US 20140276239A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2014/0276239 A1**

(43) **Pub. Date: Sep. 18, 2014**

SUBRAMANIAM et al.

(54) **METHOD AND APPARATUS FOR INTEGRATED MEDICAL SERVICES USING A MULTI-PURPOSE SENSOR FOR REMOTE MONITORING OF A PATIENT**

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(21) Appl. No.: **13/962,860**

(22) Filed: **Aug. 8, 2013**

Related U.S. Application Data

(63) Continuation-in-part of application No. 13/842,191, filed on Mar. 15, 2013.

Publication Classification

(51) **Int. Cl.**

A61B 5/00	(2006.01)
G06F 19/00	(2006.01)
A61B 5/11	(2006.01)

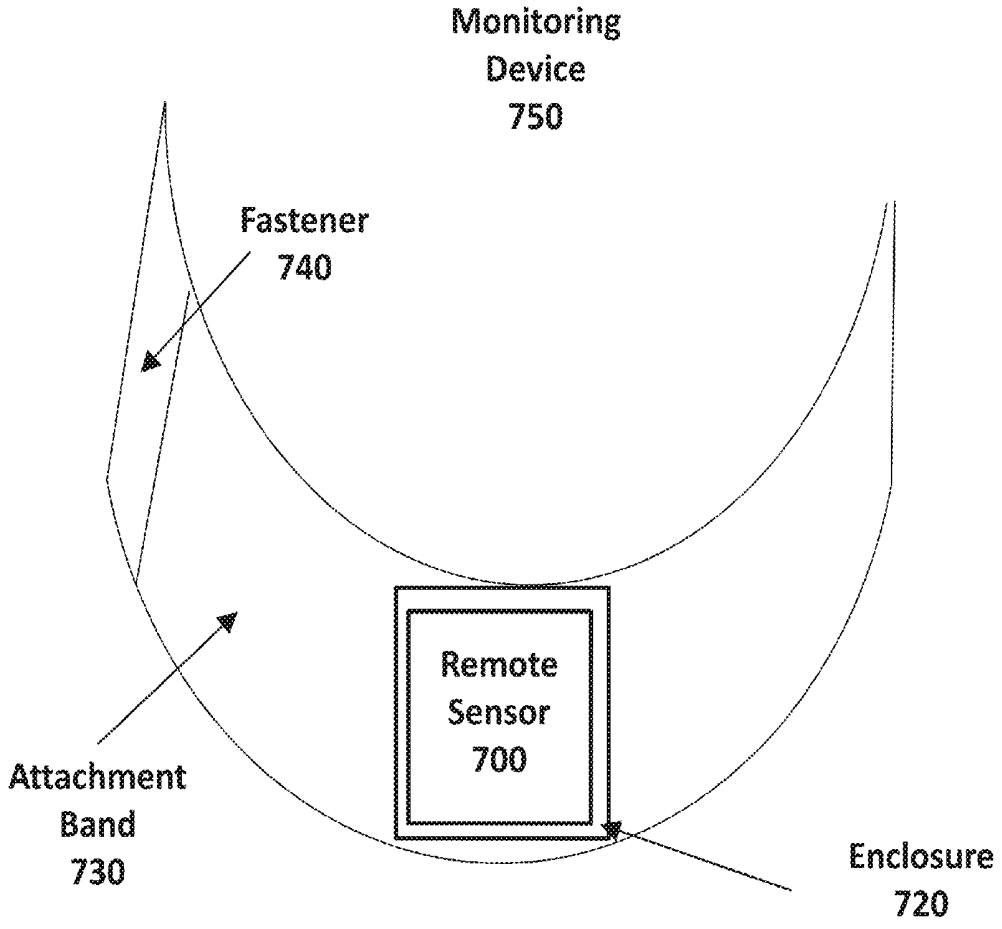
(52) **U.S. Cl.**

CPC ***A61B 5/747*** (2013.01); ***A61B 5/1113*** (2013.01); ***A61B 5/1117*** (2013.01); ***A61B 5/0004*** (2013.01); ***A61B 5/0022*** (2013.01); ***A61B 5/7282*** (2013.01); ***A61B 5/746*** (2013.01); ***A61B 5/7275*** (2013.01); ***A61B 5/6831*** (2013.01); ***G06F 19/3431*** (2013.01)

USPC **600/595**; 705/2

(57) **ABSTRACT**

A method and apparatus for remote monitoring of a medical patient is described. A sensor device is placed in physical contact with the patient. The sensor communicates with a computing device using Bluetooth or another wireless communication protocol. The computing device then communicates with a remote server that compiles data regarding the patient. The system can gather data such as the patient's temperature, the amount of exercise undertaken by the patient, the amount of sleep by the patient, and whether the patient has physically fallen.



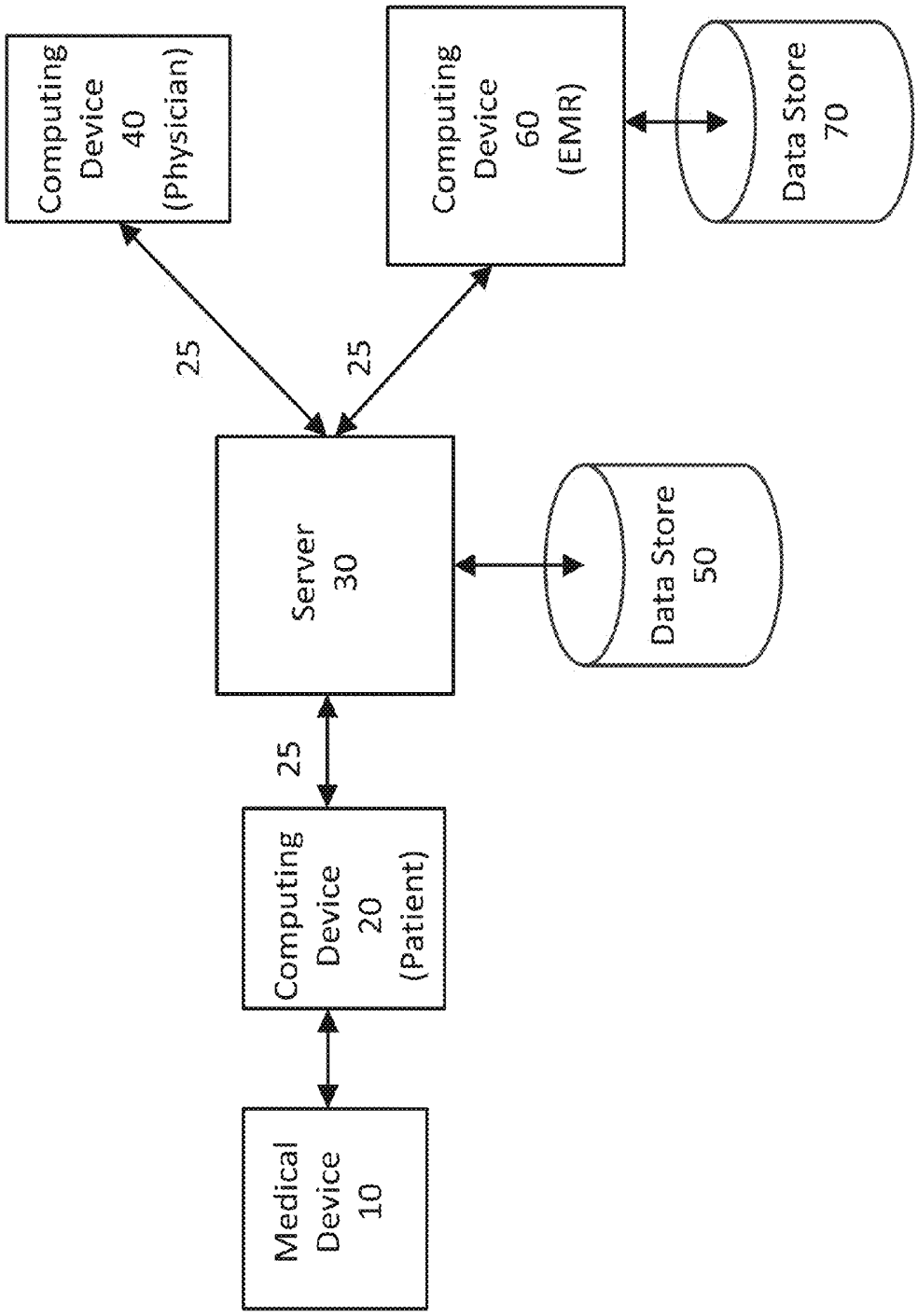

Computing Device 40 (Physician)
Computing Device 60 (EMR)
Data Store 70
25
25
Server 30
Data Store 50
25
Computing Device 20 (Patient)
Medical Device 10

FIGURE 1

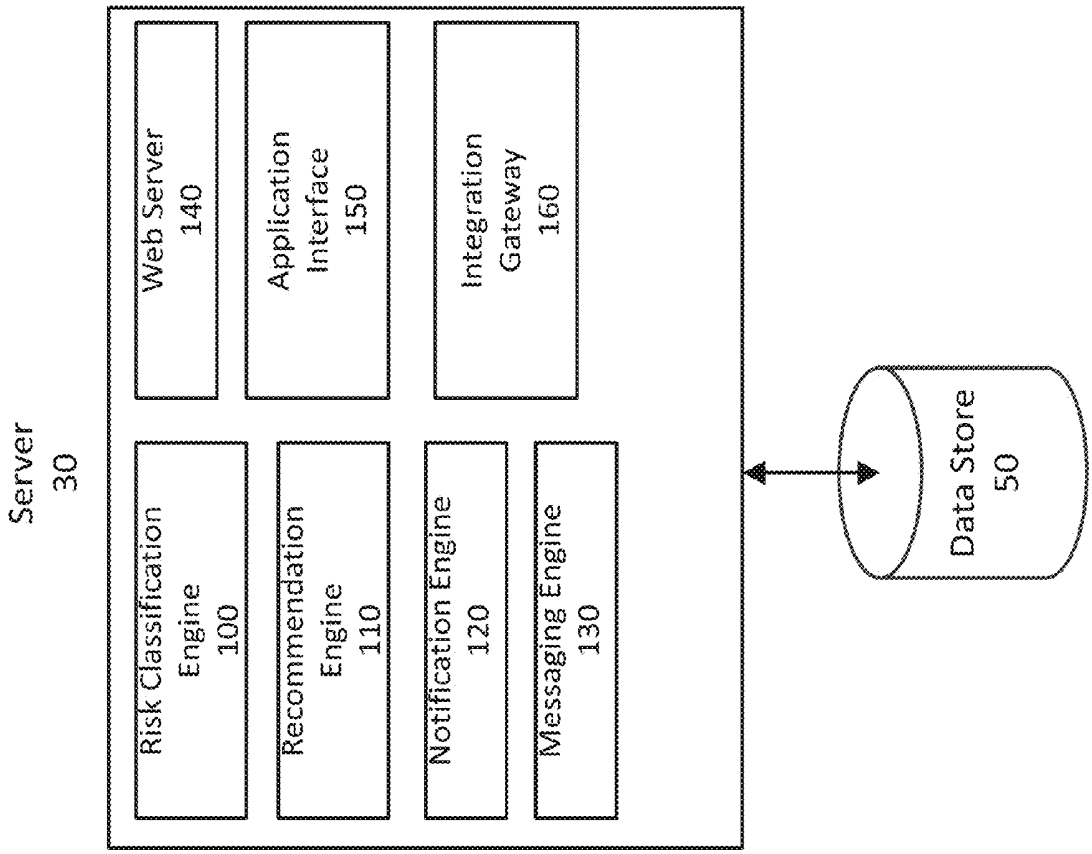

Server
30
Risk Classification Engine 100
Recommendation Engine 110
Notification Engine 120
Messaging Engine 130
Web Server 140
Application Interface 150
Integration Gateway 160
Data Store 50

