



(11) **EP 2 560 141 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
14.03.2018 Bulletin 2018/11

(51) Int Cl.:
G06T 7/20 ^(2017.01) **A61B 5/11** ^(2006.01)
A61B 5/00 ^(2006.01)

(21) Application number: **12005871.4**

(22) Date of filing: **14.08.2012**

(54) **Interactive virtual care**

Interaktive virtuelle Pflege

Soins virtuel interactif

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **19.08.2011 US 201113213930**

(43) Date of publication of application:
20.02.2013 Bulletin 2013/08

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Description

BACKGROUND

[0001] In facilities, such as, for example, a health care facility, where an individual's movements may be evaluated, an individual (e.g., a patient) may be evaluated by a health care provider. The evaluation may be based, for example, on visual inspection of the individual's movements. Such visual inspection can result in subjective diagnosis based on the health care provider's interpretation of the individual's movements. The degree or type of impairment of an individual's movements can be a relevant factor in interpretation of the individual's movements. An objective understanding of an individual's movements may facilitate accurate interpretation.

[0002] DAVID, D. et al.: "Method and apparatus for remote medical monitoring incorporating video processing and system of motor tasks" (US 2003/228033), December 11, 2003, discloses a method to receive video image data of a subject performing one or more predetermined tasks within a new environment. From the video image data, a plurality of silhouettes is generated and combined to provide a motion portrait. Based on the motion portrait, motion characteristics are calculated and compared with normal or previous motion characteristics as part of diagnostic analysis.

[0003] DOELLING, E. N. et al.: "Devices, systems and methods for monitoring, analyzing, and/or adjusting sleep conditions" (WO 2011/082346), July 07, 2011, discloses therapeutic and diagnostic systems and methods for helping an individual with a sleep disordered breathing condition, such as habitual snoring or obstructive sleep apnea to achieved deep, restorative sleep. To do so, components that serve complementary sensing, monitoring and corrective or diagnostic functions are utilized.

[0004] WOLFSON, R.: "Interactive surface and display system" (US 2008/0191864), August 14, 2008, discloses an interactive training system for generating continuous feedback for physical therapy and training applications based on capturing and analyzing the movement of a user on an interactive surface. To do so, input such as entire areas in contact with the interactive surface, center of gravity, pressure distribution, velocity, acceleration, direction, orientation etc. is captured. In addition, the position of a body part while in the air, not touching the interactive surface is captured. The training system can provide alerts for predefined events such as a fall or the beginning of a fall.

BRIEF DESCRIPTION OF DRAWINGS

[0005] The embodiments are described with reference to the following figures:

Figure 1 illustrates a system diagram for an interactive virtual care system, according to an embodiment;

Figure 2 illustrates an example of a screen display for the interactive virtual care system, illustrating, for example, a user view of general user data;

Figure 3 illustrates an example of a screen display for the interactive virtual care system, illustrating, for example, user vital data entry;

Figure 4 illustrates an example of a screen display for the interactive virtual care system, illustrating, for example, a responder view of general and user vital data;

Figure 5 illustrates an example of a screen display for the interactive virtual care system, illustrating, for example, a responder view of a user movement test; Figure 6 illustrates an example of a screen display for the interactive virtual care system, illustrating, for example, a user view of remote movement instructions;

Figure 7 illustrates an example of a screen display for the interactive virtual care system, illustrating, for example, a responder view of user movement;

Figure 8 illustrates an example of a screen display for the interactive virtual care system, illustrating, for example, a responder view of user movement and historical analysis;

Figure 9 illustrates an example of a screen display for the interactive virtual care system, illustrating, for example, a user view for on-screen instructions;

Figure 10 illustrates a method for interactive virtual care, according to an embodiment;

Figure 11 illustrates a method for interactive virtual care, according to an embodiment; and

Figure 12 illustrates a computer system, according to an embodiment.

35 DETAILED DESCRIPTION OF EMBODIMENTS

[0006] For simplicity and illustrative purposes, the principles of the embodiments are described by referring mainly to examples thereof. In the following description, numerous specific details are set forth in order to provide a thorough understanding of the embodiments. It will be apparent that the embodiments may be practiced without limitation to all the specific details. Also, the embodiments may be used together in various combinations.

