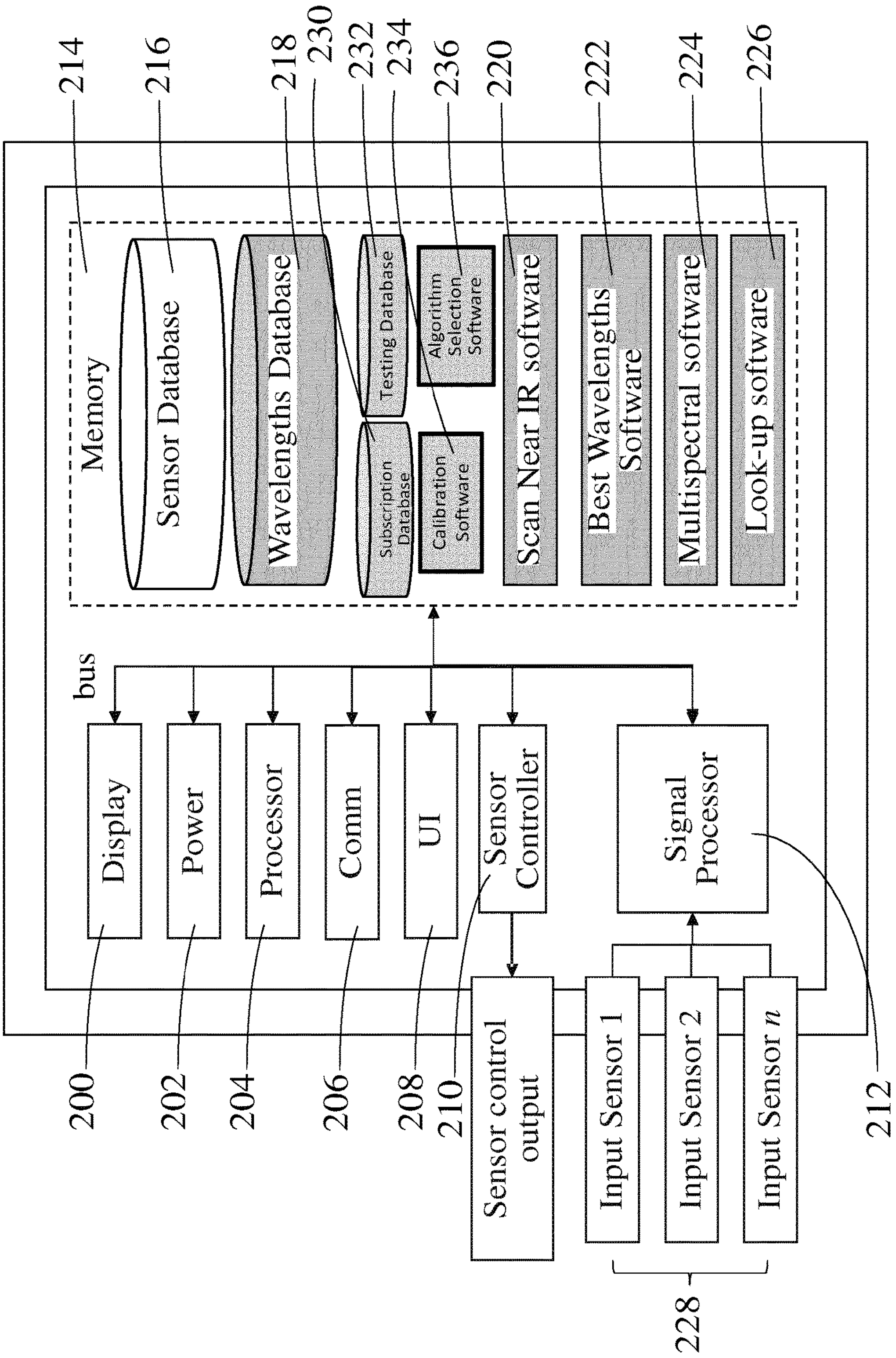

214
216
218
230
232
234
236
220
222
224
226
Memory
Sensor Database
Wavelengths Database
Subscription Database
Testing Database
Calibration Software
Algorithm Selection Software
Scan Near IR software
Best Wavelengths Software
Multispectral software
Look-up software
bus
Display
Power
Processor
Comm
UI
Sensor Controller
Signal Processor
Sensor control output
Input Sensor 1
Input Sensor 2
Input Sensor n
200
202
204
206
208
210
212
228

FIG. 2

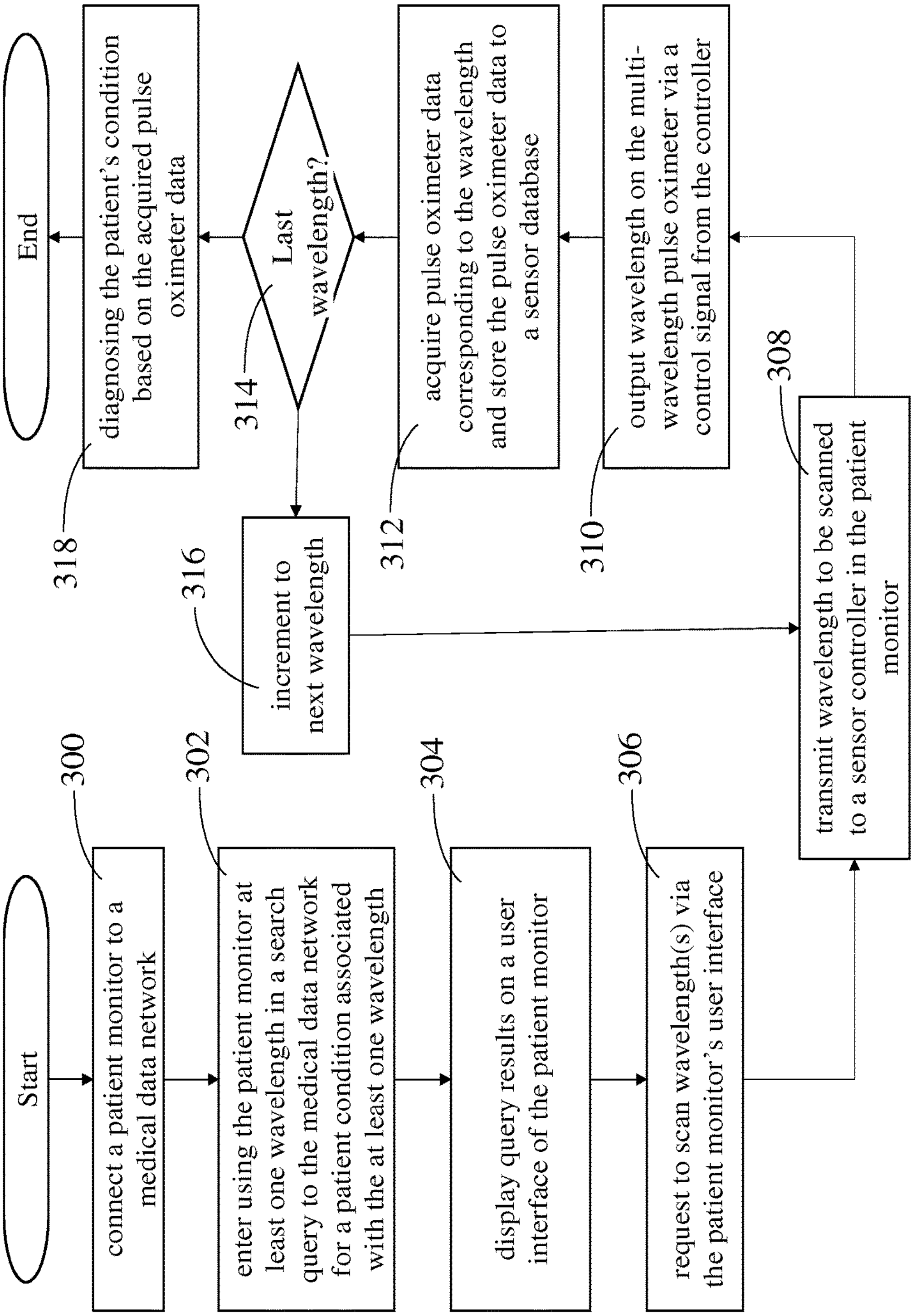

Start
300
connect a patient monitor to a medical data network
302
enter using the patient monitor at least one wavelength in a search query to the medical data network for a patient condition associated with the at least one wavelength
304
display query results on a user interface of the patient monitor
306
request to scan wavelength(s) via the patient monitor's user interface
308
transmit wavelength to be scanned to a sensor controller in the patient monitor
310
output wavelength on the multi-wavelength pulse oximeter via a control signal from the controller
312
acquire pulse oximeter data corresponding to the wavelength and store the pulse oximeter data to a sensor database
314
Last wavelength?
316
increment to next wavelength
318
diagnosing the patient's condition based on the acquired pulse oximeter data
End