FIGURE 2

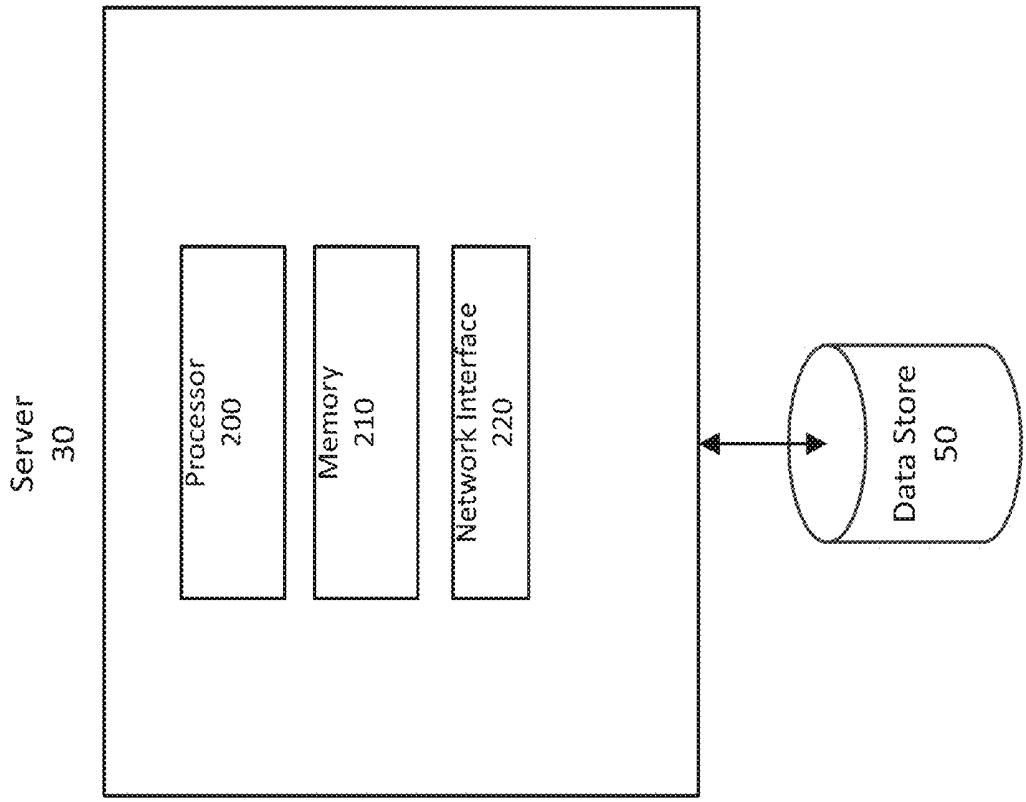

Server
30
Processor
200
Memory
210
Network Interface
220
Data Store
50

FIGURE 3

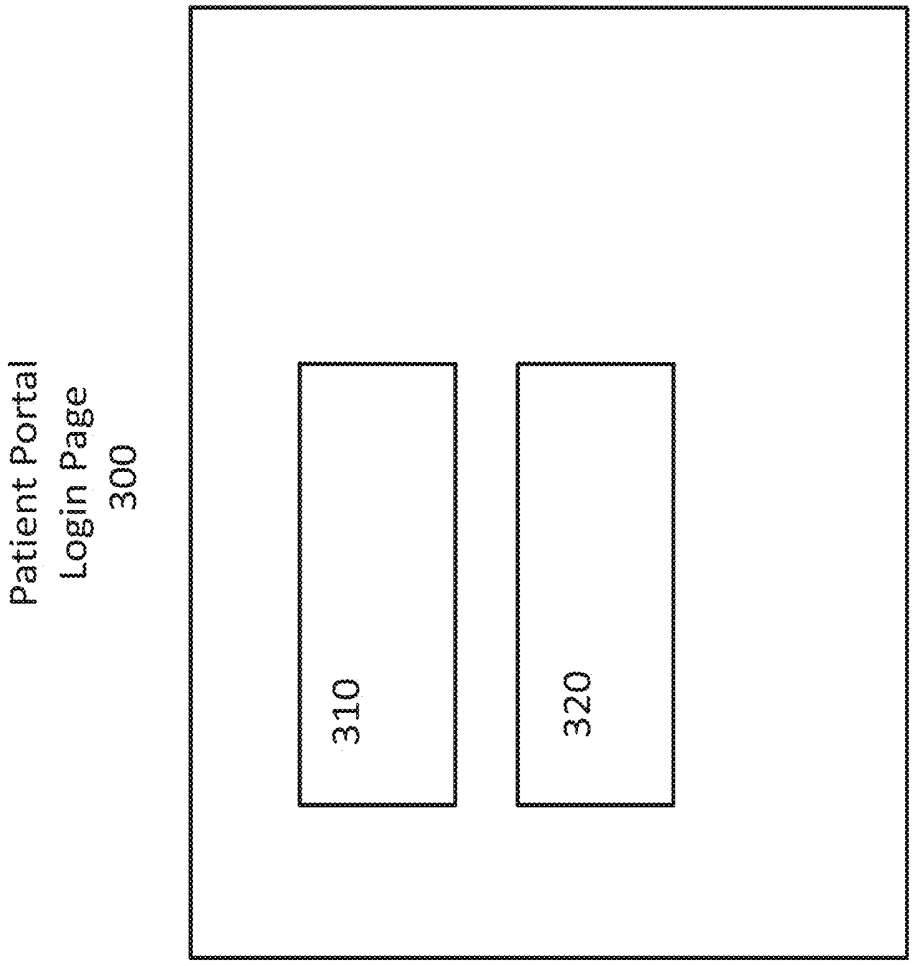


FIGURE 4

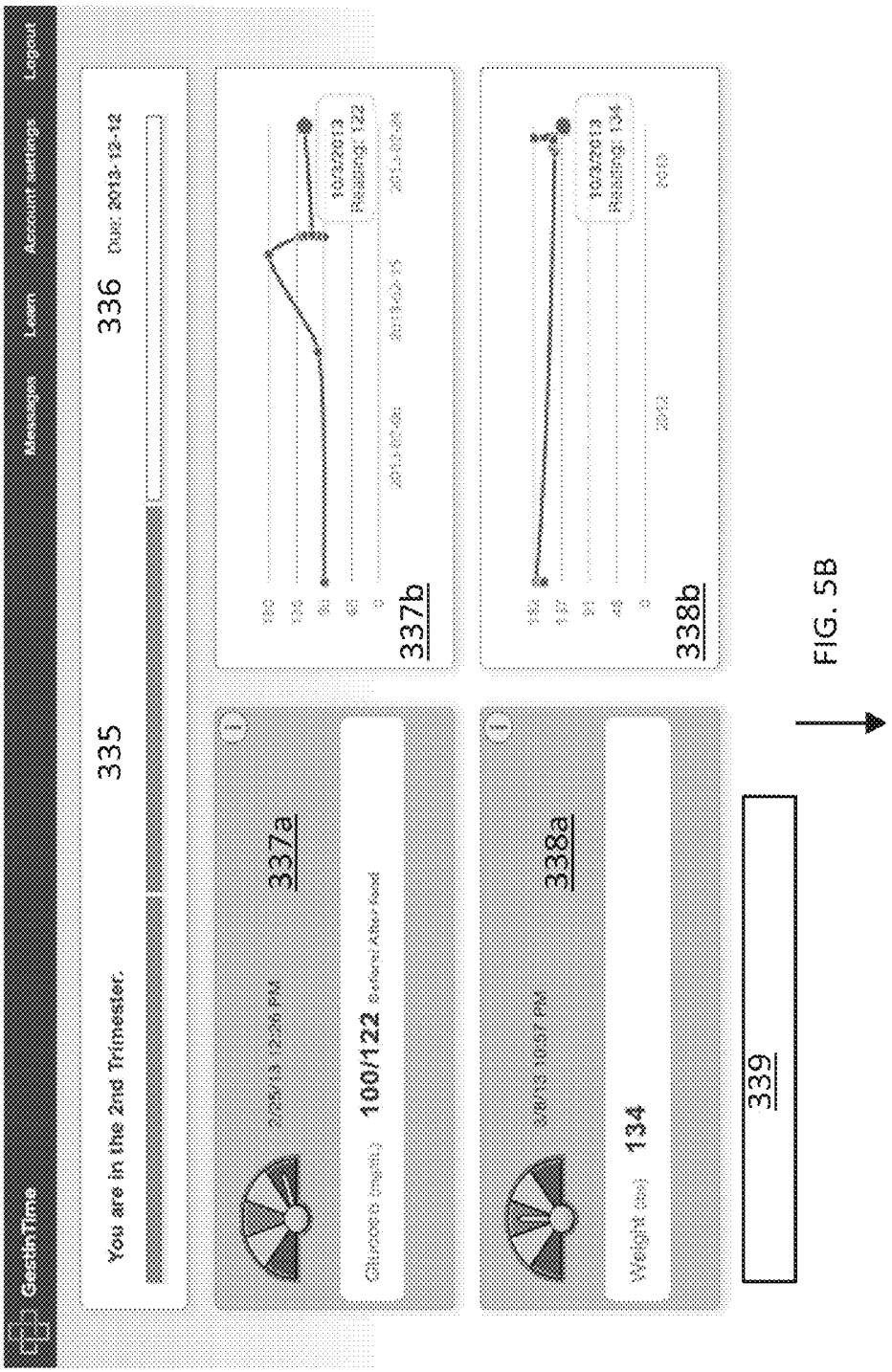

Patient Portal
Welcome Page
330
331
332
333
334
GestaTime
Messages
Learn
Account settings
Logout
You are in the 2nd Trimester.
335
336
Date: 2013-12-12
337a
100/122
337b
338a
Weight (lbs) 134
338b
339