45 1. Overview

[0007] An interactive virtual care system may provide for highly interactive virtual care consultations, for example, between two remote individuals. For facilities, such as, for example, a health care facility, the individuals may include a user (e.g., a patient) and a responder (e.g., a health care provider) located at a remote location from the user. The discussion below includes examples of application of the system for a patient and a health care provider. However, the system may be used with other industries for evaluation of any type of movement of an individual. For a health care facility, the system may pro-

vide for face-to-face video and two-way sharing of a patient's health information, and further include the use of computer-vision technology to assist the remote interaction by capturing and analyzing, for example, the patient's movements. These capabilities may offer a remote health care provider an enhanced view of a patient's condition. The system may also provide for computer-assisted speech and audio analysis of a health care provider's and patient's interactions.

[0008] The interactive virtual care system may include a user sensory module to acquire multi-modal user data related to user movement. The modules and other components of the system may include machine readable instructions, hardware or a combination of machine readable instructions and hardware. Multi-modal user data may refer to data acquired by multiple modes of input or output, such as a depth camera and/or a microphone array as discussed below. A data analysis module may compare the multi-modal user data to predetermined historical user data and/or statistical norm data for users to identify an anomaly in the user movement. The user sensory module may include a depth camera to acquire the multi-modal user data. The user sensory module may also include a microphone array to acquire multi-modal user data related to speech. A responder sensory module may acquire multi-modal responder data related to responder movement. The data analysis module may compare the multi-modal user data to the multi-modal responder data to identify an anomaly in the user movement. A user and/or responder interface modules may display a computer-generated version of the user movement that highlights movements of predetermined portions of a user's body. The user and/or responder interface modules may further display a real-time version of the user movement adjacent to and/or superimposed on the computer-generated version of the user movement, for example, to facilitate identification of an anomaly. The user and/or responder interface modules may further highlight the anomaly in the user movement in the computer-generated version of the user movement. For comparison of the multi-modal user data to the predetermined historical user data, a range of the predetermined historical user data is selectable. The user and/or responder interface modules may include, for example, a keyboard and/or touch screen format for data entry.

[0009] A method for interactive virtual care may include acquiring multi-modal user data related to user movement, and comparing the multi-modal user data to predetermined historical user data and/or statistical norm data for users to identify at least one anomaly in the user movement. The method may further include acquiring the multi-modal user data by a depth camera and multi-modal user data related to speech by a microphone array. The method may include displaying a computer-generated version of the user movement that highlights movements of predetermined portions of a user's body. The method may include displaying a real-time version of the user movement adjacent to and/or superimposed on the

computer-generated version of the user movement. The method may include highlighting the anomaly in the user movement in the computer-generated version of the user movement.

[0010] A non-transitory computer readable medium having stored thereon a computer executable program to provide interactive virtual care, the computer executable program when executed may cause a computer system to acquire multi-modal user data related to user movement, and compare the multi-modal user data to predetermined historical user data and/or statistical norm data for users to identify at least one anomaly in the user movement.

[0011] An example of a use scenario of the interactive virtual care system may include a user (e.g., a patient) with a medical condition visiting, for example, a retail clinic for a virtual visit with a remotely located responder (e.g., a health care provider). The user may be checked into the system by a nurse or another locally disposed health care provider. The health care provider may collect the user data, such as, for example, vitals and enter the information via the user interface module. The user data may be sent to the responder interface module for viewing by the remotely located responder. The remote responder may send, for example, exercises to the user interface module for user diagnosis and evaluation, and may otherwise communicate with the user via the responder sensory module. The user may perform the exercises or proceed as directed by the remote responder, and all user activities may be captured by the user sensory module. The data analysis module may analyze all data captured from the user and responder interface modules, and all data captured by the user and responder sensory modules to generate results based on comparison of user specific history data and/or history data of a range of users generally to determine any anomalies. The history data for the range of users may be in the form of statistical norms for users. These anomalies and other result data may be reported to the remote responder, whereby the responder may diagnose the user's condition and render appropriate treatment in the form of a prescription or other activities.