FIG. 3

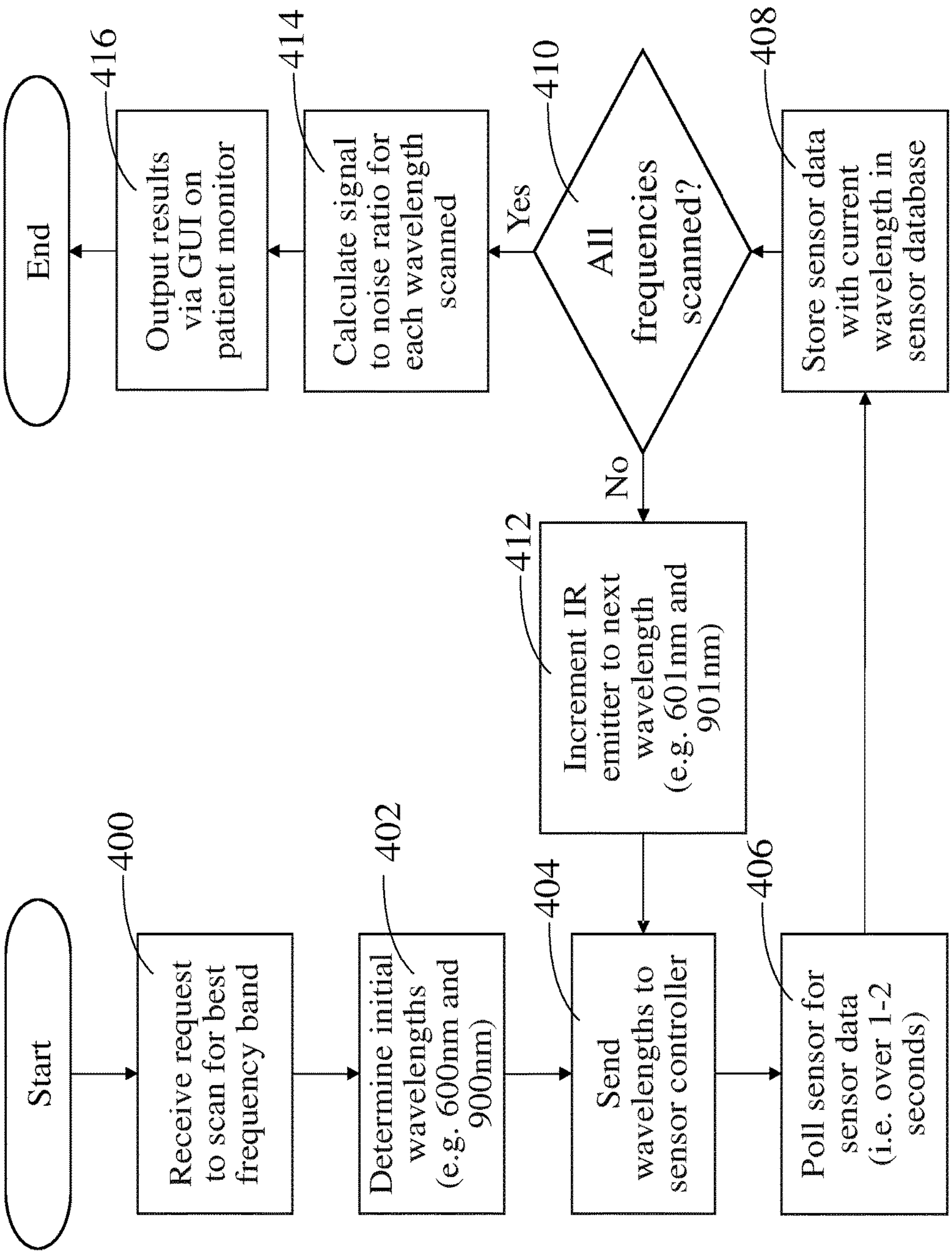

Start
Receive request to scan for best frequency band
400
Determine initial wavelengths (e.g. 600nm and 900nm)
402
Send wavelengths to sensor controller
404
Poll sensor for sensor data (i.e. over 1-2 seconds)
406
Store sensor data with current wavelength in sensor database
408
All frequencies scanned?
410
No
Increment IR emitter to next wavelength (e.g. 601nm and 901nm)
412
Yes
Calculate signal to noise ratio for each wavelength scanned
414
Output results via GUI on patient monitor
416
End

FIG. 4A

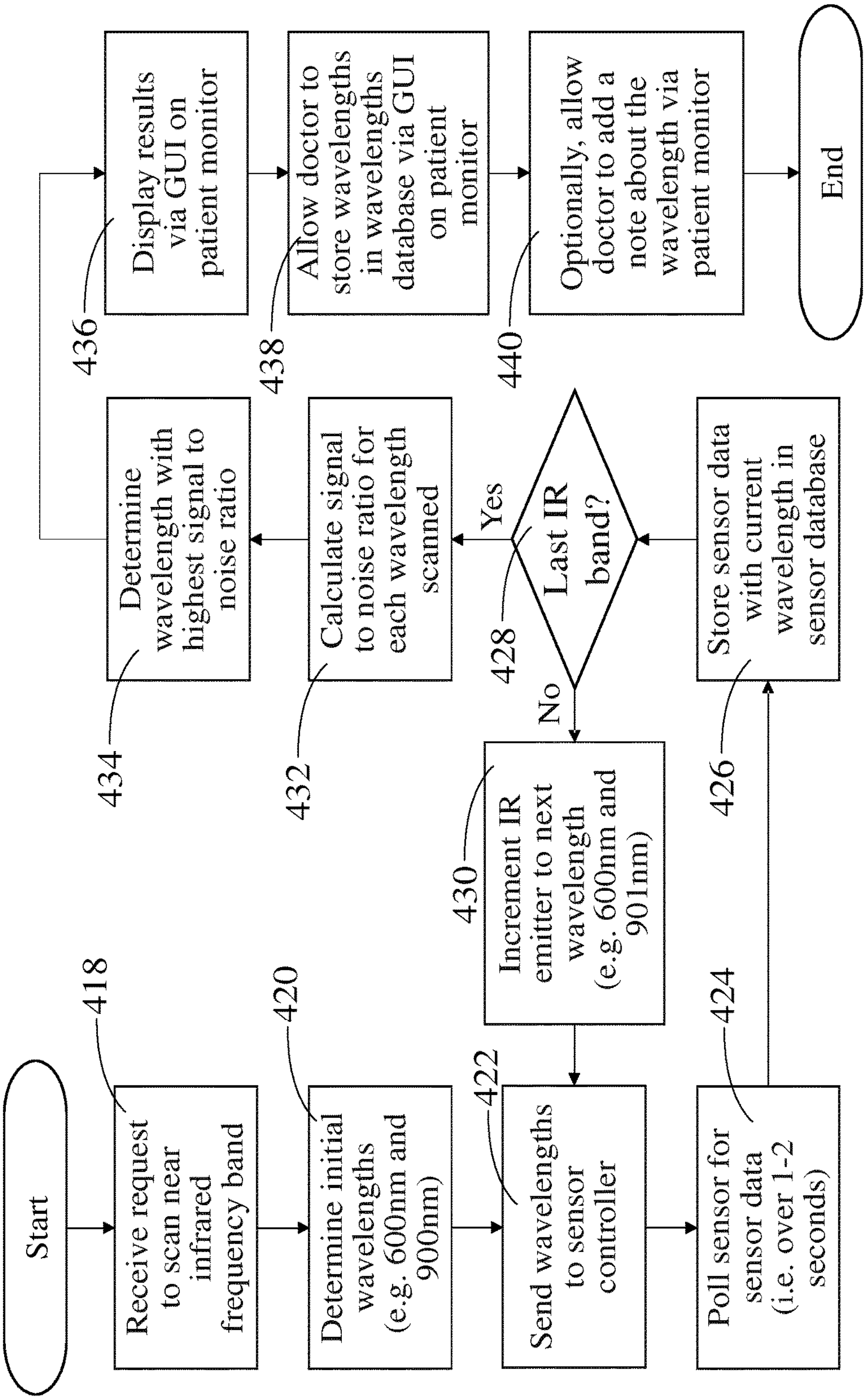

Start
418
Receive request to scan near infrared frequency band
420
Determine initial wavelengths (e.g. 600nm and 900nm)
422
Send wavelengths to sensor controller
424
Poll sensor for sensor data (i.e. over 1-2 seconds)
426
Store sensor data with current wavelength in sensor database
428
Last IR band?
No
430
Increment IR emitter to next wavelength (e.g. 600nm and 901nm)
Yes
432
Calculate signal to noise ratio for each wavelength scanned
434
Determine wavelength with highest signal to noise ratio
436
Display results via GUI on patient monitor
438
Allow doctor to store wavelengths in wavelengths database via GUI on patient monitor
440
Optionally, allow doctor to add a note about the wavelength via patient monitor
End