FIG. 5A

FIG. 5B

FIGURE 5B

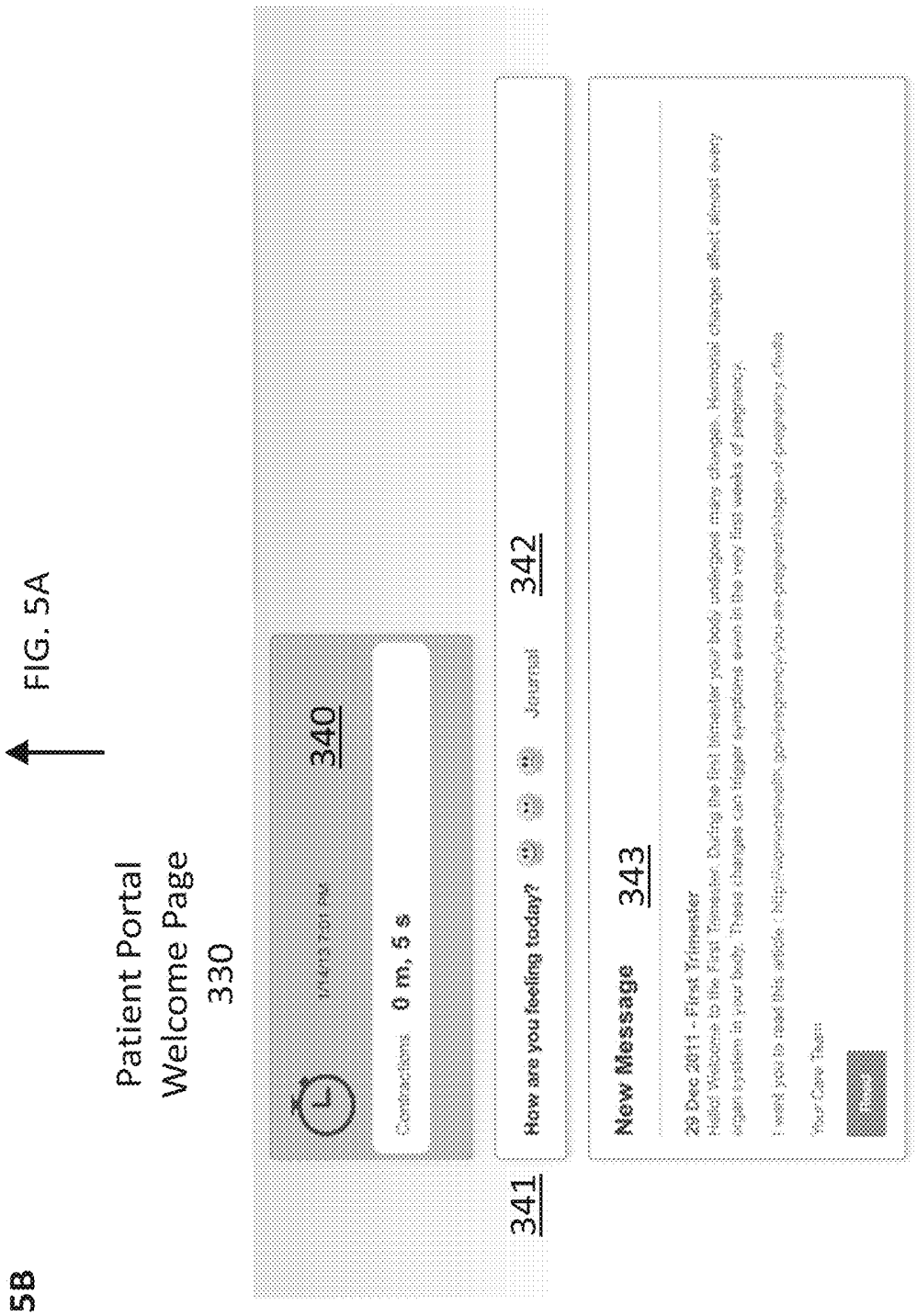


FIG. 5A

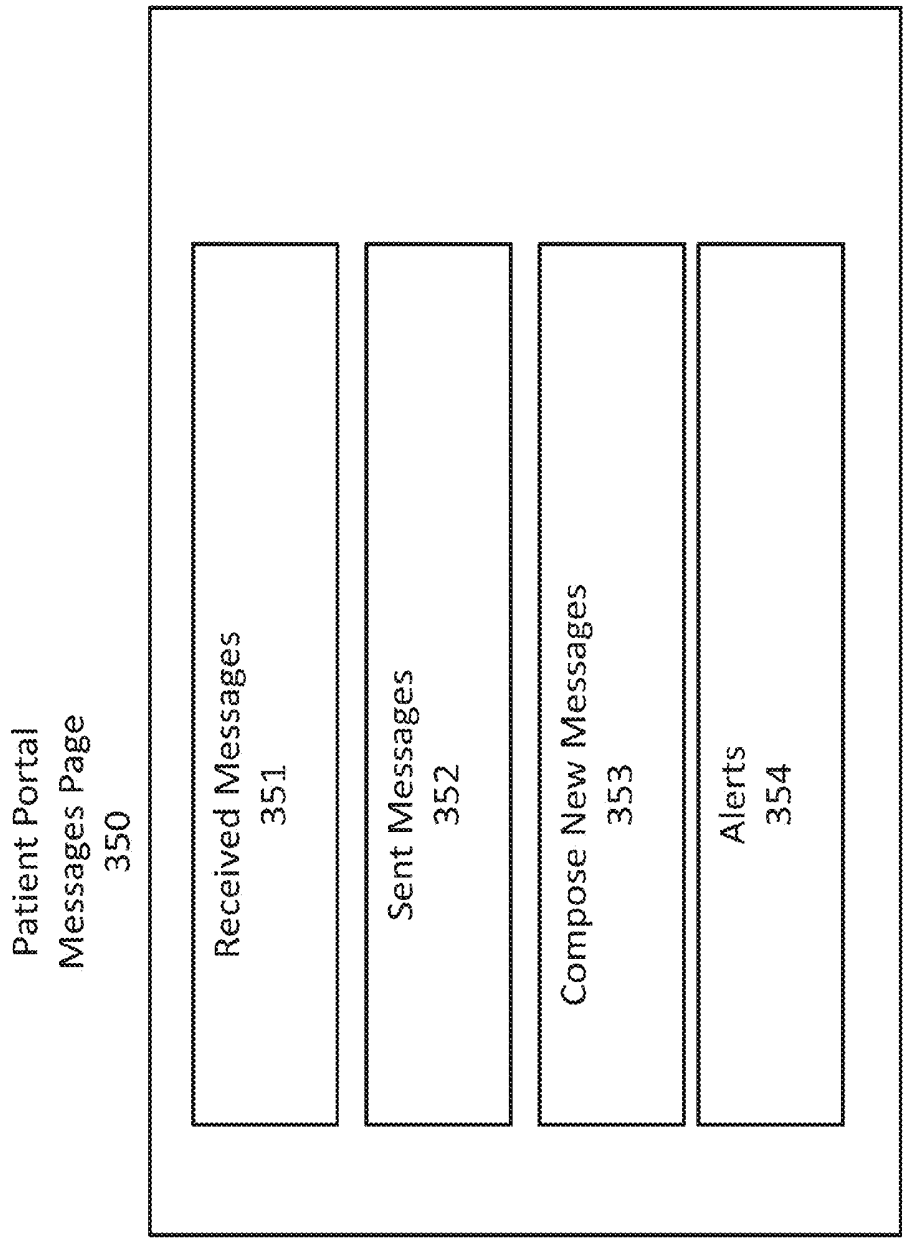

Patient Portal
Messages Page
350
Received Messages
351
Sent Messages
352
Compose New Messages
353
Alerts
354

FIGURE 6

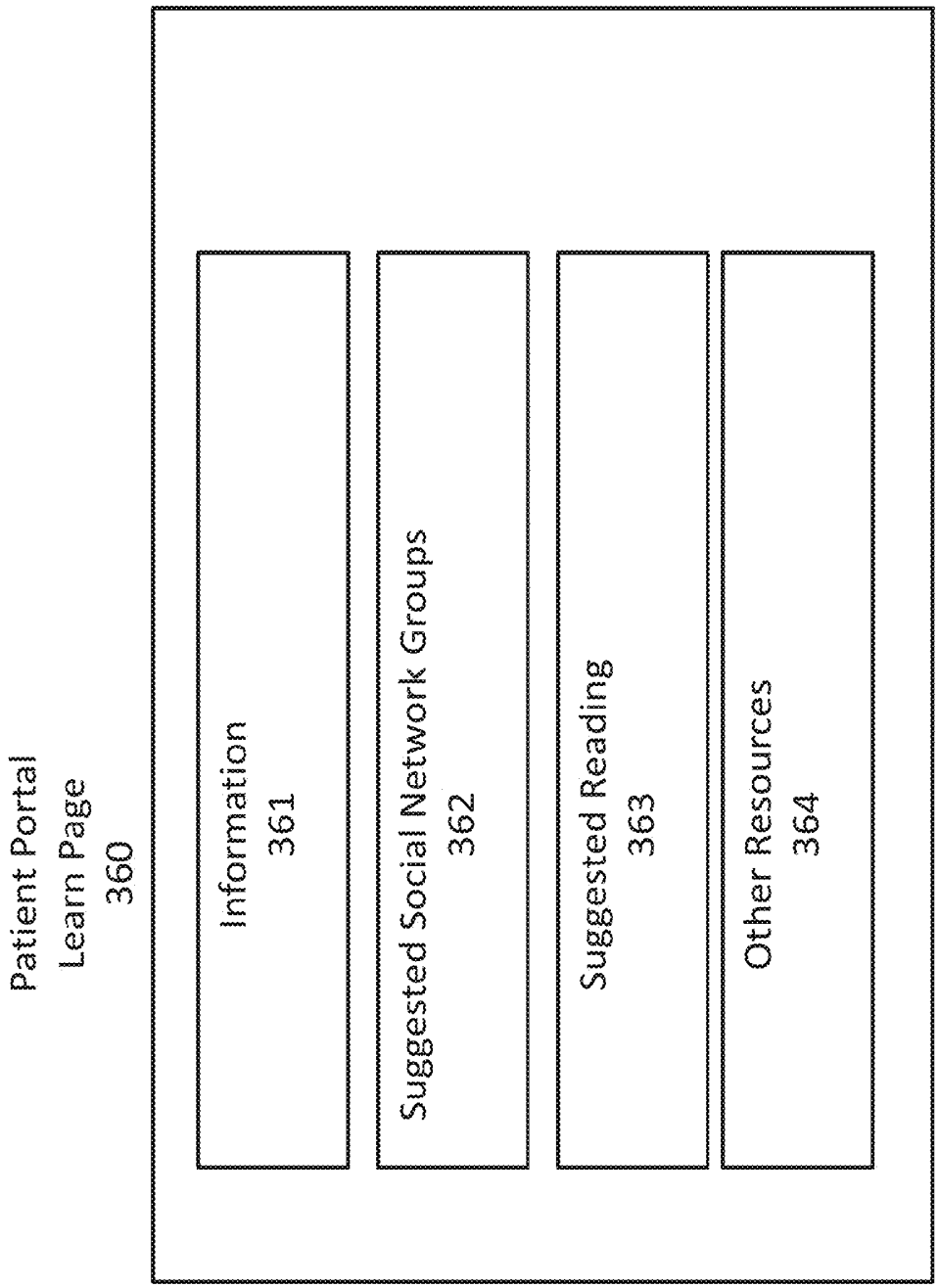

Patient Portal
Learn Page
360
Information
361
Suggested Social Network Groups
362
Suggested Reading
363
Other Resources
364

FIGURE 7

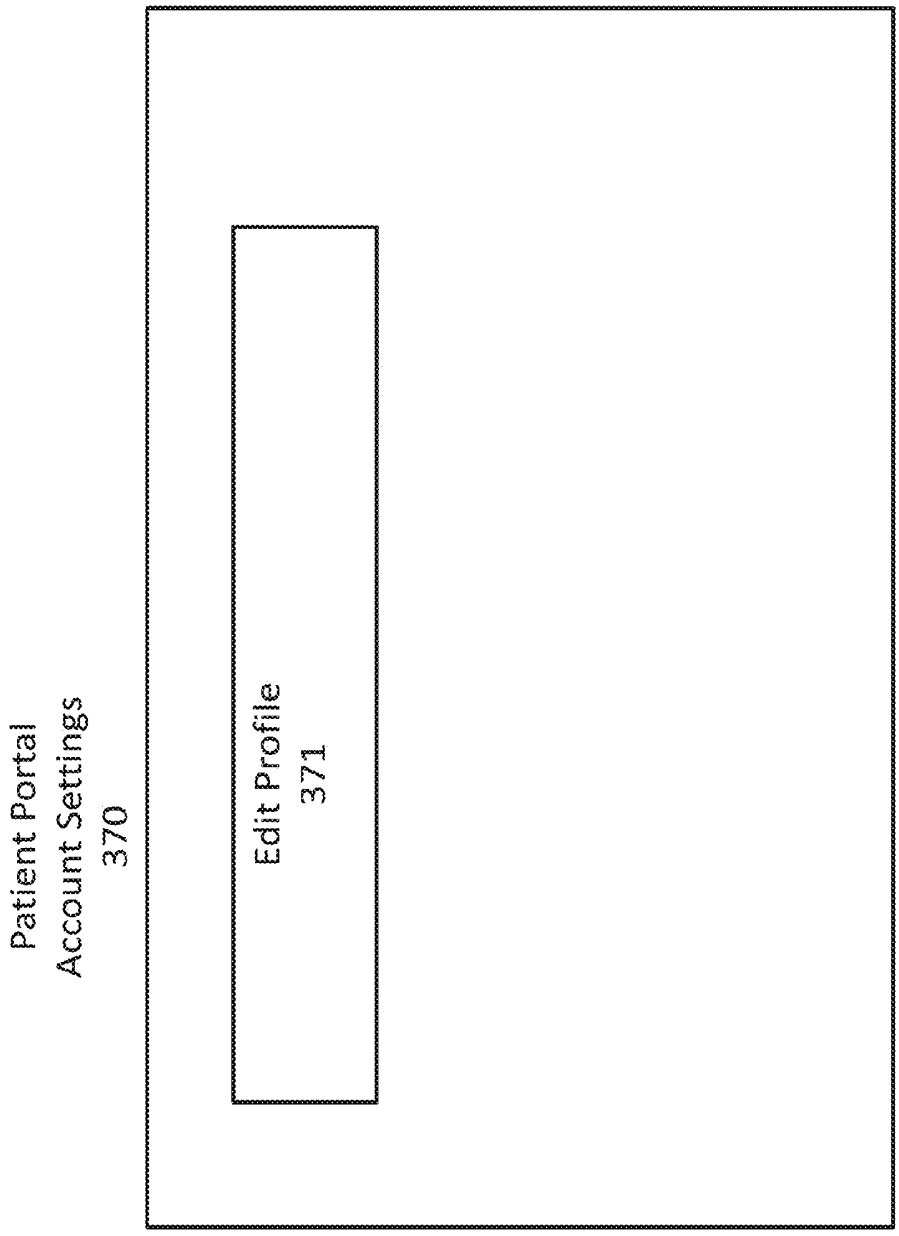


FIGURE 8

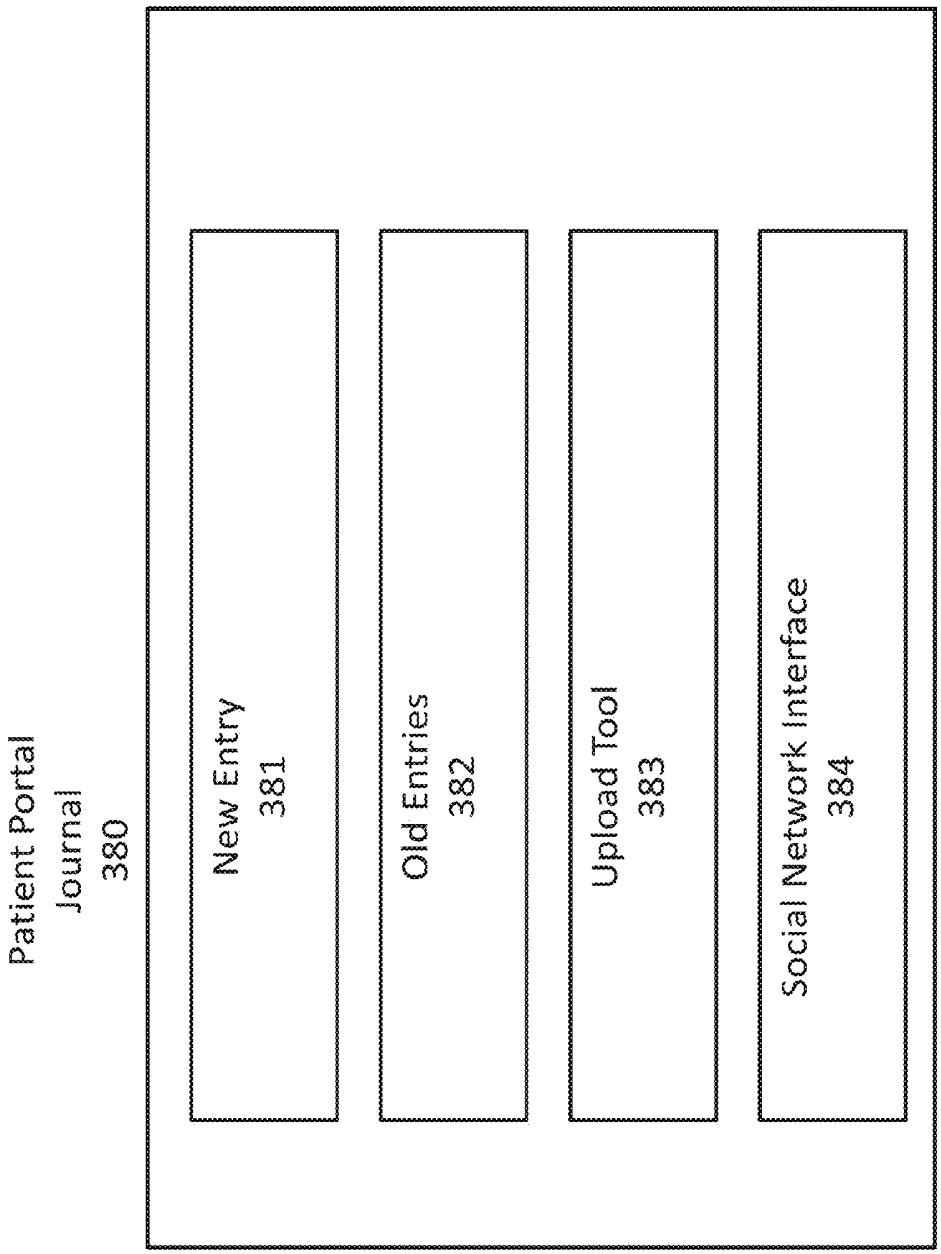

Patient Portal
Journal
380
New Entry
381
Old Entries
382
Upload Tool
383
Social Network Interface
384