[0012] As discussed above, the interactive virtual care system may provide remote acquisition of multi-modal user data via the user sensory module, which may include, for example, high-fidelity audio-video sensory devices. Likewise, responder data may be remotely acquired via the responder sensory module, which may also include, for example, high-fidelity audio-video sensory devices. As described in detail below, the audio-video sensory devices may include, for example, a depth camera and microphone arrays. The depth camera may include, for example, a MICROSOFT KINECT camera system. In a healthcare environment, the data acquired from the user and responder sensory modules may be used to augment patient reported symptoms and professionally obtained biometric data to assist a remote health care provider in arriving at more accurate medical diag-

noses.

[0013] As discussed herein, the interactive virtual care system may facilitate an interactive care delivery approach that may involve the use of user data to help a responder arrive at more accurate medical diagnoses. For example, data related to a user's walking and gesture patterns (e.g., gaits, strides, balances) may be acquired unobtrusively using, for example, depth-perceiving camera arrays. Data related to a user's vocal and/or speech patterns may be acquired unobtrusively using, for example, microphone arrays. The visual and audio data may be transmitted to the data analysis module and analyzed for anomaly identification by comparing, for example, population norms as well as historical patterns of the particular user. Such anomalies may be highlighted and presented on the user and/or responder interface modules based on the system configuration. For example, the responder interface module may be used by a health care provider at a remote location to simultaneously view a real-time live video stream of the user (e.g., the patient) performing an action (e.g., walking, stretching) side-by-side with results generated by the data analysis module to assist in arriving at a medical diagnosis. The results generated by the data analysis module may also be shown as an overlay to the real-time video stream of the user.

[0014] The interactive virtual care system may also be used in an unsupervised environment (e.g., without interaction with a responder) to provide a user (e.g., a patient) visual cues to guide the user through the correct process. For example, a treatment process (e.g., physical therapy routine or exercise) may be observed, validated and recorded under the direction of a health care provider at a remote location. A derivative outline from the recorded footage may be used to automatically guide a user through a treatment process regimen while the user is in an unsupervised setting, such as, for example, at home. The user's subsequent unsupervised in-home exercise/physical therapy sessions may be recorded and transmitted through the same remote hosting application for purposes of being viewed by a remote health care provider and/or additional analysis and comparison against the user's historical patterns. As the remote health care provider monitors the user's progress, the remote health care provider may adapt the user's treatment regimen over time, for example, by adjusting and transmitting a new or modified derivative outline from the user's recorded footage.

[0015] The interactive virtual care system may be usable, for example, to provide remote health care expertise to any environment located a distance away from a primary health care provider, such as, for example, a remote clinic. The system may also be usable at any location convenient to a user, such as, for example, a user's home. The system may be usable in a stand-alone configuration, such as, for example, a kiosk, or may be uploaded to an existing computer system, for example, in a clinic environment.

[0016] The systems and methods described herein provide a technical solution to the technical problem of comparing user movement and/or speech with prior historical data or statistical norms for users to determine anomalies. In many instances, manual comparison of user movement or speech with prior historical data or statistical norms is not a viable solution given the size of such data and variability involved in the manual comparison, which can lead to inconsistent results. The systems and methods according to the embodiments provide the technical solution of objectively determining anomalies based on, for example, a computer-generated version of the user movement that highlights anomalies.

2. System

[0017] Figure 1 illustrates an interactive virtual care system 100, according to an embodiment. Referring to Figure 1, the system 100 may include a user interface module 101 to input user data 102, and a responder interface module 103 to input responder data 104. As described in further detail below, the various components of the system 100 may be operable to capture and analyze data from multiple users and responders, which may include data pertaining to a user, for example a patient, and data pertaining to a responder, for example a health care provider. The modules and sub-components of the system 100 may be combined or partitioned without departing from the scope of the system 100, and are partitioned as shown in Figure 1 for facilitating an understanding of the system 100. For example, the user and responder interface modules 101, 103 may be combined as a general system interface module. A user sensory module 105 may include audio and video capture and relay capabilities for respectively capturing and relaying information related to a user to a responder. A responder sensory module 106 may likewise include audio and video capture and relay capabilities for respectively capturing and relaying information from a responder to a user. A data analysis module 107 may analyze the user and responder data 102, 104 and data captured by the user and responder sensory modules 105, 106 to generate results 108, such as, for example, patient specific metrics to a health care provider or results and/or instructions to a patient. The data analysis module 107 may be implemented in a cloud environment, instead of as a component of the system 100. The system 100 may provide for the same data to be viewed by either the user or the responder without sending the actual data between the user and responder interface modules 101, 103. A data storage 109 may be provided for storing information utilized by the system 100, which may include, for example, user specific history data or history data of a range of users generally. The user data and history data may be used to generate statistical norms used for comparison as described below.