FIG. 4B

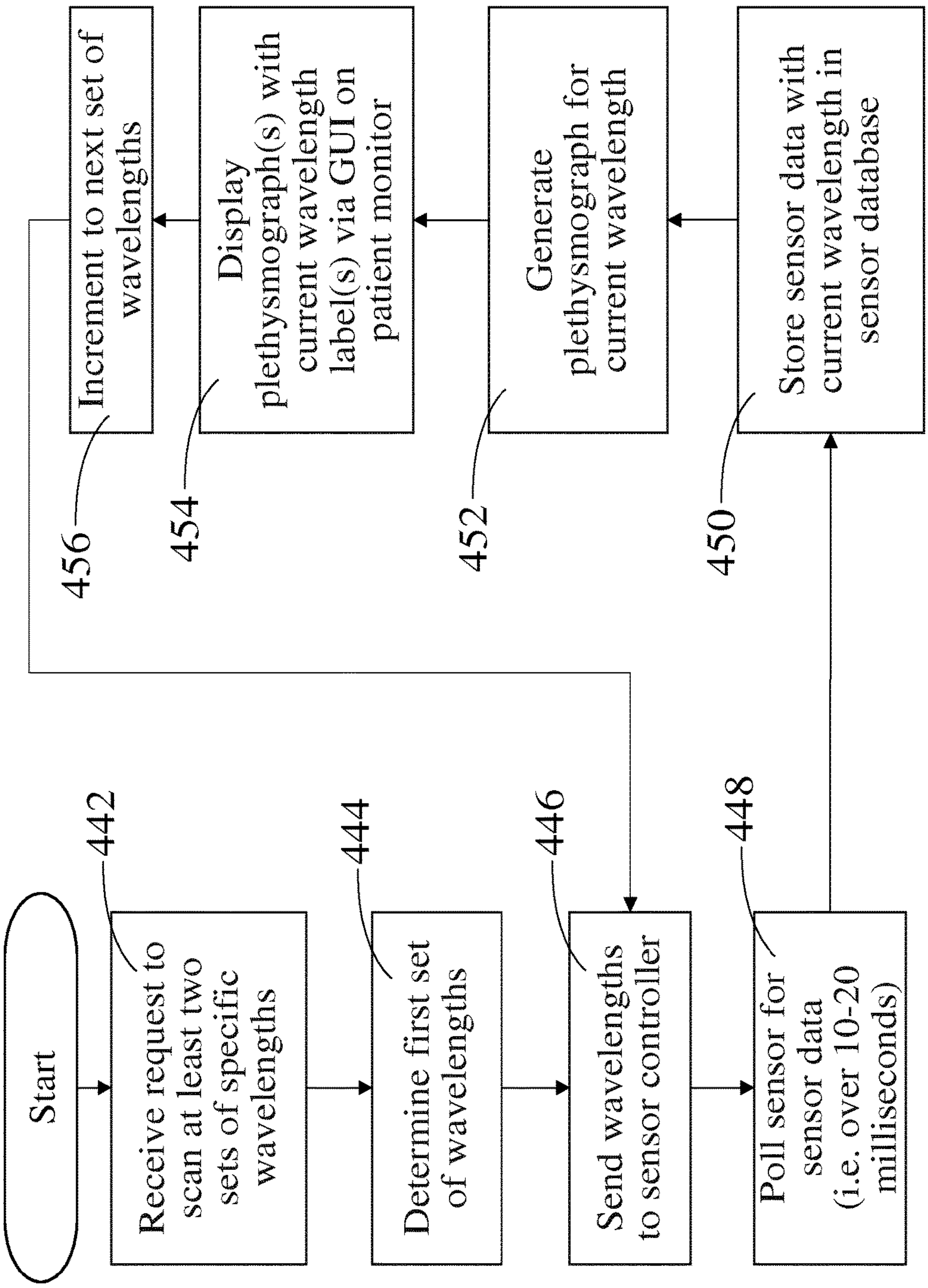

Start
442
Receive request to scan at least two sets of specific wavelengths
444
Determine first set of wavelengths
446
Send wavelengths to sensor controller
448
Poll sensor for sensor data (i.e. over 10-20 milliseconds)
450
Store sensor data with current wavelength in sensor database
452
Generate plethysmograph for current wavelength
454
Display plethysmograph(s) with current wavelength label(s) via GUI on patient monitor
456
Increment to next set of wavelengths

FIG. 4C

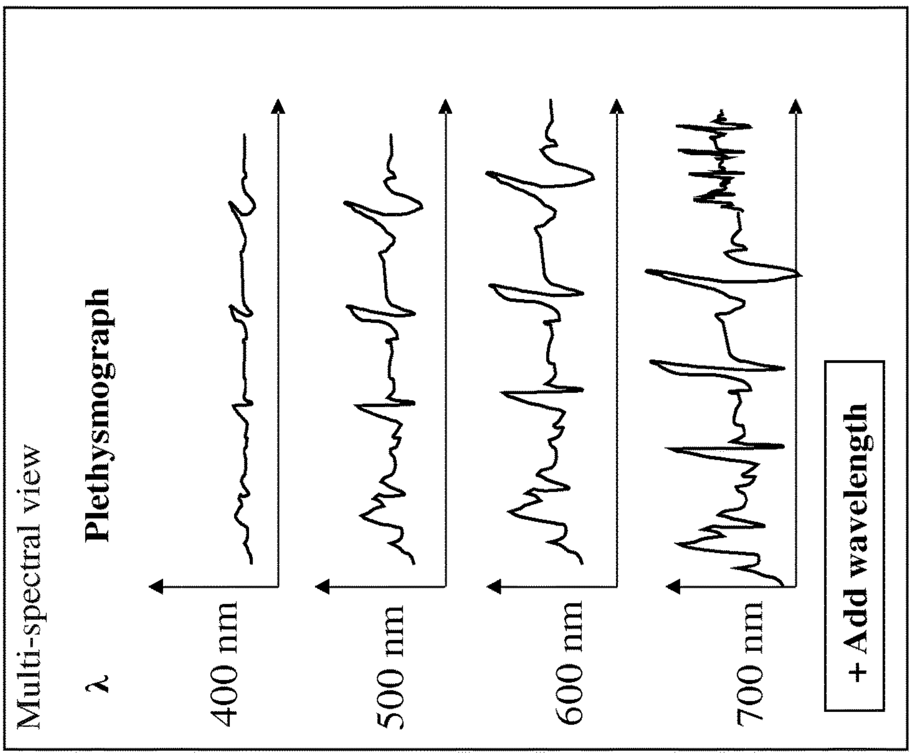

Multi-spectral view
λ
Plethysmograph
400 nm
500 nm
600 nm
700 nm
+ Add wavelength

FIG. 5A

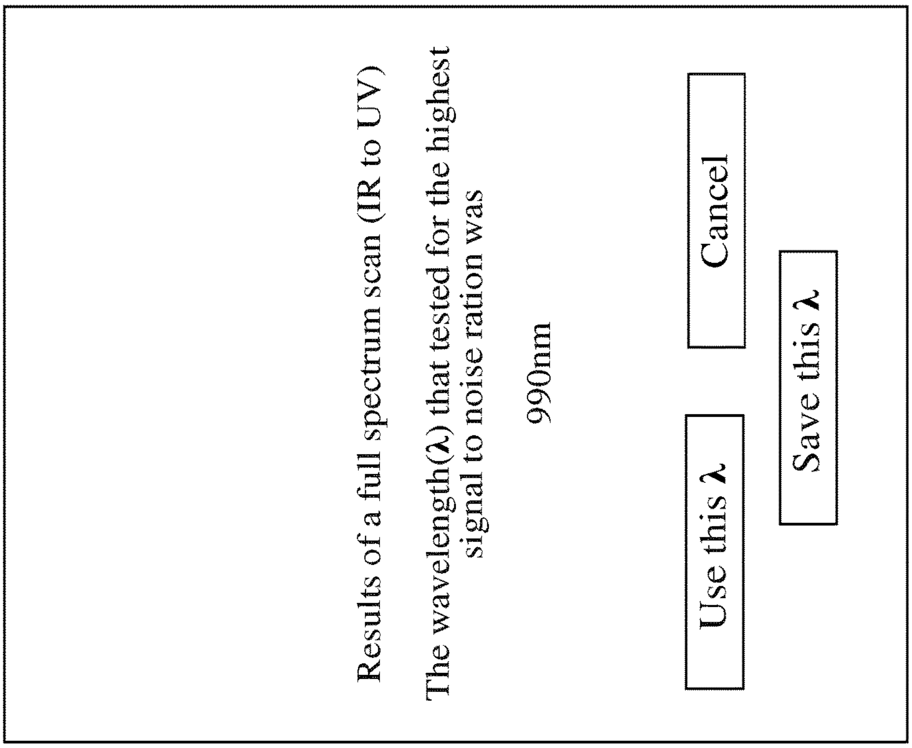

Results of a full spectrum scan (IR to UV)
The wavelength(λ) that tested for the highest signal to noise ration was
990nm
Use this λ
Cancel
Save this λ