FIGURE 9

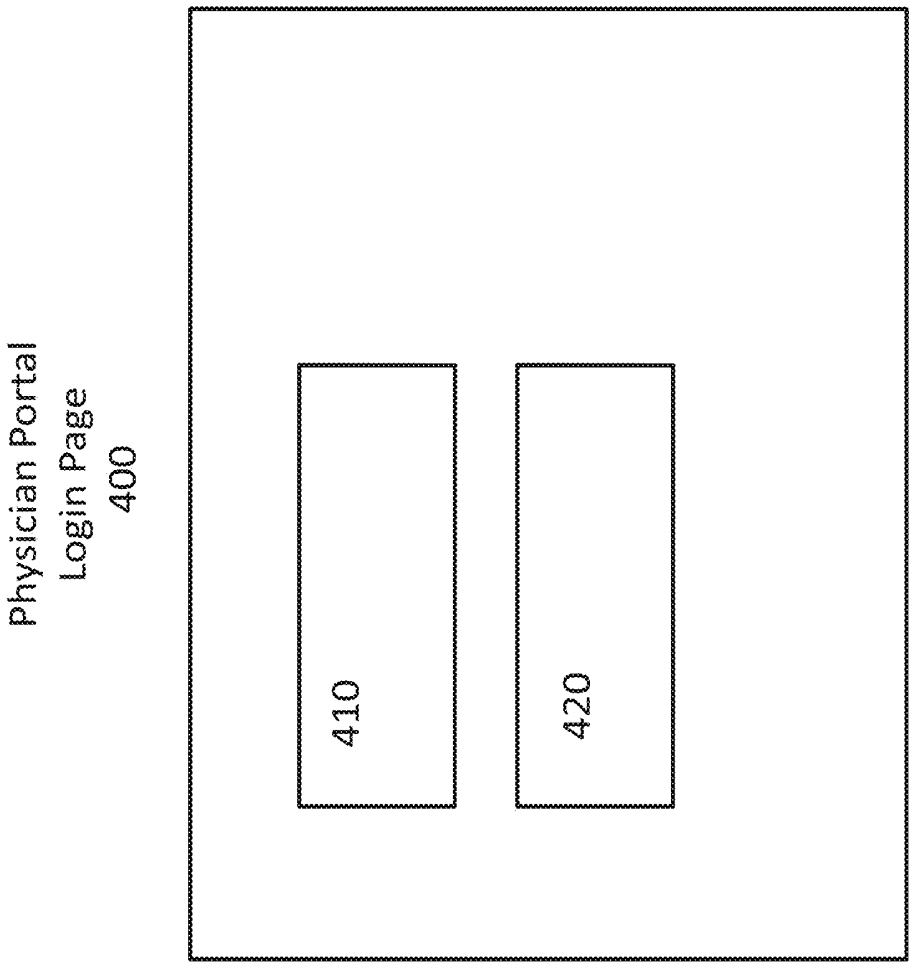


FIGURE 10

FIGURE 11


Physician Portal
Welcome Page
430
GastinTime
431
All Patients
432
Search by name
433
Name
Status
Due Date
Weight (BMI)
Amy Doe
December 11, 2013
1340
July 31, 2013
1340
July 31, 2013
1340
July 31, 2013
1340
July 31, 2013
1340
Previous
2
Next
434

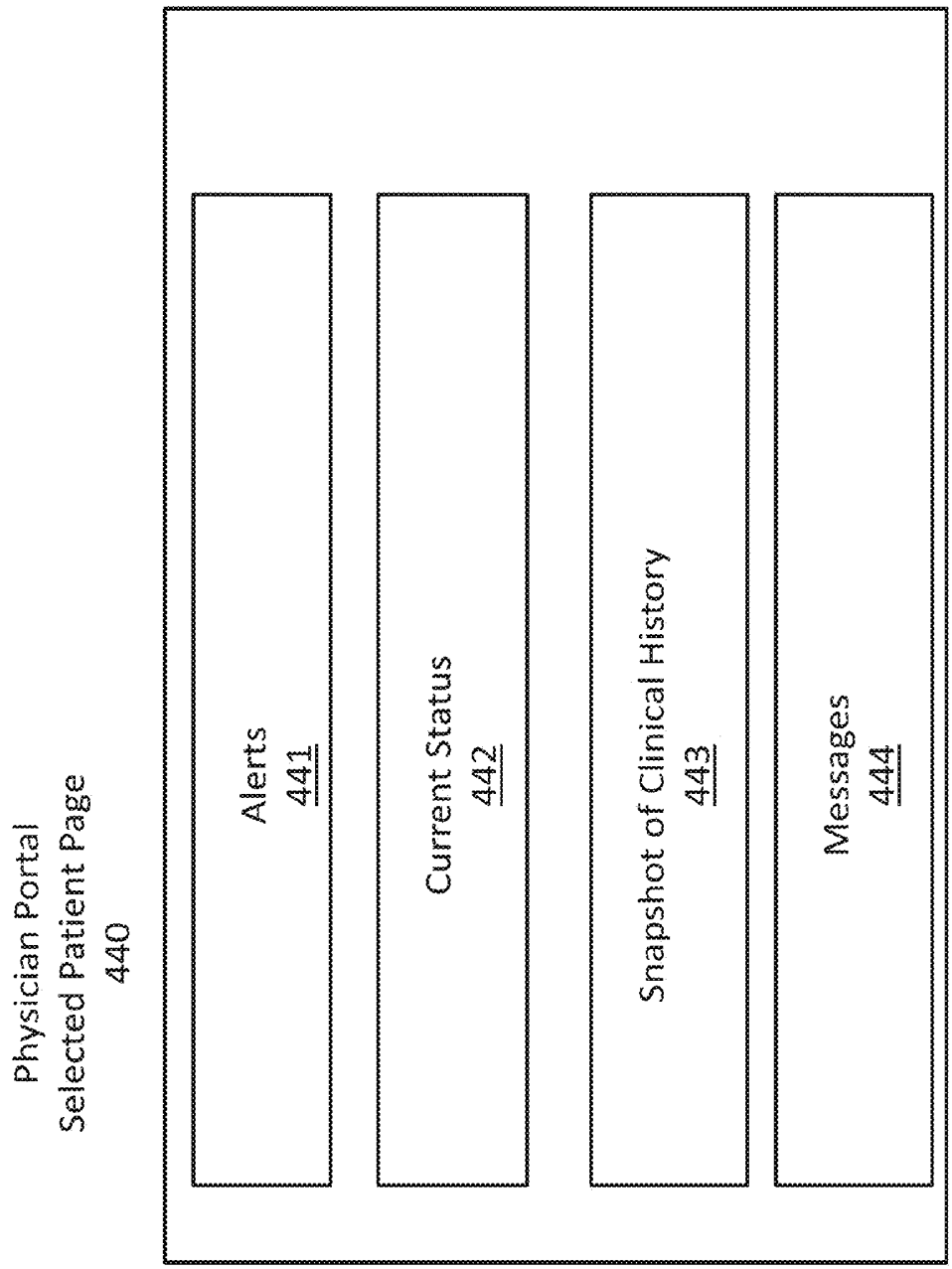

Physician Portal
Selected Patient Page
440
Alerts
441
Current Status
442
Snapshot of Clinical History
443
Messages
444

FIGURE 12

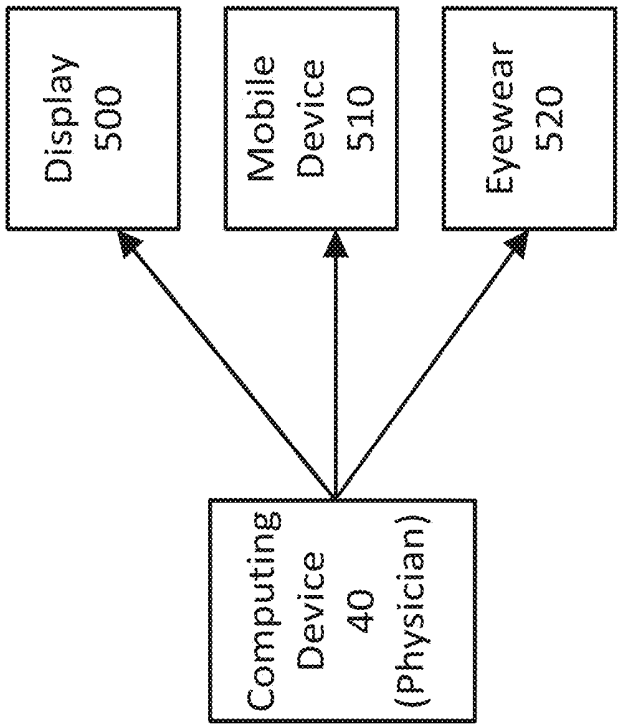

Display
500
Mobile
Device
510
Eyewear
520
Computing
Device
40
(Physician)