[0018] Referring to Figure 2, an example is shown of a user screen display 120 for the user interface module

101, illustrating, for example, use of the system 100 in a health care facility and a patient view of general patient data. The screen display 120 may include, for example, general patient data, such as, patient date of birth at 121, insurance information at 122, health care provider information at 123, and agreements to proceed with the virtual health care process at 124.

[0019] Figure 3 illustrates an example of the user screen display 120 illustrating, for example, patient vital data entry. The screen display 120 may include, for example, patient vital data, such as, patient height at 125, weight at 126 etc., and a touch screen keypad 127 for entry of the patient vital data. Alternatively, biometric devices, such as, for example, a blood pressure monitor or a weight scale may be coupled to the user sensory module 105 for automatic capture of patient vital data.

[0020] Referring to Figure 4, an example is shown of a responder screen display 130 for the responder interface module 103, illustrating, for example, a health care provider view of the general and patient vital data. For the system 100 implemented, for example, as a kiosk, the screen displays 120, 130 may be provided adjacent each other so that the user and healthcare provider may each see two or more displays. As discussed above, the screen displays 120, 130 are provided for illustrative purposes only and may be combined in a single or distributed across other multiple displays. For example, a user may see the screen display 120 including user specific information and the screen display 130 including instructions from the responder as a combined display.

[0021] Referring to Figure 4, the screen display 130 may include, for example, general patient data, such as, patient date of birth at 121, and patient vital data, such as, patient height at 125, weight at 126 etc. The screen display 130 may also include a timeline 131 selectable to determine a patient's medical history for comparison. For example, as shown in Figure 4, a health care provider may select a timeline from March 25, 2010 - April 1, 2010. The user medical records may be displayed at windows 132, and may include, for example, notes related to previous patient ailments at 133 and health care provider diagnosis at 134. Other windows may display metrics related to a patient's walking goals at 135, with the goal metrics being displayed at 136 and patient actual metrics being displayed at 137. A history of patient performance in other tests may be displayed at 138 and 139.

[0022] Figure 5 illustrates an example of the screen display 130, illustrating, for example, a health care provider view of a patient movement test which may be initiated by selecting a "tools & tests" option at 140 as shown in the Figure 4 screen display. Assuming for example the user complains of knee pain, the test options 141 or 142 may be selected. Figure 6 illustrates an example of the user screen display 120, illustrating, for example, a patient view of remote movement instructions. Assuming the health care provider selects the test at 141, the user screen display 120 may provide the patient an example of movement at 143 requested by the health care pro-

vider. For example, the patient may be requested to walk ten feet as shown in the illustration of Figure 6.

[0023] Referring to Figure 7, an example of the responder screen display 130 may illustrate, for example, a health care provider view of patient movement recorded by the user sensory module 105. The user sensory module 105 may include high-fidelity audio-video sensory devices. The audio-video sensory devices may include, for example, a depth camera and microphone arrays. The depth camera may include, for example, a MICROSOFT KINECT camera system. Responder data may also be acquired via the responder sensory module 106, which may also include, for example, high-fidelity audio-video sensory devices. The user sensory module 105 provides real-time digitization of user movement to produce a computer-generated version of the user movement that highlights anomalies, where the movement may be displayed at 150. For example, an anomaly related to a knee joint may highlight the knee joint area in the display at 150 and/or provide metrics related to the degree or extent of the anomaly in the results 108. The real-time digitization is based on interpretation of movement by the user sensory module 105.