FIG. 5B

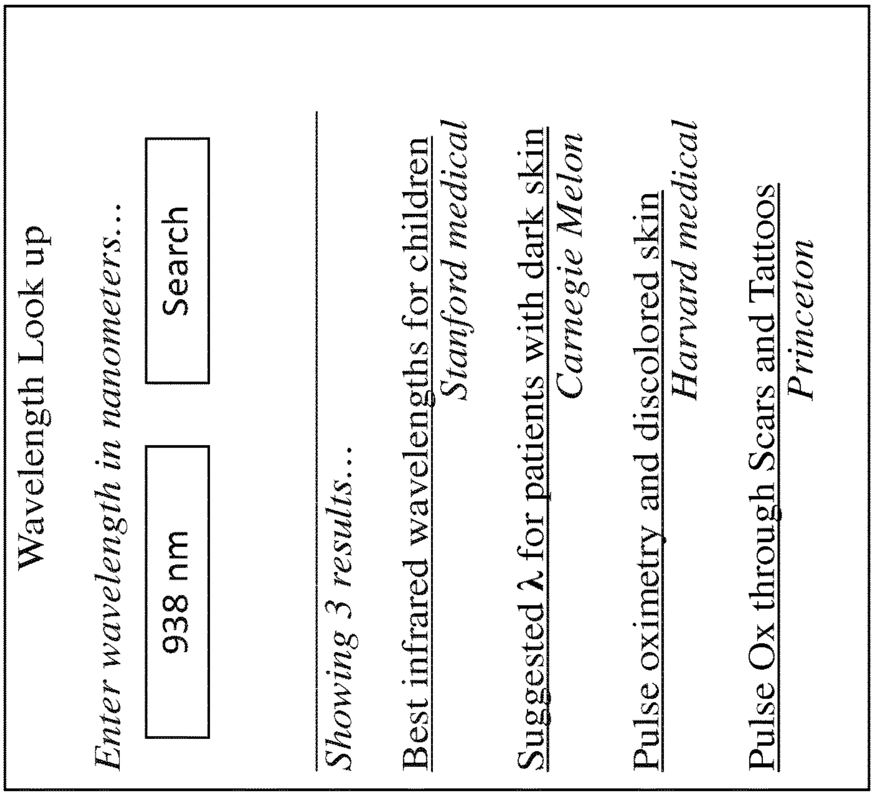

Wavelength Look up
Enter wavelength in nanometers…
938 nm
Search
Showing 3 results…
Best infrared wavelengths for children
Stanford medical
Suggested λ for patients with dark skin
Carnegie Melon
Pulse oximetry and discolored skin
Harvard medical
Pulse Ox through Scars and Tattoos
Princeton

FIG. 5C

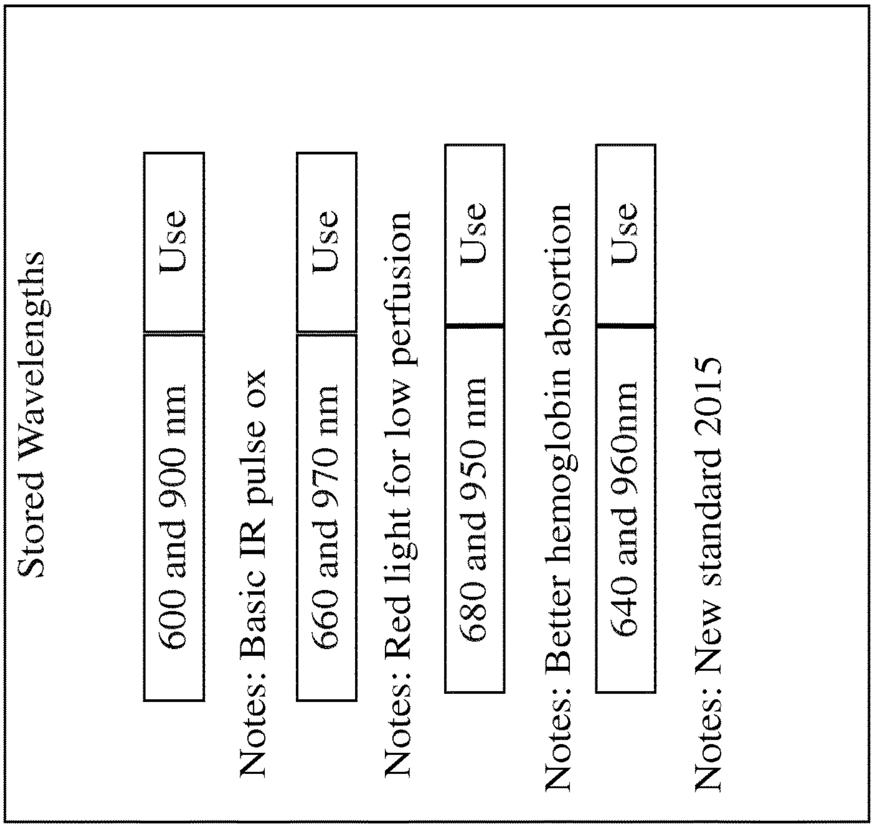

Stored Wavelengths
600 and 900 nm
Use
Notes: Basic IR pulse ox
660 and 970 nm
Use
Notes: Red light for low perfusion
680 and 950 nm
Use
Notes: Better hemoglobin absortion
640 and 960nm
Use
Notes: New standard 2015

FIG. 5D

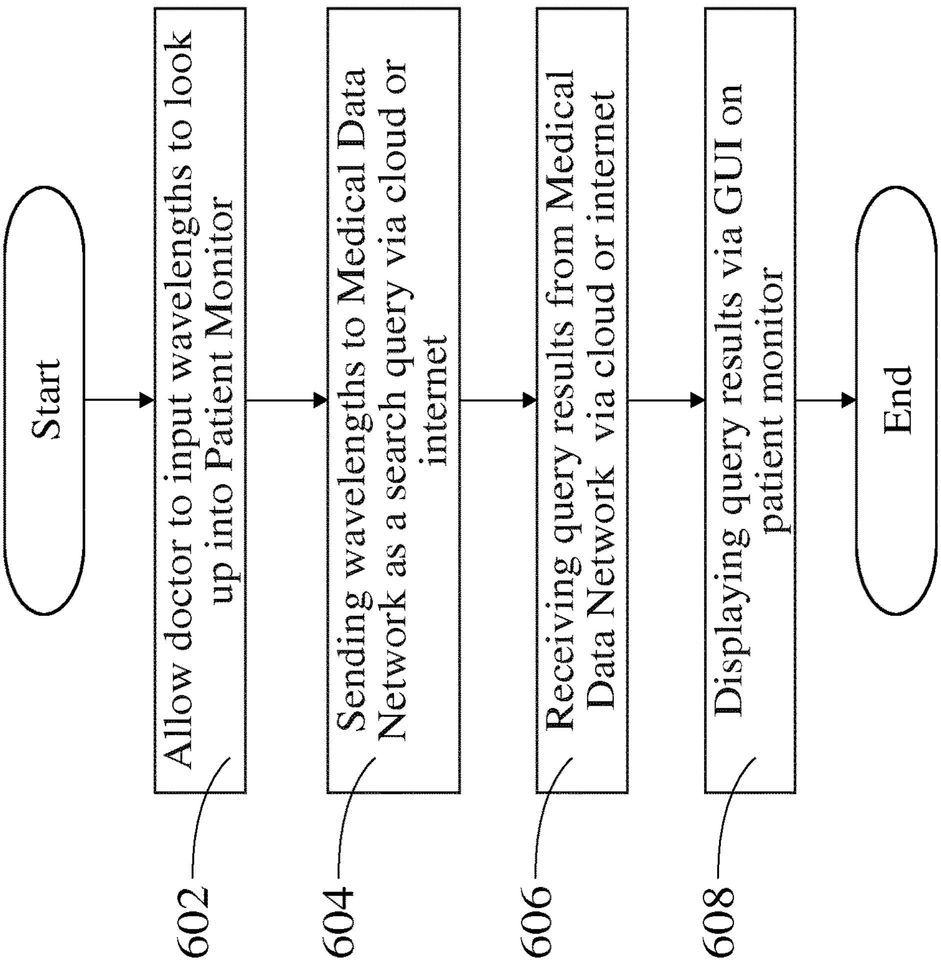
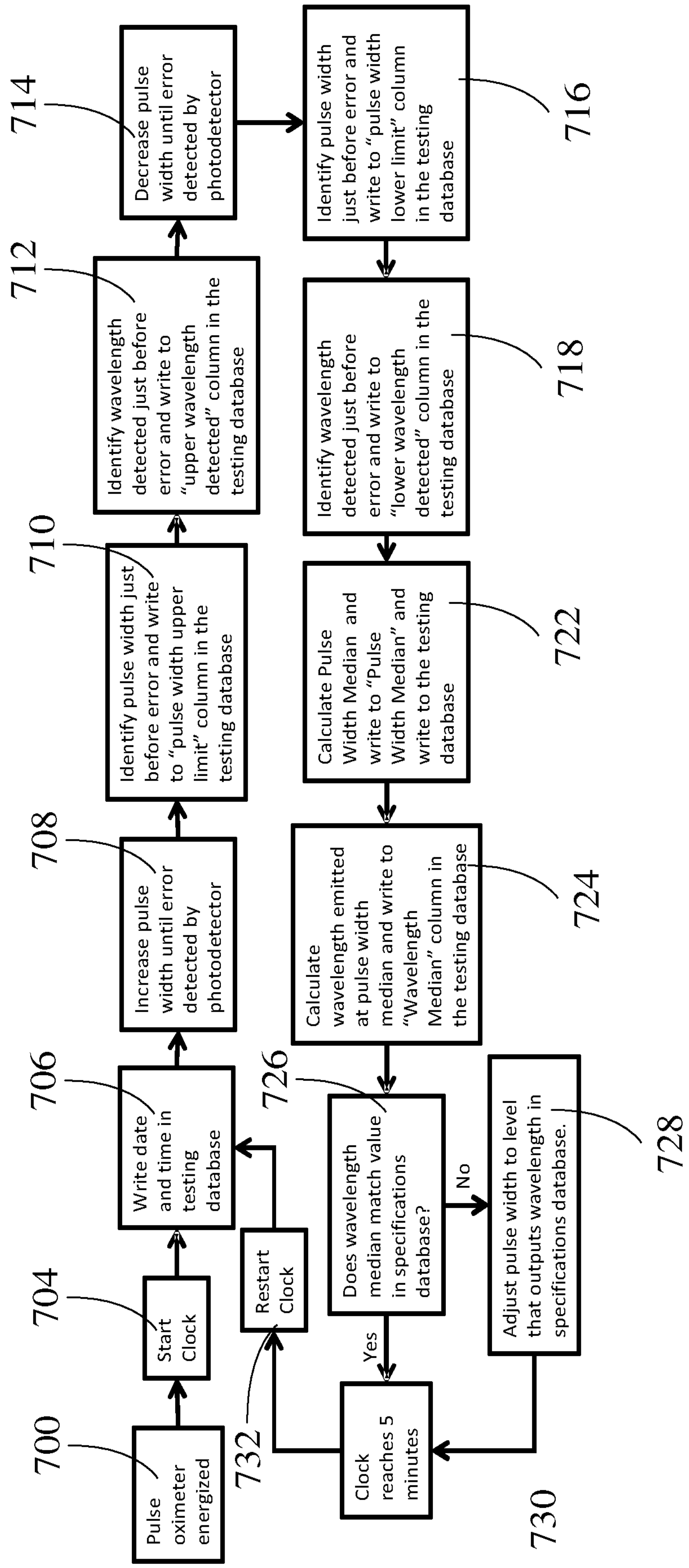