FIGURE 13

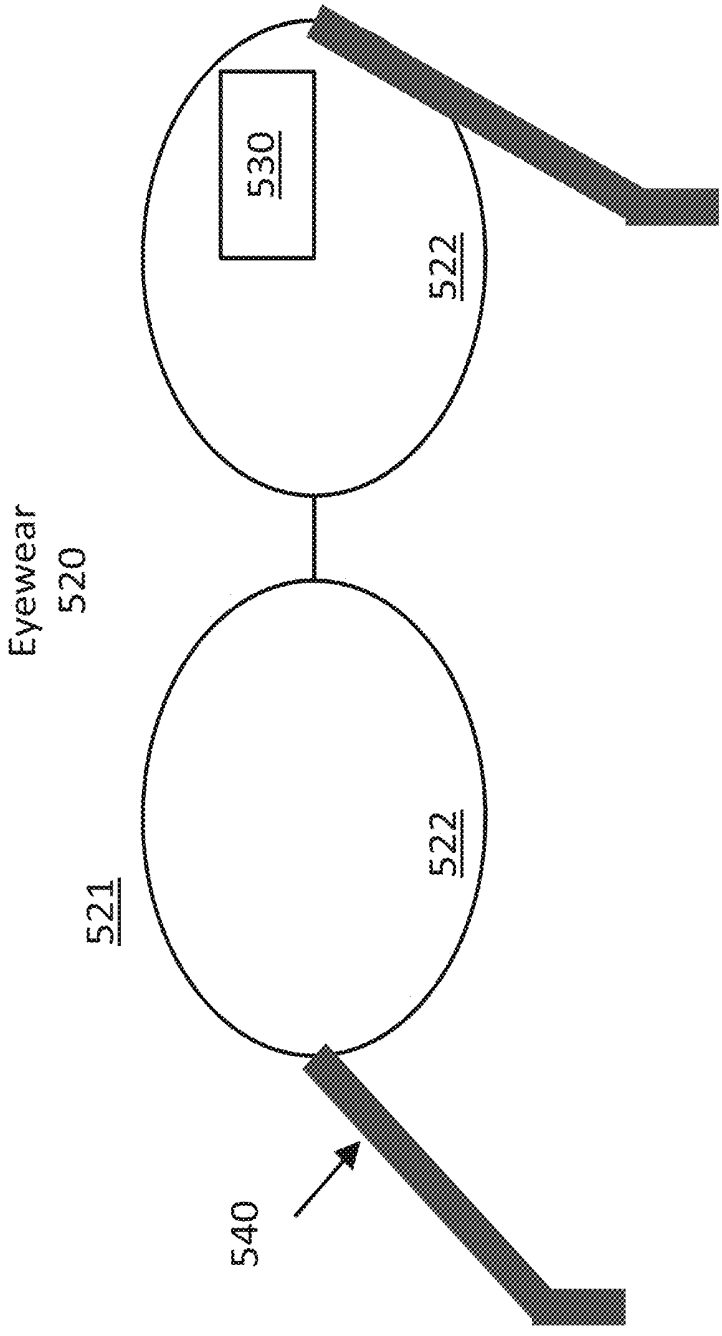


FIGURE 14

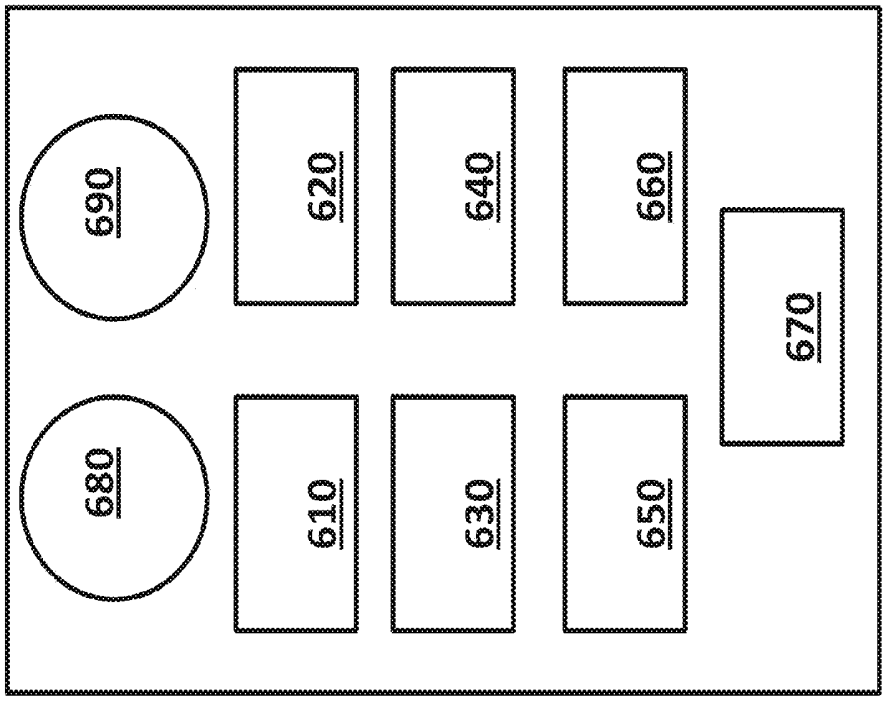


FIGURE 15 (PRIOR ART)

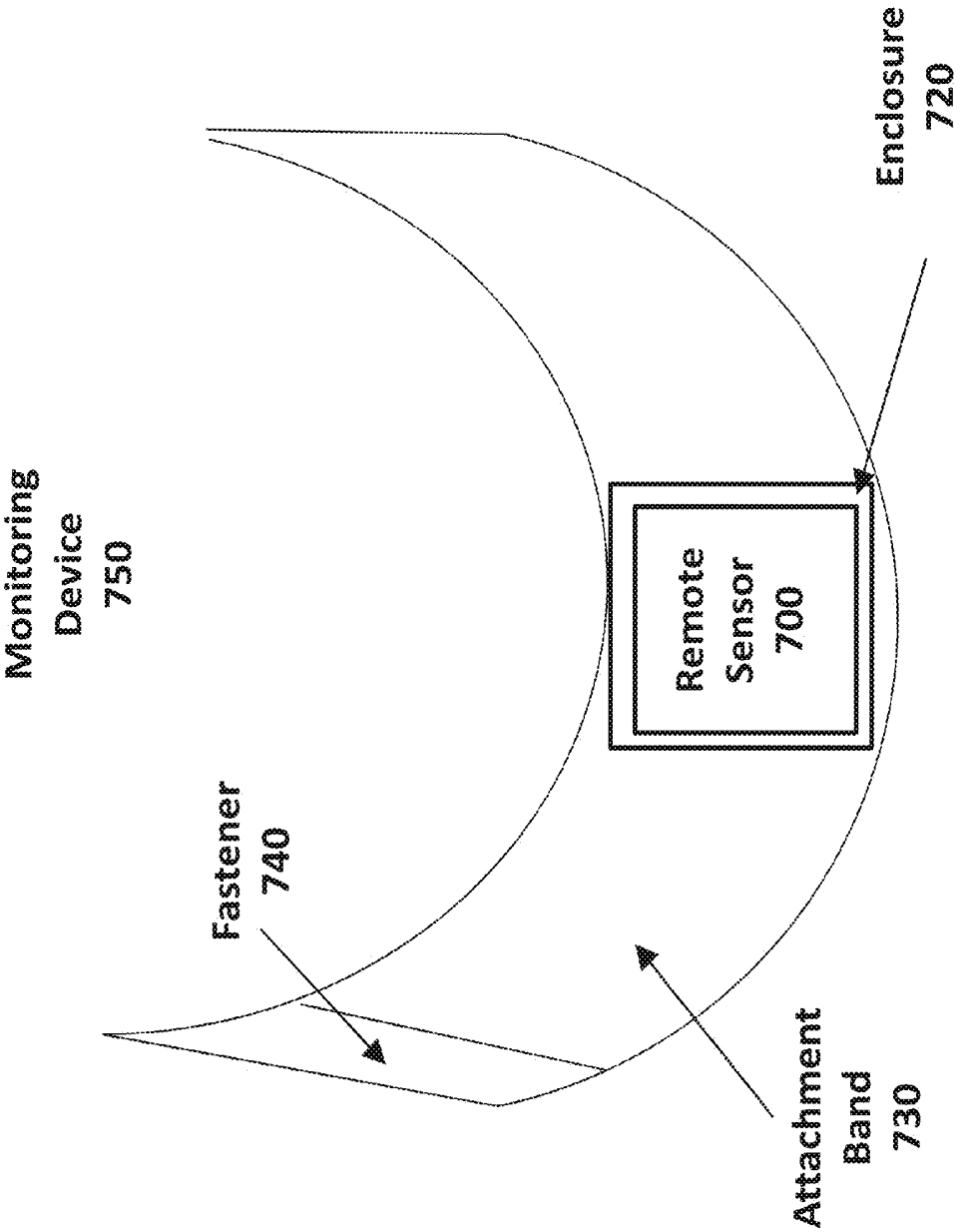

Enclosure
720
Monitoring
Device
750
Remote
Sensor
700
Fastener
740
Attachment
Band
730

FIGURE 16

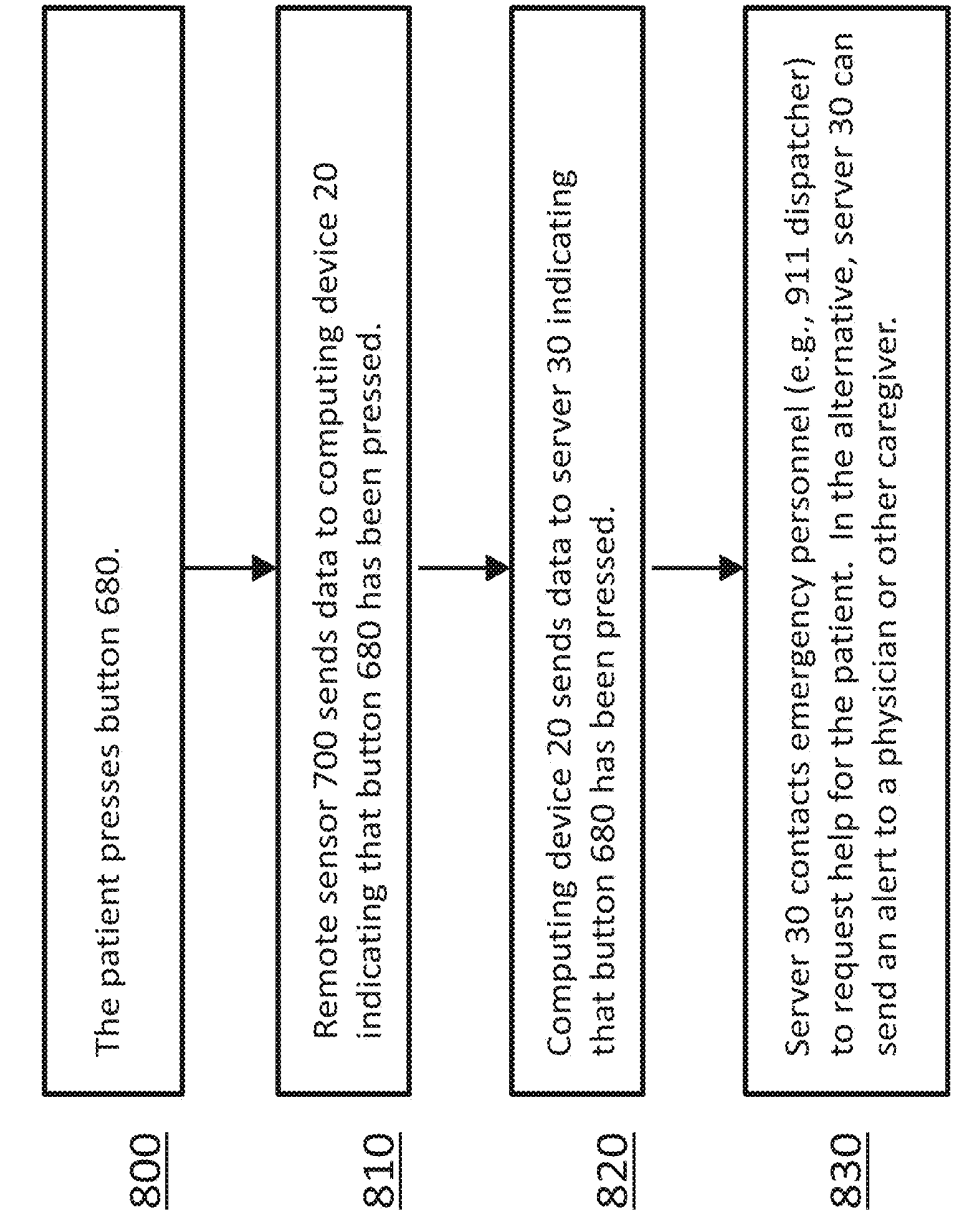

The patient presses button 680.
800
Remote sensor 700 sends data to computing device 20 indicating that button 680 has been pressed.
810
Computing device 20 sends data to server 30 indicating that button 680 has been pressed.
820
Server 30 contacts emergency personnel (e.g., 911 dispatcher) to request help for the patient. In the alternative, server 30 can send an alert to a physician or other caregiver.
830

FIGURE 17

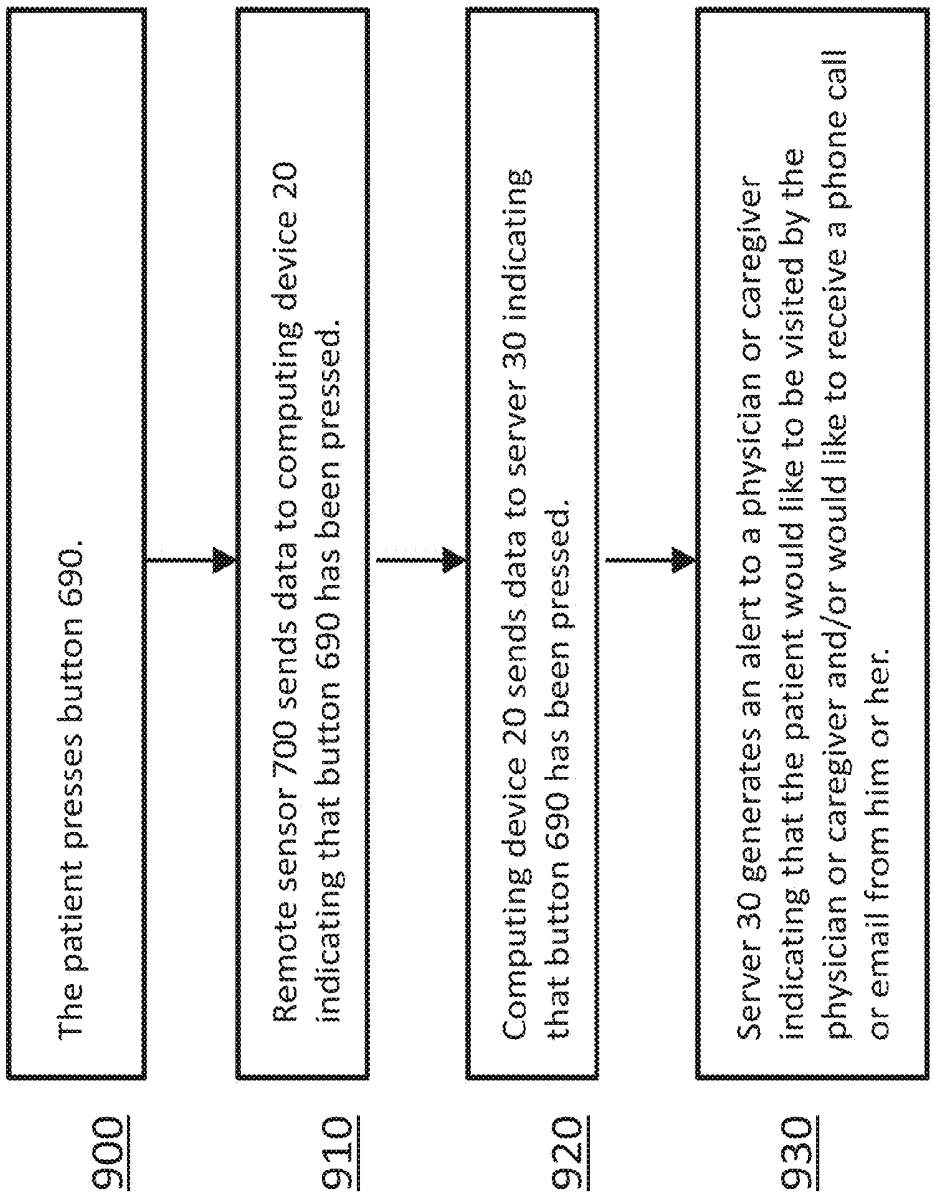

The patient presses button 690.
900
Remote sensor 700 sends data to computing device 20 indicating that button 690 has been pressed.
910
Computing device 20 sends data to server 30 indicating that button 690 has been pressed.
920
Server 30 generates an alert to a physician or caregiver indicating that the patient would like to be visited by the physician or caregiver and/or would like to receive a phone call or email from him or her.
930