[0024] Options for selecting user historical movements may be presented at 151, and a listing of all previously recorded user movement analysis may be presented at 152. The data acquired from the user sensory module 105 may be used to augment patient reported symptoms and the biometric data related to patient movement at 150 to assist the remote health care provider in arriving at more accurate medical diagnoses. Data related to the user's vocal and/or speech patterns may also be acquired by the user sensory module 105 by using, for example, microphone arrays.

[0025] Referring to Figure 8, an example is shown of the screen display 130, illustrating, for example, a health care provider view of patient movement and historical analysis. Referring to Figures 7 and 8, assuming a comparison is made between a patient's current movement at 150 and historical movement at 153, the current and historical movements may be displayed adjacent each other as shown. The historical movement may be selected from the user historical movements at 151 or the listing of previously recorded user analysis at 152. Based on the selection, the data analysis module 107 may perform an analysis for anomaly identification by comparing the patient's current movement at 150 with the patient's selected historical movement. Alternatively, the data analysis module 107 may perform an analysis for anomaly identification by comparing the patient's current movement at 150 with statistical population norms, and identifying any significant deviation from such population norms. Such anomalies may be highlighted and presented on the user and/or responder interface modules 101, 103 based on the system configuration. For example, the responder interface module 103 may include the display at 130 as shown in Figure 8. The display may be used by a health care provider at a remote location to simul-

taneously view in real-time a live video stream of the user (e.g., the patient) performing an action side-by-side with the computer-generated results (e.g., the patient's current movement at 150) generated by the data analysis module 107 to assist in arriving at a medical diagnosis. Based on anomaly identification, the health care provider at the remote location may provide a medical diagnosis and further instructions as needed.

[0026] The anomaly identification performed by the data analysis module 107 may be determined by comparing user specific movement and/or audio information with prior history information for the user (e.g., movement data collected 6 months ago), or with statistical norms of similar users. The similarity of users may be based, for example, on metrics such as age, gender, race, height, weight, general demographics and other health conditions. The real-time digitization of user movement captured by the user sensory module 105 may be used to compare points of interest for the patient to prior patient history information and/or statistical norms of similar users as described above. For example, for movement information, the data analysis module 107 may compare changes at various joints of a patient to determine, for example, limp development, changes in posture, a length of time taken for a certain movement etc. For example, in order to determine limp development, the data analysis module 107 may determine that based on a starting position, the patient has a longer stride using a right leg as compared to a left leg. Factors such as a length of time taken for certain movement may also be compared to historical data for the patient which may be used as a threshold to determine if there has been improvement compared to the historical data. Alternatively, factors such as a length of time taken for certain movement may also be compared to statistical norms which may be used as a threshold to determine if the user falls within or outside of such statistical norms.

[0027] The data analysis module 107 may also be trainable to recommend diagnosis based on anomaly identification. For example, for an anomaly related to a length of time it takes for movement of a right leg versus a left leg, or based on the length of a stride using a right leg versus a left leg, the data analysis module 107 may recommend a diagnosis related to limp development (e.g., physical therapy focused on gait). The data analysis module 107 may also be trainable to generate a recommended treatment based on the recommended diagnosis.

[0028] Referring to Figure 9, an example is shown of the screen display 120, illustrating, for example, a user view for on-screen instructions. As shown in Figure 9, an example of the on-screen instructions is shown at 154 where the user (e.g., the patient) may follow the instructions and the user's movements may be displayed in the window at 155. The on-screen instructions 154 of Figure 9 may be performed with a responder (e.g., the health care provider) viewing the user response at a remote location or under unsupervised conditions. Alternatively,

a user or a responder may record the on-screen instructions 154, which may serve as a template for the user to follow, and the user may perform the movements under unsupervised conditions. The template may serve as the baseline for anomaly identification. The data analysis module 107 may identify anomalies based on comparison of the data obtained by the user sensory module 105 with the template, or based on comparison of the data obtained by the user sensory module 105 with prior user-specific historical data or with statistical norms of similar users as discussed above. The user may also follow instructions from a responder and the multi-modal user data may be compared to the multi-modal responder data to identify an anomaly in the user movement. The identified anomalies may be subsequently analyzed by a responder (e.g., the health care provider).