Start
Allow doctor to input wavelengths to look up into Patient Monitor
602
Sending wavelengths to Medical Data Network as a search query via cloud or internet
604
Receiving query results from Medical Data Network via cloud or internet
606
Displaying query results via GUI on patient monitor
608
End

FIG. 6



700
Pulse oximeter energized
704
Start Clock
706
Write date and time in testing database
708
Increase pulse width until error detected by photodetector
710
Identify pulse width just before error and write to "pulse width upper limit" column in the testing database
712
Identify wavelength detected just before error and write to "upper wavelength detected" column in the testing database
714
Decrease pulse width until error detected by photodetector
716
Identify pulse width just before error and write to "pulse width lower limit" column in the testing database
718
Identify wavelength detected just before error and write to "lower wavelength detected" column in the testing database
722
Calculate Pulse Width Median and write to "Pulse Width Median" and write to the testing database
724
Calculate wavelength emitted at pulse width median and write to "Wavelength Median" column in the testing database
726
Does wavelength median match value in specifications database?
No
728
Adjust pulse width to level that outputs wavelength in specifications database.
Yes
730
Clock reaches 5 minutes
732
Restart Clock

FIG. 7A

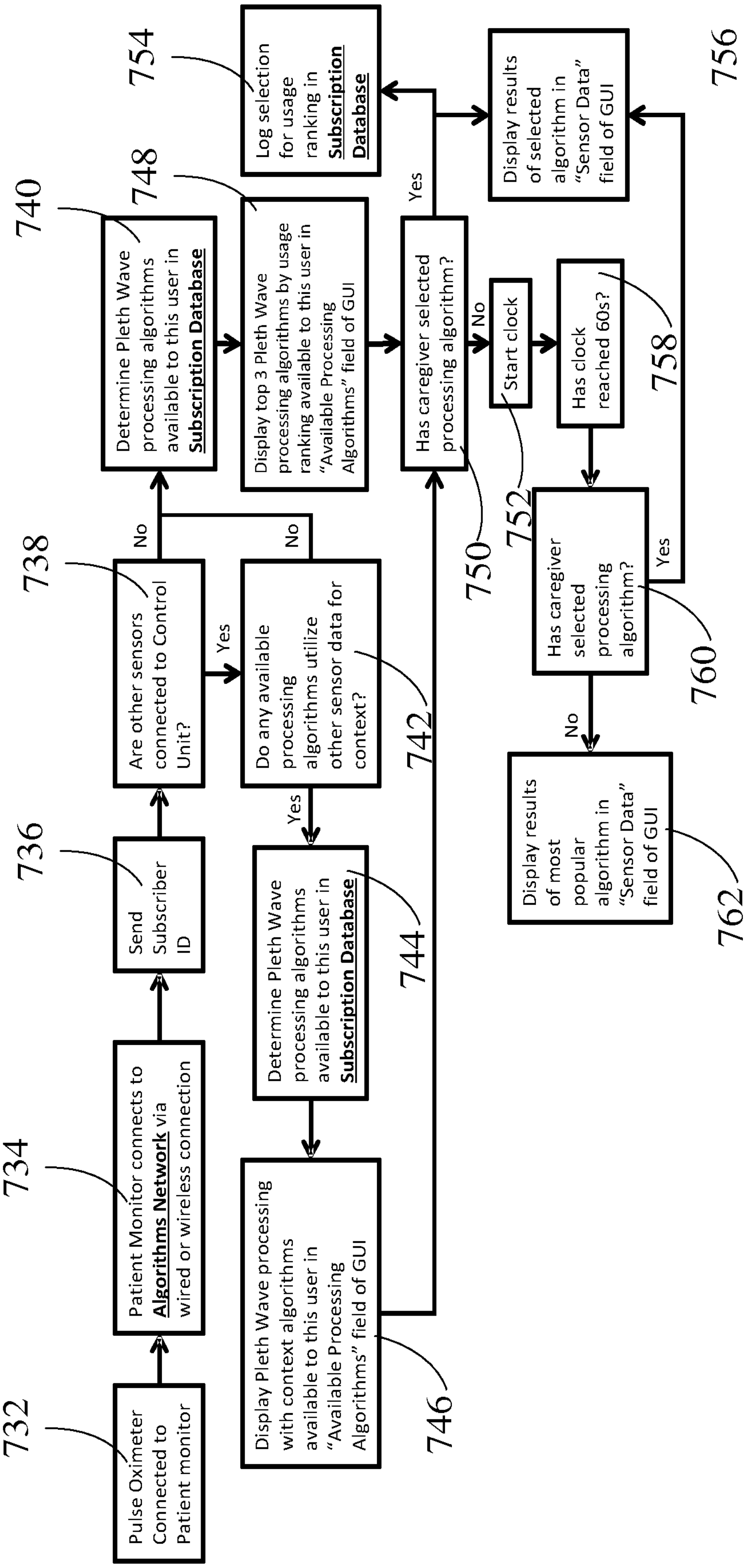

732
Pulse Oximeter Connected to Patient monitor
734
Patient Monitor connects to Algorithms Network via wired or wireless connection
736
Send Subscriber ID
738
Are other sensors connected to Control Unit?
Yes
No
740
Determine Pleth Wave processing algorithms available to this user in Subscription Database
742
Do any available processing algorithms utilize other sensor data for context?
Yes
No
744
Determine Pleth Wave processing algorithms available to this user in Subscription Database
746
Display Pleth Wave processing with context algorithms available to this user in "Available Processing Algorithms" field of GUI
748
Display top 3 Pleth Wave processing algorithms by usage ranking available to this user in "Available Processing Algorithms" field of GUI
750
Has caregiver selected processing algorithm?
Yes
No
752
Start clock
754
Log selection for usage ranking in Subscription Database
756
Display results of selected algorithm in "Sensor Data" field of GUI
758
Has clock reached 60s?
760
Has caregiver selected processing algorithm?
Yes
No
762
Display results of most popular algorithm in "Sensor Data" field of GUI