FIGURE 18

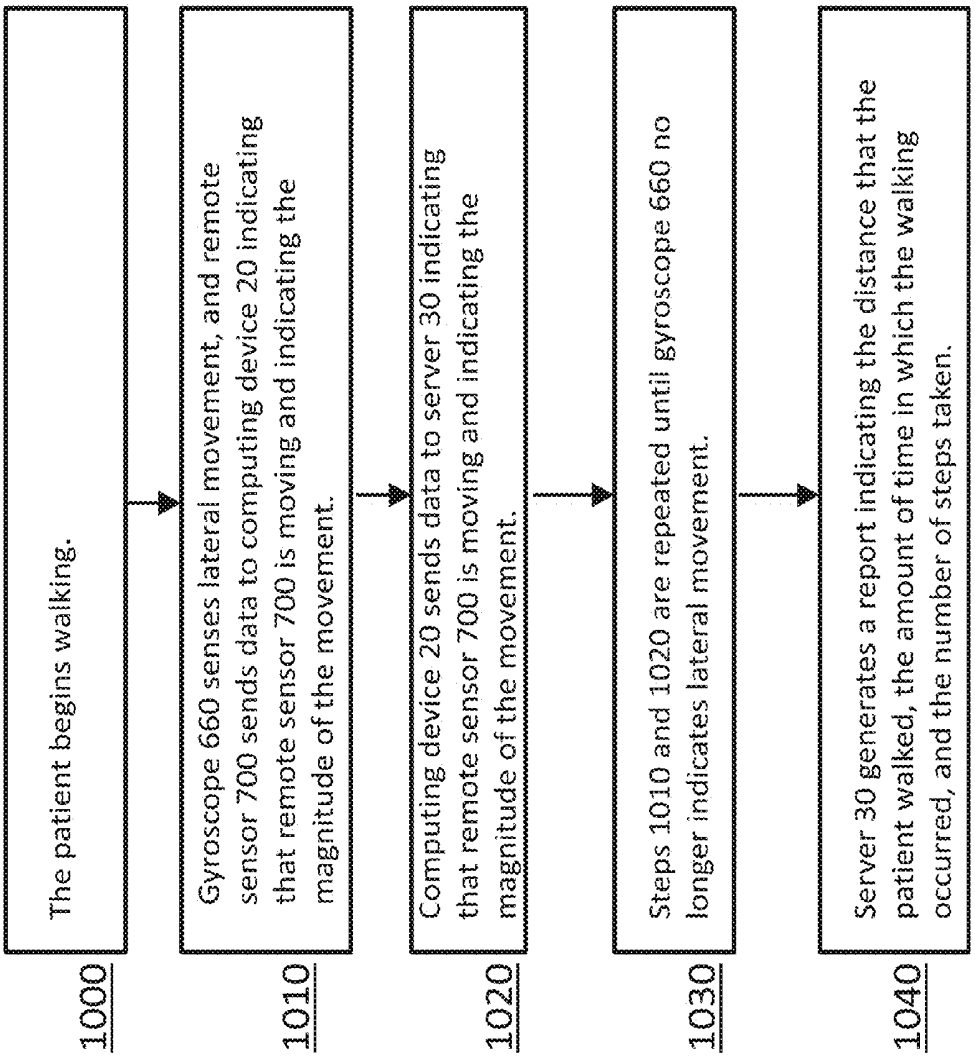

1000
The patient begins walking.
1010
Gyroscope 660 senses lateral movement, and remote sensor 700 sends data to computing device 20 indicating that remote sensor 700 is moving and indicating the magnitude of the movement.
1020
Computing device 20 sends data to server 30 indicating that remote sensor 700 is moving and indicating the magnitude of the movement.
1030
Steps 1010 and 1020 are repeated until gyroscope 660 no longer indicates lateral movement.
1040
Server 30 generates a report indicating the distance that the patient walked, the amount of time in which the walking occurred, and the number of steps taken.

FIGURE 19

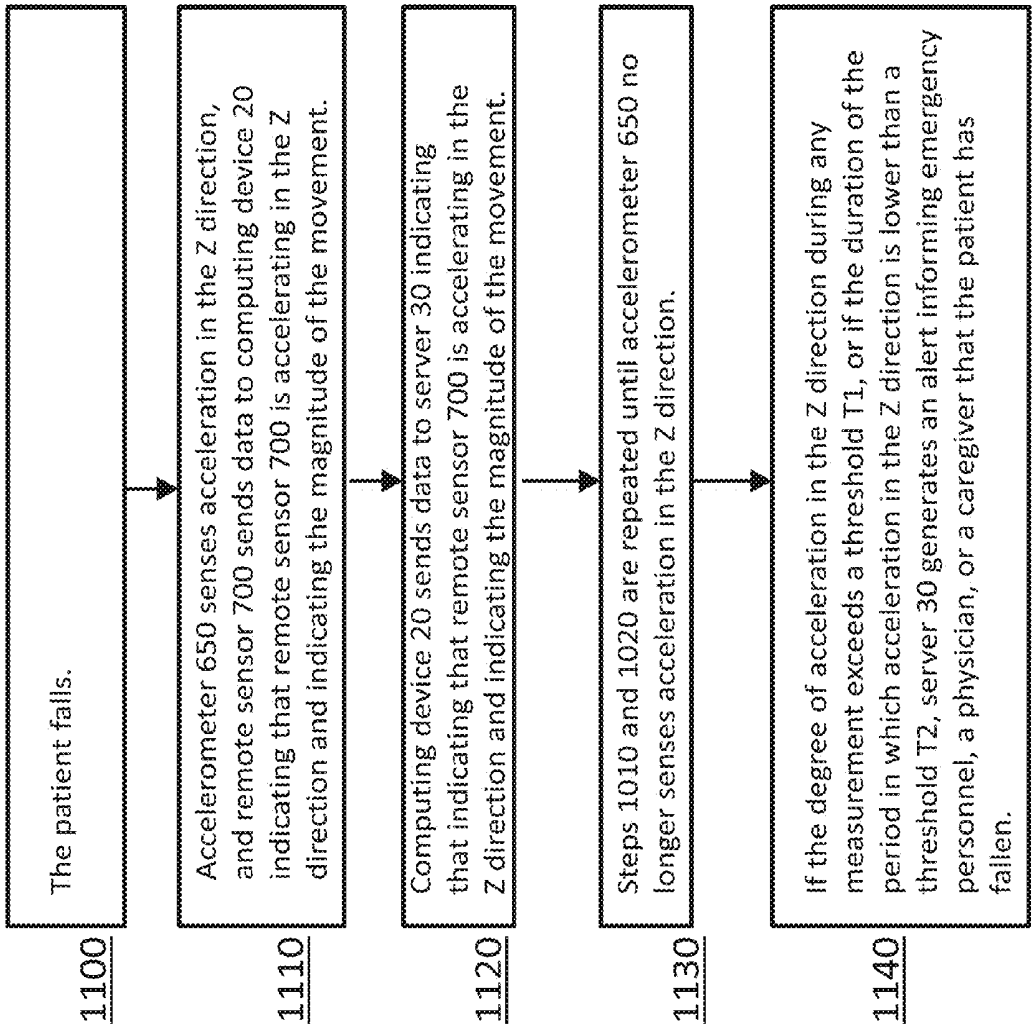

1100
The patient falls.
1110
Accelerometer 650 senses acceleration in the Z direction, and remote sensor 700 sends data to computing device 20 indicating that remote sensor 700 is accelerating in the Z direction and indicating the magnitude of the movement.
1120
Computing device 20 sends data to server 30 indicating that indicating that remote sensor 700 is accelerating in the Z direction and indicating the magnitude of the movement.
1130
Steps 1010 and 1020 are repeated until accelerometer 650 no longer senses acceleration in the Z direction.
1140
If the degree of acceleration in the Z direction during any measurement exceeds a threshold T1, or if the duration of the period in which acceleration in the Z direction is lower than a threshold T2, server 30 generates an alert informing emergency personnel, a physician, or a caregiver that the patient has fallen.

FIGURE 20

METHOD AND APPARATUS FOR INTEGRATED MEDICAL SERVICES USING A MULTI-PURPOSE SENSOR FOR REMOTE MONITORING OF A PATIENT

PRIORITY CLAIM

[0001] This application claims priority under 35 U.S.C. Section 120 and is a continuation-in-part of U.S. patent application Ser. No. 13/842,191, filed on Mar. 15, 2013 and titled "Method and Apparatus for Providing Integrated Medical Services," which is incorporated by reference.

TECHNICAL FIELD

[0002] A method and apparatus for remote monitoring of a medical patient is described. A sensor device is placed in physical contact with the patient. The sensor communicates with a computing device using Bluetooth or another wireless communication protocol. The computing device then communicates with a remote server that compiles data regarding the patient. The system can gather data such as the patient's temperature, the amount of exercise undertaken by the patient, the amount of sleep by the patient, and whether the patient has physically fallen.

BACKGROUND OF THE INVENTION

[0003] The collection and analysis of medical data in the prior art is relatively localized. Patients typically visit their physicians, and the physicians collect and record data (such as blood pressure) at the physician's office. Patients are able to collect certain data at home, such as by using blood pressure devices that can be purchased at a pharmacy, but the prior art does not include any satisfactory mechanism for integrating the collection of medical data at the home and the physician's office. In addition, there is no automated way to share medical data collected at the home with your physician.

[0004] Texas Instruments (TI) recently introduced the CC2541 SensorTag device. The SensorTag device is an example of a remote sensor **700**, represented in FIG. **15**, where a functional depiction of remote sensor **700** is shown. Remote sensor **700** is designed to communicate with other devices, such as smartphones, using a Bluetooth transceiver **610**. Remote sensor **700** comprises infrared temperature sensor **620**, humidity sensor **630**, pressure sensor **640**, accelerometer **650**, gyroscope **660**, and magnetometer **670**. Remote sensor **700** also comprises button **680** and button **690**.

[0005] When placed on or in close proximity to a human patient, infrared temperature sensor **620** can determine the temperature of the human patient. Humidity sensor **630** can measure the humidity of the environment surrounding remote sensor **700**. Pressure sensor **640** determine the pressure generated by the remote sensor **700** being in physical contact with the human patient. Accelerometer **650** can measure acceleration of remote sensor **700** in three directions (e.g., the X, Y, and Z directions). Gyroscope **660** can determine the movement of remote sensor **700** in three directions (e.g., the X, Y, and Z directions). Magnetometer **670** is a compass. Button **680** and button **690** each can be pressed by the human patient. When this happens, remote sensor **700** generates a signal indicating which button—button **680** or button **690** or both—was pressed. Other design aspects of remote sensor **700** are described in the "CC2541 SensorTag Quick Start Guide," which is submitted with this application and is incorporated by reference.

[0006] To date, the development of applications for using remote sensor **700** is in its infancy. What is needed is a housing for remote sensor **700** for protecting remote sensor **700** and for attaching it to a human patient. What is further needed is a backend application that gathers information from remote sensor **700**, processes the information, and generates alerts and reports based upon pre-determined criteria.

[0007] What is further needed is an integrated approach to medical data collection and analysis, including use of data from remote sensor **700**, and an improved medium by which patients and physicians can communicate.

SUMMARY OF THE INVENTION

[0008] The aforementioned problem and needs are addressed through an embodiment for gathering patient data using remote sensor **700**, transferring that data to a computing device, uploading the data into a server, processing the data, generating alerts to a physician if necessary, and providing portals by which the patient and physician can communicate and exchange data and information. Also disclosed are different enclosures for remote sensor **700**.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** depicts an embodiment of a system for providing integrated medical services.

[0010] FIG. **2** depicts software components of a server for providing integrated medical services.

[0011] FIG. **3** depicts hardware components of an embodiment of a server.

[0012] FIG. **4** depicts an exemplary patient portal login page.

[0013] FIG. **5**A depicts an exemplary patient portal welcome page.