3. Method

[0029] Figure 10 illustrates a flowchart of a method 300 for interactive virtual care, according to an embodiment. Figure 11 illustrates a flowchart of a method 400 for interactive virtual care, according to an embodiment. The methods 300 and 400 may be implemented on the interactive virtual care system 100 described above with reference to Figures 1-9 by way of example and not limitation. The methods 300 and 400 may be practiced in other systems.

[0030] For the method 300, referring to Figures 1, 2 and 10, at block 301, for use in a health care facility, the interactive virtual care system 100 may acquire general user (e.g., patient) data, such as, patient date of birth at 121, insurance information at 122, health care provider information at 123, and agreements to proceed with the virtual health care process at 124. Capture of the general user data may be automated, for example, by attaching a magnetic strip card or a user-specific ID issued, for example, by a health insurer.

[0031] At block 302, referring to Figures 1, 3 and 10, the system 100 may acquire user vital data, such as, patient height at 125, weight at 126 etc.

[0032] At block 303, referring to Figures 1, 4 and 10, the system 100 may display the general user data and user vital data at the responder interface module 103. The system 100 may receive selection of the timeline 131, which is selectable to determine a patient's medical history for comparison. As discussed above, the user medical records may be displayed at windows 132, and may include, for example, notes related to previous patient ailments at 133 and health care provider diagnosis at 134. Other windows may display metrics related to a patient's walking goals at 135, with the goal metrics being displayed at 136 and patient actual metrics being displayed at 137. A history of patient performance in other tests may be displayed at 138 and 139.

[0033] At block 304, referring to Figures 1, 5 and 10, the system 100 may receive a selection of a test by a responder. For example, the system 100 may receive

selection of the "tools & tests" option at 140 as shown in the Figure 4 screen display. Assuming the system 100 receives selection of the test 141, the user screen display 120 may provide the patient an example of movement at 143 requested by the health care provider. For example, the patient may be requested to walk ten feet as shown in the illustration of Figure 6.

[0034] At block 305, referring to Figures 1, 7 and 10, the user sensory module 105 may acquire multi-modal user data related to user movement. Referring to Figure 7, an example of the responder screen display 130 may illustrate, for example, a health care provider view of patient movement recorded by the user sensory module 105.

[0035] At block 306, referring to Figures 7 and 10, the user sensory module 105 may provide real-time digitization of user movement to produce a computer-generated version of the user movement that highlights anomalies, where the movement may be displayed at 150. The real-time digitization may be based on interpretation of movement by the user sensory module 105.

[0036] At block 307, referring to Figures 7 and 10, the responder interface module 103 may provide options for selecting user historical movements at 151, and a listing of all previously recorded user movement analysis may be displayed at 152.

[0037] At block 308, referring to Figures 1,7,8 and 10, the data analysis module 107 may compare a patient's current movement at 150 and historical movement at 153, with the current and historical movements being displayed adjacent each other as shown. The historical movement may be selected from the user historical movements at 151 or the listing of previously recorded user analysis at 152. Based on the selection, the data analysis module 107 may perform an analysis for anomaly identification by comparing the patient's current movement at 150 with the patient's selected historical movement. Alternatively, the data analysis module 107 may perform an analysis for anomaly identification by comparing the patient's current movement at 150 with statistical population norms, and identifying any significant deviation from such population norms.

[0038] At block 309, referring to Figures 1, 7, 8 and 10, the data analysis module 107 may highlight and present anomalies on the user and/or responder interface modules 101, 103 based on the system configuration. The data analysis module 107 may also generate metrics of the degree or extent of the anomalies as the results 108. For example, the responder interface module 103 may include the display at 130 as shown in Figure 8. The display may be used by a health care provider at a remote location to simultaneously view in real-time a live video stream of the user (e.g., the patient) performing an action side-by-side with the computer-generated results (e.g., the patient's current movement at 150) generated by the data analysis module 107 to assist in arriving at a medical diagnosis. Based on anomaly identification, the health care provider at the remote location may provide a med-

ical diagnosis and further instructions as needed.

[0039] For the method 400, referring to Figures 1, 9 and 11, at block 401, the interactive virtual care system 100 may acquire general user (e.g., patient) data.