FIG. 7B

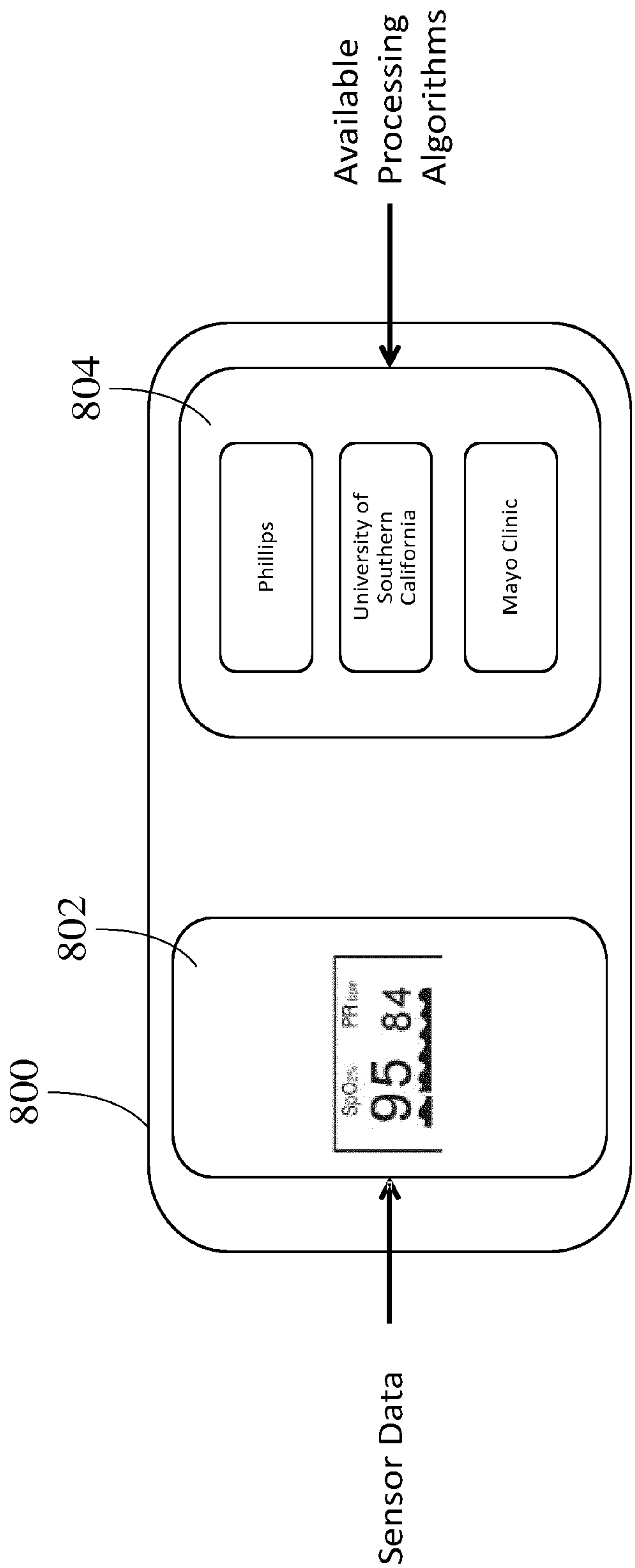

Available Processing Algorithms
804
Phillips
University of Southern California
Mayo Clinic
802
800
SpO2%
95
PR bpm
84
Sensor Data

FIG. 8

900

Subscription Database

Pleth Wave Processing Algorithm Provider	Uses Context?	Context Data	Context Data 2	...	Context Data n	Subscriber ID 1	Subscriber ID 2	...	Subscriber ID n	Usage ranking
Phillips	Y	Core Body Temp	Null		Null	Hospital A	Hospital B		Hospital Z	1
Mayo Clinic	N	Null	Null		Null	Hospital A	Hospital B		Hospital Z	3
University of Southern California	Y	Breathing Rate	Core Body Temp		Null	Free	Free		Free	2
...										
Algorithm n	N	Null	Null		Null	Hospital A	Hospital B		Hospital Z	62

FIG. 9A

910

Testing Database

Date	Time	Pulse Width Upper Limit	Upper Wavelength Detected	Pulse Width Lower Limit	Lower Wavelength Detected	Pulse Width Median	Wavelength Median
9/21	3:15pm	100Hz	670nm	80Hz	650nm	90Hz	660nm
9/21	3:20pm	102Hz	674nm	82Hz	654nm	92Hz	664nm
9/21	3:25am	103Hz	678nm	83Hz	658nm	93Hz	668nm
...							
9/25	4:30pm	102Hz	674nm	82Hz	654nm	92Hz	664nm

FIG. 9B

MULTI COLOR PULSE OXIMETER

BACKGROUND OF THE INVENTION

[0001] Pulse oximeters are spectrophotometric devices that use spectroscopy for monitoring desired physiological characteristics of a patient. Pulse oximeters noninvasively monitor the blood oxygen saturation (SpO2) of a person. As such, a wide variety of pulse oximeters have been developed to provide doctors and other healthcare personnel with the information they need to provide the best possible healthcare for their patients.

[0002] Pulse oximeters emit wavelengths of light through the body part to a photodetector to measure the amount of oxygen being carried in the blood. Current pulse oximeters usually use at least two wavelengths of light, infrared and red. Also, although there are certain wavelengths of light that are proven more effective for use in pulse oximetry, current pulse oximeters are designed to emit and detect only a limited number of wavelengths of light. Hence, there is a need for a pulse oximeter that can scan the full electromagnetic spectrum, outputting only the most relevant wavelengths associated to a patient's current condition.

SUMMARY OF THE CLAIMED INVENTION

[0003] Some embodiments of the present invention relates to systems and methods for measuring blood oxygen saturation via a multi-wavelength pulse oximeter. The system comprises a multi-wavelength pulse oximeter with an LED array, a patient monitor connected to the multi-wavelength pulse oximeter, a medical data network for querying an at least one wavelength associated with a patient condition, an algorithm network for providing subscription based algorithms to process sensor data, and a user interface on the patient monitor for configuring a pulse oximeter's scanning mode, for querying the at least one wavelength associated with a patient condition, and for displaying a plethysmograph.

[0004] The method of the present invention comprises connecting a patient monitor to a medical data network; entering using the patient monitor at least one wavelength in a search query to the medical data network for a patient condition associated with the at least one wavelength; displaying query results corresponding to at least one wavelength on a user interface of the patient monitor; requesting to scan an initial wavelength via the patient monitor's user interface; transmitting the initial wavelength to be scanned to a sensor controller in the patient monitor; outputting the initial wavelength on the multi-wavelength pulse oximeter via a control signal from the controller; acquiring a first set of pulse oximeter data corresponding to the initial wavelength and storing the acquired first set of pulse oximeter data to a sensor database; incrementing the initial wavelength to a succeeding wavelength; acquiring a second set of pulse oximeter data corresponding to the succeeding wavelength and storing the acquired second set of pulse oximeter data to the sensor database; and diagnosing the patient's condition based on the acquired first and second set of pulse oximeter data.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] 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:

[0006] FIG. **1** illustrates a block diagram of a system for measuring blood oxygen saturation via a multi-wavelength pulse oximeter according to a preferred embodiment of the present invention.

[0007] FIG. **2** illustrates a block diagram of a patient monitor according to a preferred embodiment of the present invention.

[0008] FIG. **3** illustrates a flowchart according to a preferred embodiment of the present invention.

[0009] FIGS. **4**A, **4**B, and **4**C illustrate the flowcharts in configuring the scanning mode of the multi-wavelength pulse oximeter according to a preferred embodiment of the present invention.

[0010] FIGS. **5**A, **5**B, **5**C and **5**D illustrate a graphical user interface of the patient monitor according to a preferred embodiment of the present invention.

[0011] FIG. **6** illustrates a flowchart for a lookup software according to a preferred embodiment of the present invention.

[0012] FIGS. **7**A and **7**B illustrates the flowcharts for a calibration software and an algorithm Selection software according

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0013] An embodiment of the present invention relates to a method for measuring blood oxygen saturation via a multi-wavelength pulse oximeter comprising: connecting a patient monitor to a medical data network; entering using the patient monitor at least one wavelength in a search query to the medical data network for a patient condition associated with the at least one wavelength; displaying query results corresponding to at least one wavelength on a user interface of the patient monitor; requesting to scan an initial wavelength via the patient monitor's user interface; transmitting the initial wavelength to be scanned to a sensor controller in the patient monitor; outputting the initial wavelength on the multi-wavelength pulse oximeter via a control signal from the controller; acquiring a first set of pulse oximeter data corresponding to the initial wavelength and storing the acquired first set of pulse oximeter data to a sensor database; incrementing the initial wavelength to a succeeding wavelength; acquiring a second set of pulse oximeter data corresponding to the succeeding wavelength and storing the acquired second set of pulse oximeter data to the sensor database; and diagnosing the patient's condition based on the acquired first and second set of pulse oximeter data.

[0014] Embodiments of the present invention also relate to a system for measuring blood oxygen saturation via a multi-wavelength pulse oximeter comprising: a multi-wavelength pulse oximeter with an LED array; a patient monitor connected to the multi-wavelength pulse oximeter; a medical data network for querying an at least one wavelength associated with a patient condition; and a user interface on the patient monitor for configuring a pulse oximeter's scanning mode, for querying the at least one wavelength associated with a patient condition, and for displaying a plethysmograph.