[0014] FIG. **5**B depicts an exemplary patient portal welcome page.

[0015] FIG. **6** depicts an exemplary patient portal messages page.

[0016] FIG. **7** depicts an exemplary patient portal learning page.

[0017] FIG. **8** depicts an exemplary patient portal account settings page.

[0018] FIG. **9** depicts an exemplary patient portal journal page.

[0019] FIG. **10** depicts an exemplary physician portal login page.

[0020] FIG. **11** depicts an exemplary physician portal welcome page.

[0021] FIG. **12** depicts an exemplary physician portal selected patient page.

[0022] FIG. **13** depicts an embodiment of a computing device with various display options.

[0023] FIG. **14** depicts an embodiment of display eyewear.

[0024] FIG. **15** depicts a functional overview of a prior art remote sensor.

[0025] FIG. **16** depicts an embodiment of a monitoring device comprising a remote sensor.

[0026] FIG. **17** depicts an embodiment of a method of remote monitoring.

[0027] FIG. **18** depicts another embodiment of a method of remote monitoring.

[0028] FIG. **19** depicts another embodiment of a method of remote monitoring.

[0029] FIG. **20** depicts another embodiment of a method of remote monitoring.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] An embodiment will now be described with reference to FIG. **1**. Medical device **10** collects data from a patient in the home, physician's office, or any other site. Medical device **10** can be a device to measure weight, heart rate, blood pressure, blood sugar levels, contractions, fetal heart rate, or any other device to take a measurement relevant to the health of the patient. The data is transmitted to computing device **20** over known interfaces, such as a USB connector, Bluetooth, or Wifi (e.g., 802.11).

[0031] Computing device **20** can be a desktop, notebook, server, mobile phone, tablet, game console, or any other type of device with a processor, memory, and network interface. Computing device **20** communicates with server **30** over a network **25**. Network **25** optionally can be the Internet and can be hardwired, wireless, or some combination of the two. In this embodiment, computing device **20** is operated by a patient.

[0032] Server **30** is coupled to data store **50**. Server **30** is also coupled to computing device **40** over network **25**. Computing device **40** can be a desktop, notebook, server, mobile phone, tablet, game console, or any other type of device with a processor, memory, and network interface. In this embodiment, computing device **40** is operated by a physician.

[0033] Server **30** is coupled to computing device **60** over network **25**. Computing device **60** can be a desktop, notebook, server, mobile phone, tablet, game console, or any other type of device with a processor, memory, and network interface. Computing device **60** is coupled to data store **70**. In this embodiment, computing device **60** is operated by an electronic medical records (EMR) company, such as a health insurance company or billing agency.

[0034] Data store **50** and data store **70** optionally can each be a relational database for storing data records, such as a MySQL database.

[0035] With reference to FIG. **2**, various software components of server **30** are depicted. Server **30** comprises risk classification engine **100**, recommendation engine **110**, notification engine **120**, messaging engine **130**, web server **140**, application interface **150**, and integration gateway **160**.

[0036] Risk classification engine **100** comprises lines of code executed by processor **200** of server **30**. Risk classification engine **100** analyzes the data collected from a patient using medical device **10**, compares it against known criteria, such as those available from the American Congress of Obstetricians and Gynecologists (ACOG), and characterizes the patient in her current state with risk ratings, such as "low risk," "medium risk," or "high risk." For example, a patient with an extremely high blood sugar reading could be categorized as "high risk." The risk ratings are stored in data store **50** and are associated with the patient's profile.

[0037] Recommendation engine **100** comprises lines of code executed by processor **200** of server **30**. Recommendation engine **100** generates a recommendation based on the data collected from the patient and existing data in data store **50** and makes a recommendation for a physician. For example, for a "high risk" patient, the recommendation could be "Call patient immediately," or "Instruct patient to engage in 30 minutes of exercise to lower blood sugar level." The recommendation is stored in data store **50** and also made known to notification engine **120** and/or messaging engine **130**.

[0038] Notification engine **120** comprises lines of code executed by processor **200** of server **30**. Notification engine **120** provides notifications or alerts to patients, physicians, or other persons using email, SMS or MMS messages, intra-system messages, phone calls, or on-screen alerts. For example, if recommendation engine **100** generated a recommendation of "Call patient immediately," notification engine **120** would send that message to the physician associated with the patient in data store **50**.

[0039] Messaging engine **130** comprises lines of code executed by processor **200** of server **30**. It permits messages to be sent among patients, physicians, and server **30**.

[0040] Web server **140** comprises lines of code executed by processor **200** of server **30**. Web server **140** generates a web-based portal for patients and a web-based portal for physicians, as described in subsequent paragraphs.

[0041] Web server **140** is capable of generating web pages that are specifically suited for the particular computing device **20** or **40** that is being used. For example, different cascading style sheets can be used for a desktop computer and a mobile device, such that the web pages are optimized for display on the particular device. The underlying device can be identified, and the appropriate cascading style sheet selected, using well-known HTTP communication.

[0042] Application interface **150** comprises lines of code executed by processor **200** of server. Application interface **150** is capable of interfacing with applications running on computing device **20**, computing device **40**, or computing device **60** using Application Programming Interfaces (APIs), such as APIs known and used in conjunction with the iOS and Android operating systems, facebook, and Twitter.

[0043] Integration gateway **160** comprises lines of code executed by processor **200** of server **30**. Integration gateway **160** interfaces with computing device **60** to exchange data relating to EMR. Computing device **60** optionally can be operated by a health insurance provider. Integration gateway **160** is designed to exchange data in a protocol and/or format that is expected or specified by the computing device **60** or its operator. For example, health insurance companies typically require that data be sent to them in a certain format with certain billing codes.

[0044] FIG. **3** depicts server **30** and some of its hardware components. Server **30** comprises a processor **200**, memory **210**, and network interface **220**. Network interface **220** can comprise one or more wired or wireless interfaces, such as an Ethernet interface, WiFi (e.g., 802.11), WiMax, cell phone (e.g., 3G or 4G), Bluetooth, or other interface.

[0045] Patient Portal

[0046] The patient portal accessible and used by a patient will now be described. FIG. **4** shows a screenshot of an exemplary login page **300** for patients. Login page **300** is generated by server **30** and is sent to computing device **20** using web server **140** (if served as a web page) or application interface **150** (if served as a non-web browser application). Login page **300** comprises input device **310** to receive the patient's user name and input device **320** to receive the patient's password. Input device **310** and input device **320** can comprise, for example, HTML text boxes.

[0047] FIGS. **5**A and **5**B show screenshots of an exemplary "welcome page" **330** for a particular patient. This page might be displayed, for example, after a patient logs in using the

login screen depicted in FIG. **4**. Welcome page **300** comprises user input device **331** (to access messages), input device **332** (to access a learning page), input device **333** (to access account settings) and input device **334** (to logout of the server). Input devices **331**, **332**, **333**, and **334** can be, for example, HTML buttons, tabs, or links.

[0048] Welcome page **330** comprises graphical timeline **335** that can show major health events for the patient. For example, graphical timeline **335**, for a maternity patient, might show the number of trimesters that have elapsed, the temporal position within the current trimester, and major tests and events that have occurred (such as an ultrasound test). Welcome page **330** also contains an entry **336** displaying the patient's due date or upcoming appointment dates.

[0049] Welcome page **330** further comprises data box **337***a*, graph **337***b*, data box **338***a*, and graph **338***b*. Data boxes **337***a*, **338***b*, and **340** display important data regarding the patient's health, such as current or recent readings of important metrics, such as blood sugar level, weight, blood pressure, or heart rate. Graphs **337***b* and **338***b* display the data in graphical form. Optionally, graphs **337***b* and **338***b* can be displayed in animated form to show how the data has changed over time. Optionally, data boxes **3371**, **338***b*, and **340** and graphs **337***b* and **338***b* can compare the patient's data against ideal or expected data for those items or against the patient's prior data (for example, from a previous pregnancy), or against data collected from other persons such as persons within the patient's social network.

[0050] Welcome page **330** further comprises data upload field **339**. Data upload field **339** comprises a button, menu, link, or other input device that, when selected by a patient, will provide an interface by which the patient can upload or enter data from a medical device **10**. For example, data upload field **339** can generate a new page with a text box and menu item to enable a patient to type in data and to indicate the type of data it is (e.g., 150 lbs, weight). Data upload field **339** also can enable computing device **20** to receive data directly from medical device **10**.

[0051] Welcome page **330** further comprises input field **341** to receive information regarding the patient's current mood. In this embodiment, the patient can click on one of three icons to convey her mood (happy; sad; or in between). A patient can create a journal entry or access prior journal entries by selecting input field **342**.

[0052] Welcome page **330** further comprises new messages field **343** to display any new or recent messages received from a physician or elsewhere.

[0053] FIG. **6** depicts exemplary patient portal messages page **350**, such as may be accessed through input device **331** on welcome page **330**. Patient portal messages page **350** comprises field **351** to display received messages; field **352** to display sent messages, field **353** to allow the patient to composes a new message; and field **354** to display any alerts generated by server **30**.

[0054] FIG. **7** depicts exemplary patient portal learning page **360**, such as may be accessed through input device **332** on welcome page **330**. Patient portal learning page **360** comprises field **351** to display information, field **362** to suggest social network groups for the patient (based on recommendations from recommendation engine **110**), field **363** to provide suggested reading materials (based on recommendations from recommendation engine **110**), and field **364** to display other resources for the patient (such as videos).

[0055] FIG. **8** depicts exemplary patient portal account settings page **370**, such as may be accessed through input device **333** on welcome page **330**. Patient portal account settings page **360** comprises field **371** to allow the patient to edit his or her profile, such as by editing information concerning name, address, medical plan, demographics, etc.

[0056] FIG. **9** depicts exemplary patient portal journal page **380**, such as may be accessed through input device **342** on welcome page **330**. Patient portal account journal page **380** includes field **381** for creating a new journal entry, field **382** for reviewing old journal entries, field **383** for uploading data or files (such as photos), and social network interface **384** for sharing journal entries for uploaded data or files (such as a "post on facebook" button).

[0057] Physician Portal

[0058] The physician portal accessible and used by a physician will now be described. FIG. **10** shows a screenshot of an exemplary login page **400** for patients. Login page **400** is generated by server **30** and is sent to computing device **40** using web server **140** (if served as a web page) or application interface **150** (if served as a non-web browser application). Login page **400** comprises input device **410** to receive the patient's user name and input device **420** to receive the patient's password. Input device **410** and input device **420** can comprise, for example, HTML text boxes.

[0059] FIG. **11** shows a screenshot of an exemplary "welcome page" **430** for a particular physician. This page might be displayed, for example, after a physician logs in using the login screen depicted in FIG. **10**. Welcome page **430** comprises user field **431** for selecting "all patients" or a particular patient. User field **341** might include a drop-down menu, pop-up menu, scroll entries, etc. Welcome page **430** further comprises text box **432** to enable a physician to search by name (which the physician types into the box). Welcome page **430** further comprises field **433** for patients, displaying key information for each patient (such as risk categorization, due date, and weight). Welcome page **430** further comprises text box **434** for displaying alerts, notifications, or anything else warranting the physician's immediate attention. For example, text box **434** can display notifications from notification engine **120** ("Call patient immediately").

[0060] FIG. **12** depicts exemplary physician portal selected patient page **440**. This page might be generated, for example, when the patient selects a particular patient on welcome page **430**. Physician portal selected patient page **440** comprises field **441** to display alerts or notifications concerning that patient, field **442** to display the current status of the patient, field **443** for displaying a snapshot of the patient's clinical history, and field **444** for displaying any messages from or concerning that patient.

[0061] Display Options

[0062] FIG. **13** depicts computing device **40** and various mechanisms for a physician to view the physician portal or relevant pages therein. These mechanisms include a display **500** (such as an LCD), mobile device **510** (such as a tablet or mobile phone), and eyewear **520**.

[0063] FIG. **14** depicts an example of eyewear **520**. Eyewear **520** comprises lenses **522** and frame **521** (just as with normal glasses). But it also includes display unit **530** and processing and transmission unit **540** (embedded within the frame **521**).

[0064] An example of eyewear **520** was recently announced by Google as the "Google Glass" product. Eyewear **520**, such as the Google Glass, comprises a display unit

530 that displays data that you could otherwise display on an LCD or other display. For example, all of the pages described previously for the physician portal could be displayed on display unit 530.

[0065] The possible uses of eyewear 520 by physicians are numerous. For example, a physician could: (a) view pages from the physician portal on display unit 530 during a patient examination, during a remote consultation, or during a collaborative session with a fellow physician (e.g., two physicians viewing the same x-ray); (b) look at the patient in the physician's office while the display unit 530 displays patient medical data such as blood pressure, etc.; (c) apply physical pressure to the patient and get instant visual feed-back on soreness, pain points, soft-tissue, broken bones etc. The physician's view can be augmented with enhanced clinical data, such as heart rate; (d) look at a patient's hospital ID band (which gets scanned) and then view the patient's information on display unit 530; (e) Look at the patient and then have server 30 perform image/facial recognition to identify the patient and access and display his or her information in display unit 530; and (f) examine patient, and can get assisted by visual feedback critical information such as simulated images of the patient's internal organs. For example, the physician would be able to identify the location of the patient's spleen and then feel the spleen, because he or she could see the exact location of the spleen as a visual overlay of the patient's internal organ structure on the patient.