[0040] At block 402, if a user is to perform tests under unsupervised conditions or following a responder's movements, the user interface module 101 may present on-screen instructions as shown at 154 where the user (e.g., the patient) may follow the instructions and the user's movements may be displayed in the window at 155. The on-screen instructions 154 of Figure 9 may be performed with a responder (e.g., the health care provider) viewing the user response at a remote location or under unsupervised conditions. Alternatively, a user or a responder may record the on-screen instructions 154, which may serve as a template for the user to follow, and the user may perform the movements under unsupervised conditions. The template may serve as the baseline for anomaly identification. In the unsupervised setting, a user may contact the responder at a remote location for assistance as needed.

[0041] At block 403, the data analysis module 107 may identify anomalies based on comparison of the data obtained by the user sensory module 105 with the template, or based on comparison of the data obtained by the user sensory module 105 with prior user-specific historical data or with statistical norms of similar users as discussed above. The identified anomalies may be subsequently analyzed by a responder (e.g., the health care provider).

4. Computer Readable Medium

[0042] Figure 12 shows a computer system 500 that may be used with the embodiments described herein.

The computer system 500 represents a generic platform that includes components that may be in a server or another computer system. The computer system 500 may be used as a platform for the system 100. The computer system 500 may execute, by a processor or other hardware processing circuit, the methods, functions and other processes described herein. These methods, functions and other processes may be embodied as machine readable instructions stored on computer readable medium, which may be non-transitory, such as hardware storage devices (e.g., RAM (random access memory), ROM (read only memory), EPROM (erasable, programmable ROM), EEPROM (electrically erasable, programmable ROM), hard drives, and flash memory).

[0043] The computer system 500 includes a processor 502 that may implement or execute machine readable instructions performing some or all of the methods, functions and other processes described herein. Commands and data from the processor 502 are communicated over a communication bus 504. The computer system 500 also includes a main memory 506, such as a random access memory (RAM), where the machine readable instructions and data for the processor 502 may reside during runtime, and a secondary data storage 508, which

may be nonvolatile and stores machine readable instructions and data. The memory and data storage are examples of computer readable mediums. The memory 506 may include modules 520 including machine readable instructions residing in the memory 506 during runtime and executed by the processor 502. The modules 520 may include the modules 101, 103 and 105-107 of the system 100 shown in Figure 1.

[0044] The computer system 500 may include an I/O device 510, such as a keyboard, a mouse, a display, touchscreen, etc. The computer system 500 may include a network interface 512 for connecting to a network. Other known electronic components may be added or substituted in the computer system 500.

[0045] While the embodiments have been described with reference to examples, various modifications to the described embodiments may be made without departing from the scope of the claimed embodiments.

Claims

1. An interactive virtual care system (100) comprising:

a user sensory module (105) to acquire multi-modal user data related to user movement, wherein the user sensory module (105) includes a depth camera to acquire the multi-modal user data, and wherein the user sensory module (105) is adapted to provide real-time digitization of the user movement, based on an interpretation of the user movement by the user sensory module (105), and to produce a computer-generated version of the user movement, wherein the user sensory module (105) includes audio and video capture and relay capabilities for respectively capturing and relaying information related to a user to a responder;
 a responder sensory module (106) to acquire multi-modal responder data related to responder movement;
 a data analysis module (107), executed by a processor, to

- compare the multi-modal user data to predetermined historical user data and statistical norm data for users to identify at least one anomaly being a first anomaly in the user movement, and
- compare the multi-modal user data to the multi-modal responder data (104) to identify at least one anomaly being a second anomaly in the user movement,

wherein the data analysis module (107) is adapted to analyse the multi-modal user data captured by the user sensory module (105), and the multi-modal responder data captured by the re-

sponder sensory module (106) to generate results (108) ; wherein the results (108) comprise metrics related to a degree or an extent of the first and/or second anomalies in the results (108);

a responder interface module (103) and a user interface module (101) adapted to display the computer-generated version of the user movement with highlights of movements of predetermined portions of a user's body, wherein the responder interface module (103) is adapted to further highlight the first anomaly in the user movement in the computer-generated version of the user movement, wherein at least one of the responder interface module (103) and the user interface module (101) provide options for selecting a range of the predetermined historical user data for comparison of the multi-modal user data to the predetermined historical user data, wherein the responder interface module (103) is adapted to further display a real-time version of the multi-modal user data of the user movement superimposed on the computer-generated version of the user movement; and wherein the user interface module (101) is further adapted to

- highlight the first anomaly in the user movement in the computer-generated version of the user movement; and
- display the real-time version of the multi-modal user data of the user movement superimposed on the computer-generated version of the user movement.