[0015] In a preferred embodiment of the present invention as illustrated in FIG. **1**, a system for measuring blood oxygen saturation via a multi-wavelength pulse oximeter comprises a multi-wavelength pulse oximeter **100** and a patient monitor **102** with a graphical user interface **112** which is connected to a medical data network **110** and Algorithms Network **116** with algorithms **1**-*n* **118** and a Subscription database **120**, all residing in the cloud or internet **108**. The multi-wavelength pulse oximeter **100** preferably emits multiple electromagnetic spectrum wavelengths ranging from infrared to ultraviolet. As shown in FIG. **1**, the graphical user interface **112** displays the plethysmograph **104** of the acquired pulse oximeter data, the corresponding wavelengths, and the scanning mode **106** selected by the user. The graphical user interface **112** preferably allows a user to select a scanning mode **10** such as: scanning the full electromagnetic spectrum (a full electromagnetic spectrum scan), a specific wavelength range such as infrared (IR) spectrum, a limited set of wavelengths, or wavelengths with the highest signal-to-noise ratio. The graphical user interface **112** also preferably allows a user, which may be a doctor or medical professional, to query selected wavelengths associated with a patient condition using a lookup software **114**. The queries are sent to the medical data network **110** residing in the cloud or internet **108**. The results of the queries are then displayed on the graphical user interface **112**. The graphical user interface **112** also preferably allows a user, which may be a doctor or medical professional, to calibrate emitters of the pulse oximeter to test accuracy, and select a cloud-based algorithm from the Algorithms Network to analyze the pulse oximeter data collected by the pulse oximeter **100**. FIG. **2** illustrates a preferred embodiment of a patient monitor. The patient monitor comprises a display **200**, a power module **202**, a processor **204**, a communications module **206**, a user interface **208**, a sensor controller **210**, a signal processor **212**, and a memory **214**. The memory **214** comprises a sensor database **216**, a wavelengths database **218**, a Subscription Database **230**, and a Testing Database **232**. The memory **214** also comprises programs used for scanning the electromagnetic spectrum—which are Calibration Software **234**, Algorithm Selection Software **236**, scanning near IR software **220**, best wavelength software **222**, multispectral software **224**, and a lookup software **226**. The sensor controller **210** controls the emission of wavelengths of one or more sensors **228** communicably connected to the signal processor. The signal processor processes the acquired data from the plurality of sensors **228**. The patient monitor **102** preferably allows storing a wavelength or a set of wavelengths on a wavelengths database **218** on its memory **214**. A note may also be stored with the wavelength or set of wavelengths. The patient monitor **102** also preferably receives software updates for the multi-wavelength pulse oximeter **100** and the patient monitor **102**. Software updates may include firmware updates or algorithm updates for the various scanning modes **106**.

[0016] FIG. **3** illustrates a preferred method of the present invention. A patient monitor is connected to a medical data network (step **300**). In this embodiment, a medical professional enters in a search query using the patient monitor to the medical data network one or more wavelengths for a patient condition associated with one or more wavelengths (step **302**). The results of the search query are displayed on the patient monitor (step **304**). The medical professional can then request to scan the one or more wavelengths via the patient monitor's user interface (step **306**). The one or more wavelengths are then transmitted to the sensor controller (step **308**) and a control signal is then generated to output the corresponding wavelength on the multi-wavelength pulse oximeter (step **310**). Pulse oximeter data is then acquired and stored to a sensor database (step **312**). If there is still a succeeding wavelength (step **314**), the current wavelength is incremented (step **316**) and pulse oximeter data is also acquired and stored for that succeeding wavelength. If there are no more succeeding wavelengths, the condition of the patient can then be diagnosed based on the acquired pulse oximeter data (step **318**).

[0017] In another preferred method of the present invention, the request to scan the one or more wavelengths may include a scanning mode. Scanning modes may be scanning the full electromagnetic spectrum, scanning near the infrared (IR) spectrum, scanning a limited set of wavelengths, or scanning for the wavelengths with the highest signal-to-noise ratio.

[0018] FIG. **4**A illustrates the flowchart of a preferred scanning mode of the present invention. The patient monitor receives a request to scan the whole electromagnetic spectrum to determine the wavelengths with the highest signal-to-noise ratio (step **400**). The initial wavelength is then determined (step **402**) and sent to the sensor controller (step **404**). Pulse oximeter data is then acquired for given sample time (step **406**) and then stored with the corresponding wavelength in a database (step **408**). If there is still a succeeding wavelength (step **410**), the current wavelength is incremented (step **412**) and pulse oximeter data is also acquired and stored for that succeeding wavelength. After the whole spectrum is scanned, the signal-to-noise ratio for each wavelength is calculated (step **414**) and the wavelength with the highest signal-to-noise ratio is displayed on the graphical user interface (step **416**) as shown in FIG. **5**B.

[0019] FIG. **4**B illustrates the flowchart of another preferred scanning mode of the present invention. The patient monitor receives a request to scan near the infrared spectrum (**418**). The initial wavelength in the infrared spectrum is then determined (step **420**) and sent to the sensor controller (step **422**). Pulse oximeter data is then acquired for a given sample time (step **424**) and then stored with the corresponding wavelength in a database (step **426**). If there is still a succeeding wavelength in the infrared spectrum (step **428**), the current wavelength is incremented (step **430**) and pulse oximeter data is also acquired and stored for that succeeding wavelength. After the whole infrared spectrum is scanned, the signal-to-noise ratio for each wavelength is calculated (step **432**) and the wavelength with the highest signal-to-noise ratio is determined (step **434**) and displayed on the graphical user interface (step **436**) as shown in FIG. **5**B. Further, the wavelength with the highest signal-to-noise ratio can be stored in a database (step **438**). The medical professional may also add notes regarding the wavelength (step **440**) as shown in FIG. **5**D.

[0020] FIG. **4**C illustrates the flowchart of another preferred scanning mode of the present invention. The patient monitor receives a request to scan at least two sets of wavelengths (step **442**). The first set of wavelengths is determined (step **444**) and sent to the sensor controller (step **446**). Pulse oximeter data is then acquired for a given sample time (step **448**) and then stored with the corresponding wavelength in a database (step **450**). A plethysmograph is then generated for the wavelength (step **452**) and displayed on the patient monitor (step **454**) as shown in FIG. **5**A. If there are succeeding sets of wavelengths, the current set is incremented to the next set of wavelengths (step **456**) and sent to the sensor controller for pulse oximeter data acquisition.

[0021] FIG. **5**A illustrates a preferred embodiment of a graphical user interface providing a multi-spectral view in the patient monitor. A single sensor may not be able to monitor multiple spectra simultaneously, but can scan selected wavelengths for a specific sample rate (i.e., 10-20 milliseconds). For example, sample 1 is measured at 400 nm, sample 2 is 500 nm, sample 3 is 600 nm, sample 4 is 700 nm, and sample 5 is 400 again, and so on.

[0022] FIG. **5**B illustrates another preferred embodiment of a graphical user interface of the patient monitor. The graphical user interface shows the results of a full spectrum scan to determine wavelength with the highest signal to noise ratio. The interface also allows the user to use that wavelength or store it for later use.

[0023] FIG. **5**C illustrates still another preferred embodiment of a graphical user interface of the patient monitor. The graphical user interface displays the results of a query to the medical data network. For example, the doctor has searched for scholarly articles that contain the wavelength 938 nm to determine if there is any relevant literature relating to this wavelength. Relevant literature maybe related to use of the wavelength on discolored skin, through scars and tattoos, etc.

[0024] Another preferred embodiment of a graphical user interface of the patient monitor is illustrated in FIG. **5**D. The graphical user interface displays the stored wavelengths that can be used for future monitoring. The graphical user interface also allows a user to make a note for each wavelength stored.

[0025] FIG. **6** illustrates the flowchart of a lookup software according to a preferred embodiment of the present invention. A medical professional inputs at least one wavelength as a search query to a patient monitor using the user interface (step **602**). The inputted wavelength is then looked up on the medical data network (step **604**). The results of the search query are then acquired from the medical data network (step **606**) and then displayed on the graphical user interface of the patient monitor (step **608**).

[0026] FIG. **7**A illustrates the flowchart of a preferred embodiment of a calibration software. Once the pulse oximeter is energized (step **700**), the software starts the clock (step **704**). The date and time are then recorded in the testing database (step **706**). Next, the software sends instructions to the sensor controller **210** to increase the pulse width of the sensor emitters until an error is detected by the sensor (step **708**). The software then records the pulse width at which the error occurred as the upper wavelength detected (step **710**). The software then repeats the process (step **712**, **714**, **716**), except the pulse width is decreased instead of increased, and the resultant pulse width is recorded as the lower wavelength detected (step **718**). A median value is then calculated (step **722**) and compared with a standard to determine the error tolerance of the emitters/detectors (step **724**, **726**, **728**). After 5 minutes the process restarts (step **730**, **702**).