[0066] An embodiment will now be described with reference to FIG. 3. Medical device 10 is the same prior art device described previously with reference to FIG. 1. The output of medical device 10 is provided as an input to processing device 40. In this particular example, the output is EKG data, but the same principles apply to any periodic data collected from a medical device.

[0067] In one embodiment, processing device 40 is a computing device (such as a desktop, notebook, server, tablet, mobile device, or other computer) comprising a processor, memory, non-volatile storage (such as a hard disk drive or flash memory array), I/O connection (such as a USB connection) for communicating with a medical device, and an I/O connection for sending output to a display, printer, or other device. Optionally, processing device 40 can itself include a display (as might be the case if processing device 40 is a tablet or mobile device). Processing device 40 comprises software code for performing the functions described herein.

[0068] Remote Monitoring of Patient

[0069] In one embodiment, medical device 10 can be remote sensor 700. Remote sensor 700 must be placed in physical contact with the patient for it to collect data as intended. At the same time, it is important to protect remote sensor 700 from the physical elements and physical contact.

[0070] With reference to FIG. 16, an embodiment of monitoring device 750 is depicted. Monitoring device 750 comprises remote sensor 700. Remote sensor 700 is attached to attachment band 730, using known attachment mechanisms such as Velcro, adhesive, stitching, a clear sleeve or covering, etc. Attachment band 730 protects remote sensor 700 but is designed to not interfere with the actions of infrared temperature sensor 620, humidity sensor 630, pressure sensor 640, accelerometer 650, gyroscope 660, magnetometer 670 button 680, and button 690. For example, attachment band 730 optionally comprises an opening in which infrared temperature sensor 620, humidity sensor 630, pressure sensor 640, accelerometer 650, gyroscope 660, magnetometer 670, button 680, and button 690 are placed, and those devices can therefore be placed in direct contact with the patient.

[0071] Attachment band 730 is a flexible band that can be attached to a human being, such as a strap that attaches to a wrist, arm, leg, or head. Monitoring device 750 further comprises fastener 740, which also is a known attachment mechanism such as Velcro, a clip, hooks, etc. Fastener 740 can be used to attach one end of attachment band 730 to the other end of attachment band 730 to secure attachment band 730 around a wrist, arm, leg, or head, etc.

[0072] With reference to FIGS. 1 and 15, remote sensor 700 (an example of medical device 10) collects data from a patient, including temperature of the patient measured by infrared temperature sensor 620, humidity of the environment surrounding the patient measured by humidity sensor 630, pressure between remote sensor 700 and the patient measured by pressure sensor 640, acceleration of remote sensor 700 in three directions (e.g., the X, Y, and Z directions) measured by accelerometer 650, the movement of remote sensor 700 in three directions (e.g., the X, Y, and Z directions) measured by gyroscope 660, and the north direction indicated by magnetometer 670. Button 680 and button 690 each can be pressed by the human patient. When this happens, remote sensor 700 generates a signal indicating which button—button 680 or button 690 or both—was pressed.

[0073] This data is transmitted by remote sensor 700 to computing device 20 over a Bluetooth wireless connection. As discussed previously with reference to FIG. 1, computing device 20 communicates with server 30 over a network 25. Server 30 is coupled to data store 50. Server 30 is also coupled to computing device 40 over network 25. In this embodiment, computing device 40 is operated by a physician. Server 30 is coupled to computing device 60 over network 25. Computing device 60 is coupled to data store 70.

[0074] With reference to FIG. 17, an embodiment of a method is shown. Button 680 can be used to indicate an emergency situation. If the patient needs emergency personnel to assist her, the patient presses button 680 (step 800). Remote sensor 700 sends data to computing device 20 indicating that button 680 has been pressed (step 810). Computing device 20 sends data to server 30 indicating that button 680 has been pressed (step 820). Server 30 contacts emergency personnel (e.g., 911 dispatcher) to request help for the patient, or in the alternative, server 30 can send an alert (such as an email, SMS message, or phone call) to a physician or other caregiver (step 830). The alert can be generated by notification engine 120 in response to information from risk classification engine 100 (which classifies the risk based on button 680 being pressed), as discussed previously.

[0075] With reference to FIG. 18, an embodiment of another method is shown. Button 690 can be used to indicate a non-emergency situation where the patient wishes to be contacted by his or her physician or caregiver. If the patient would like his or her physician or caregiver to visit him or her or to call him or her on the phone, the patient presses button 690 (step 900). Remote sensor 700 sends data to computing device 20 indicating that button 690 has been pressed (step 910). Computing device 20 sends data to server 30 indicating that button 690 has been pressed (step 920). Server 30 sends an alert (such as an email, SMS message, or phone call) to a physician or caregiver indicating that the patient would like to be visited by the physician or caregiver and/or would like to receive a phone call or email from him or her (step 930). The alert can be generated by notification engine 120 in response

to information from risk classification engine **100** (which classifies the risk based on button **690** being pressed), as discussed previously.

[0076] With reference to FIG. **19**, an embodiment of another method is shown. The patient wears monitoring device **750** on his or her leg or waist. The patient begins walking (step **1000**). Gyroscope **660** detects lateral movement, and remote sensor **700** sends data to computing device **20** indicating that remote sensor **700** is moving and indicating the magnitude of the movement (step **1010**). Computing device **20** sends data to server **30** indicating that remote sensor **700** is moving and indicating the magnitude of the movement (step **1020**). Steps **1010** and **1020** are repeated until gyroscope **660** no longer indicates lateral movement (step **1030**). Server **30** generates a report indicating the distance that the patient walked, the amount of time in which the walking occurred, and the number of steps taken (step **1040**). The number of steps taken is determined based on data collected during the calibration process, discussed below.

[0077] With reference to FIG. **20**, an embodiment of another method is shown. The patient wears monitoring device **750** on his or her arm, leg, or hip. The patient falls (step **1100**). Accelerometer **650** senses acceleration in the Z direction, and remote sensor **700** sends data to computing device **20** indicating that remote sensor **700** is accelerating in the Z direction and indicating the magnitude of the movement (step **1110**). Computing device **20** sends data to server **30** indicating that indicating that remote sensor **700** is accelerating in the Z direction and indicating the magnitude of the movement (step **1120**). Steps **1010** and **1020** are repeated until accelerometer **650** no longer senses acceleration in the Z direction (step **1130**). If the degree of acceleration in the Z direction during any measurement exceeds a threshold T**1**, or if the duration of the period in which acceleration in the Z direction is lower than a threshold T**2**, server **30** generates an alert (such as an email, SMS message, or phone call) informing emergency personnel, a physician, or a caregiver that the patient has fallen (step **1140**). The alert can be generated by notification engine **120** in response to information from risk classification engine **100** (which classifies the risk based on data from accelerometer **650**), as discussed previously.

[0078] In FIG. **20**, threshold T**1** is a number that typically indicates unintended falling (such as when a patient trips and falls) as opposed to intentional movement (such as when a patient lies down in bed). An example of T**1** is 9.0 m/s^2. Acceleration of this amount or greater usually indicates unintended falling and resultant acceleration due to gravity.

[0079] Threshold T**2** is a number that typically indicates unintended falling (such as when a patient trips and falls) as opposed to intentional movement (such as when a patient lies down in bed). An example of T**2** is 3 seconds. For example, acceleration of 3 seconds or less might indicate that a patient has tripped and fallen to the floor. By contrast, lying down in bed usually requires acceleration for more than 3 seconds.

[0080] The numbers provided for T**1** and T**2** above are mere examples, and other values can be used instead.

[0081] Some of the embodiments described above will require the calibration of remote sensor **700**. Prior to manufacturing of remote sensor **700**, testing of a prototype of remote sensor **700** can be performed with several patients who act as test subjects. Each patient can walk with the remote sensor **700**, and the patient or an outside observer (or a pedometer as is known in the prior art) can count the number of steps taken. Remote sensor **700** will record the lateral distance travelled. From this data, one can determine the average step size or lateral distance travelled with each step. This information can then be programmed into remote sensor **700**, such that when a patient begins laterally moving, as in FIG. **19**, the number of steps taken can be estimated with significant accuracy.

[0082] Similarly, the patients can use remote sensor **700** when they lie down in bed. Data can then be collected from each remote sensor **700** to determine information such as the average distance above ground at which a patient will sleep and the average distance that a patient will move toward the ground when the lie down to sleep (i.e., from a standing-up position to a lying down position). This data can be programmed into remote sensor **700** and can be used to help determine whether a patient is sleeping or has fallen and needs emergency medical attention. Measurement of maximum acceleration and duration of acceleration also can be performed to determine appropriate values for T**1** and T**2**.

[0083] References to the present invention herein are not intended to limit the scope of any claim or claim term, but instead merely make reference to one or more features that may be covered by one or more of the claims. Materials, processes and numerical examples described above are exemplary only, and should not be deemed to limit the claims. It should be noted that, as used herein, the terms "over" and "on" both inclusively include "directly on" (no intermediate materials, elements or space disposed there between) and "indirectly on" (intermediate materials, elements or space disposed there between). Likewise, the term "adjacent" includes "directly adjacent" (no intermediate materials, elements or space disposed there between) and "indirectly adjacent" (intermediate materials, elements or space disposed there between). For example, forming an element "over a substrate" can include forming the element directly on the substrate with no intermediate materials/elements there between, as well as forming the element indirectly on the substrate with one or more intermediate materials/elements there between.

What is claimed is:

1. A server for providing interactive medical services, comprising:

a web server for generating a first web portal and a second web portal;

a risk classification engine for generating risk classification information for a patient based on medical device data captured by a remote sensor and received through the first web portal; and

a notification engine for providing the risk classification information through the second web portal.

2. The server of claim **1**, wherein the medical device data comprises humidity data.

3. The server of claim **1**, wherein the medical device data comprises movement data.

4. The server of claim **1**, wherein the medical device data comprises temperature data.

5. The server of claim **1**, wherein the medical device data comprises acceleration data.

6. The server of claim **1**, wherein the medical device data is received from a computing device.

7. The server of claim **1**, wherein the notification engine is configured to generate a phone call in response to the risk classification information.

8. The server of claim **1**, wherein the notification engine is configured to generate an email or SMS message in response to the risk classification information.

9. A method of monitoring a patient, comprising:

detecting, by a gyroscope, lateral movement of a patient;

transmitting data regarding the lateral movement to a computing device over a wireless connection;

transmitting, by the computing device, data regarding the lateral movement to a server;

generating, by the server, a report indicating the distance that the patient has moved.

10. The method of claim **9**, wherein the report indicates the amount of time in which the movement occurred.

11. The method of claim **9**, wherein the report indicates the number of steps taken by the patient.

12. The method of claim **9**, wherein the gyroscope is contained within a remote sensor.

13. The method of claim **12**, wherein the remote sensor is connected to a band worn by the patient.

14. The method of claim **9**, wherein the report is provided by a web server to a web browser.

15. A method of detecting a fall by a patient, comprising:

sensing, by an accelerometer, acceleration;

transmitting data regarding the acceleration to a computing device;

transmitting, by the computing device, data regarding the acceleration to a server

determining, by the server, that the degree of acceleration exceeds a predetermined threshold T**1**; and

generating, by the server, an alert indicating that the patient has fallen.

16. The method of claim **15**, wherein the accelerometer is contained within a remote sensor.

17. The method of claim **16**, wherein the remote sensor is connected to a band worn by the patient.

18. The method of claim **15**, wherein the alert is a phone call.

19. The method of claim **15**, wherein the alert is an email.

20. The method of claim **15**, wherein the alert is an SMS message.

* * * * *

专利名称(译)	使用多功能传感器进行远程监控患者的集成医疗服务的方法和装置		
公开(公告)号	US20140276239A1	公开(公告)日	2014-09-18
申请号	US13/962860	申请日	2013-08-08
[标]申请(专利权)人(译)	TINTIME		
申请(专利权)人(译)	GESTINTIME INC.		
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[标]发明人	SUBRAMANIAM SURESH GARIMELLA KRISHNA		
发明人	SUBRAMANIAM, SURESH GARIMELLA, KRISHNA		
IPC分类号	A61B5/00 G06F19/00 A61B5/11		
CPC分类号	A61B5/747 A61B5/0004 A61B5/0022 A61B5/1113 G06F19/3431 A61B5/6831 A61B5/7275 A61B5/7282 A61B5/746 A61B5/1117 A61B5/0402 A61B5/14532 A61B5/742 G06F19/3418		
外部链接	Espacenet USPTO		

摘要(译)

描述了一种用于远程监控医疗患者的方法和设备。传感器装置与患者物理接触。传感器使用蓝牙或其他无线通信协议与计算设备通信。然后，计算设备与编译关于患者的数据的远程服务器通信。该系统可以收集数据，例如患者的体温，患者进行的运动量，患者的睡眠量以及患者是否身体下降。