[0027] FIG. **7**B illustrates the flowchart of an algorithm selection software. Once the pulse oximeter is connected to the patient monitor (step **732**), the patient monitor connects to algorithms network over a wired or wireless connection (step **734**). The patient monitor sends a subscriber ID (step **736**) to the algorithms network and then determines if there are other sensors connected to the patient monitor (step **738**), in order to recommend algorithms that incorporate those other sensors (step **742**, **744**, **746**). The software then displays algorithms available to the user based on their sensors and subscription (step **740**, **748**), and allows the user to select one algorithm to use to process sensor data (step **750**, **752**, **754**, **756**, **758**, **760**, **762**). The algorithm maybe related to use of a wavelength on discolored skin, through scars and tattoos, etc.

[0028] FIG. **8** illustrates a preferred embodiment of a graphical user interface **800** of a patient monitor. On the left, there is included a display of sensor data **802** collected from the patient monitor's sensors. On the right, there is displayed the available algorithms **804** to analyze sensor data, which the user can select.

[0029] FIG. **9**A illustrates a preferred embodiment of a subscription database **900**. The subscription database **900** contains data about the patient monitors subscription to the algorithm network and the algorithms available to the user.

[0030] FIG. **9**B illustrates a preferred embodiment of a testing database **910**. The testing database **910** contains data generated by the calibration software about the date, time, and results of a sensor calibration.

[0031] In an exemplary embodiment of the invention, a doctor wants to know if a 938 nm wavelength is useful in monitoring a certain condition of a patient. The doctor queries the 938 nm wavelength on the medical network and the results of the query are displayed on the patient monitor. After reading the results, the doctor concludes that the 938 nm wavelength is helpful and configures the multi-wavelength pulse oximeter using the patient monitor to scan a selected spectrum around the 938 nm range. One by one, the wavelengths are scanned for a sample time of 10-20 milliseconds, and the corresponding pulse oximeter data are stored in the sensor database. After the selected spectrum is scanned, the doctor can make a diagnosis based on the acquired pulse oximeter data from the set of wavelengths.

[0032] In another exemplary embodiment of the invention, a doctor wants to know what the most accurate wavelength is helpful in monitoring the condition of a patient. The doctor requests using the patient monitor to scan the whole electromagnetic spectrum to determine the most accurate wavelength for monitoring a specific condition of a patient. The initial wavelength is transmitted to the sensor controller to control the emitted wavelength of the LED array in a multi-wavelength pulse oximeter. Corresponding pulse oximeter data is then acquired and stored in a sensor database. The initial wavelength is then incremented until it reaches the end of the electromagnetic spectrum with the corresponding pulse oximeter data for each wavelength stored in a sensor database. The signal-to-noise ratio is then calculated for each wavelength and the one with the highest signal-to-noise ratio, for example, 990 nm is displayed. The doctor can now choose to use the 990 nm wavelength now or he can store it to a wavelength database for future use. Additionally, the doctor can also add a note regarding the 990 nm wavelength.

[0033] In another exemplary embodiment of the invention, a doctor wants to know if the wavelength displayed on the patient monitor is accurate. The doctor selects calibrate emitters and the calibration software is executed in order to determine if the upper and lower tolerances are compared to a standard.

[0034] In another exemplary embodiment of the invention, a doctor wants to select a new algorithm to process the sensor data. The algorithm selection software is executed to synchronize the patient monitor with the algorithm network using subscription data from the subscription database, and allows the doctor to select at least one algorithm from a plurality of algorithms that process sensor data.

[0035] In accordance with the various embodiments of the present invention, the memory **214** may include high-speed random access memory or non-volatile memory such as magnetic disk storage devices, optical storage devices, or flash memory. Memory **214** may also store software instructions for facilitating processes, features and applications of the system disclosed in the invention.

[0036] In accordance with the various embodiments of the present invention, communications module **206** 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 **206** may be a physical channel such as a USB cable or other wired forms of communication.

[0037] 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 a user to measure blood oxygen saturation via a multi-wavelength pulse oximeter, the system comprising:

- a multi-wavelength pulse oximeter with an LED array for acquiring a pulse oximeter data;
- a patient monitor connected to the multi-wavelength pulse oximeter, the patient monitor having a graphical user interface for configuring a pulse oximeter's scanning mode, for querying at least one wavelength associated with a patient condition, and for displaying a plethysmograph;
- a medical data network for querying an the at least one wavelength associated with the patient condition, the medical data network connected to the patient monitor and residing in the cloud or internet; and
- an algorithm network connected to the patient monitor and residing in the cloud or internet, the algorithm network comprising algorithms **1**-*n* and a subscription data base;
- wherein the graphical user interface displays the plethysmograph of the acquired pulse oximeter data, one or more corresponding wavelengths, and a scanning mode selected by the user; and
- wherein the graphical user interface allows the user to calibrate one or more emitters of the pulse oximeter, and to select at least one of the algorithms **1**-*n* from the algorithms network to analyze the pulse oximeter data collected by the pulse oximeter.

2. The system of claim **1**, wherein the multi-wavelength pulse oximeter emits multiple electromagnetic spectrum wavelengths ranging from infrared to ultraviolet.

3. (canceled)

4. The system of claim **1**, wherein the graphical user interface allows the user to select a scanning mode selected from a full electromagnetic spectrum scan, a specific wavelength range, a limited set of wavelengths, and wavelengths with the highest signal-to-noise ratio.

5. The system of claim **1**, wherein the graphical user interface allows the user to query a selected wavelength associated with a patient condition using a lookup software.

6. (canceled)

7. The system of claim **1**, wherein the patient monitor comprises a display, a power module, a processor, a communications module, a user interface, a sensor controller, a signal processor, and a memory.

8. The system of claim **7**, wherein the memory storing thereon a sensor database, a wavelengths database, the subscription database, a testing database, and one or more programs for scanning an electromagnetic spectrum.

9. The system of claim **8**, wherein the programs for scanning an electromagnetic spectrum is a calibration software, an algorithm selection software, a scanning near IR software, a best wavelength software, a multispectral software, a lookup software, or a combination thereof.

10. The system of claim **7**, wherein the sensor controller controls an emission of wavelengths of one or more sensors communicably connected to the signal processor.

11. The system of claim **10**, wherein the signal processor acquires and processes sensor data from the sensors.

12. The system of claim **1**, wherein the graphical user interface allows the user to make a note for each wavelength stored.

13. The system of claim **1**, wherein the graphical user interface provides as multispectral view in the patient monitor.

14. The system of claim **4**, wherein, when the full electromagnetic spectrum scan has been selected and performed, the graphical user interface shows a result of the full electromagnetic spectrum scan to determine the wavelength with the highest signal to noise ratio.

15. The system of claim **14**, wherein the graphical user interface allows the user to use the determined wavelength or store the determined wavelength for later use.

16. The system of claim **1**, wherein the graphical user interface displays at least one of:

- a result of a query to the medical data network;
- the stored wavelength that can be used for a future monitoring; and
- the sensor data and the algorithms **1**-*n* which can be selected by the user.

17. (canceled)

18. (canceled)

19. The system of claim **1**, wherein the subscription database contains data about a subscription of the patient monitor to the algorithm network and the algorithms available to the user.

20. The system of claim **9**, wherein the testing database contains data generated by the calibration software about a date, a time, and a result of a sensor calibration.

21. (canceled)

22. (canceled)

* * * * *

专利名称(译)	多色脉冲血氧仪		
公开(公告)号	US20180344219A1	公开(公告)日	2018-12-06
申请号	US15/761465	申请日	2016-09-21
[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 BODKIN JOSEPH		
发明人	CRONIN, JOHN BODKIN, JOSEPH		
IPC分类号	A61B5/1495 A61B5/1455 A61B5/00 G16H50/30 G16H40/63 G06F17/30		
CPC分类号	A61B5/1495 A61B5/14552 A61B5/743 A61B5/7435 A61B5/0022 G16H50/30 G16H40/63 G06F17/30864 A61B2560/0271 A61B5/0075 A61B5/1455 A61B5/7203 A61B5/7221 G16H10/60 G16H40/67 G16H70/20 G06F16/951 G06F19/324 G16B40/00		
优先权	2016161242 2016-03-18 EP 62/222529 2015-09-23 US		
外部链接	Espacenet USPTO		

摘要(译)

公开了用于通过多波长脉冲血氧计测量血氧饱和度的系统和方法。该系统包括具有LED阵列的多波长脉冲血氧计，连接至多波长脉冲血氧计的患者监测器，用于查询与患者状况相关联的至少一个波长的医疗数据网络，用于提供基于订阅的算法网络用于处理传感器数据的算法，以及患者监视器上的用户界面，用于配置脉搏血氧计的扫描模式，用于查询与患者状况相关联的至少一个波长，以及用于显示体积描记器。