2. The system of claim 1, wherein the user sensory module (105) includes a microphone array to acquire the multi-modal user data related to speech.

3. The system of any one of claims 1 to 2, wherein each user is a patient and each responder is a health care provider; and/or further comprising a responder sensory module (106) to acquire the multi-modal responder data for a responder disposed at a remote location from a user.

4. The system of claim 1, wherein the responder interface module (103) is further adapted to further display the real-time version of the multi-modal user data of the user movement adjacent to the computer-generated version of the user movement.

5. The system of any one of the preceding claims, wherein the user interface module (101) is adapted to further display the real-time version of the multi-modal user data of the user movement adjacent to

the computer-generated version of the user movement.

6. The system of any one of the preceding claims, wherein the responder interface module (103) is disposed at a remote location compared to the user interface module (101).

7. A non-transitory computer readable medium having stored thereon a computer executable program to provide interactive virtual care, the computer executable program, when executed on an interactive virtual care system of any claims 1 to 6, being configured to carry out the steps of:

acquiring (301), at a user sensory module (105), multi-modal user data related to user movement by using a depth camera to acquire the multi-modal user data;

performing, by the user sensory module (105), real-time digitization of the user movement, based on an interpretation of the user movement, to produce a computer-generated version of the user movement,

capturing and relaying, respectively by audio and video capture and relay capabilities included in the user sensory module (105), information related to a user to a responder;

providing a responder interface module (103) and a user interface module (101) to display the computer-generated version of the user movement with highlights of movements of predetermined portions of a user's body, wherein the responder interface module is to further highlight a first anomaly in the user movement in the computer-generated version of the user movement, wherein at least one of the responder interface module (103) and the user interface module (101) having options for selecting a range of predetermined historical user data for comparison of the multi-modal user data to the predetermined historical user data;

comparing (308), by a data analysis module (107) executed by a processor, the multi-modal user data to the predetermined historical user data and statistical norm data for users to identify at least one anomaly being the first anomaly in the user movement to generate results (108); displaying, at the responder interface module (103) a real-time version of the multi-modal user data of the user movement superimposed on the computer-generated version of the user movement;

highlighting, at a user interface module (101), the first anomaly in the user movement in the computer-generated version of the user movement; and

displaying, at the user interface module (101),

the real-time version of the multi-modal user data of the user movement superimposed on the computer-generated version of the user movement;

acquiring, by a responder sensory module (106), multi-modal responder data related to responder movement;

analyzing the multi-modal user data captured by the user sensory module (105), and the multi-modal responder data captured by the responder sensory module (106) to generate results (108) by comparing the multi-modal user data to the multi-modal responder data to identify at least one anomaly being a second anomaly in the user movement; and

generating metrics related to a degree or extent of the first and/or second anomalies in the results (108).

8. The non-transitory computer readable medium of claim 7, further carrying out the step of acquiring the multi-modal user data related to speech by a microphone array.

9. The non-transitory computer readable medium of claim 7 or 8, further carrying out the step of displaying the real-time version of the multi-modal user data of the user movement adjacent to the computer-generated version of the user movement.

Patentansprüche

1. Ein interaktives virtuelles Pflegesystem (100), das Folgendes umfasst:

ein sensorisches Nutzermodul (105) zur Erfassung von multimodalen Nutzerdaten, die auf Nutzerbewegungen bezogen sind, wobei das sensorische Nutzermodul (105) eine Tiefenkamera beinhaltet, um die multimodalen Nutzerdaten zu erfassen, und wobei das sensorische Nutzermodul (105) dazu angepasst ist, basierend auf einer Interpretation der Nutzerbewegung durch das sensorische Nutzermodul (105), eine Echtzeit-Digitalisierung der Nutzerbewegung bereitzustellen, und eine computergenerierte Version der Nutzerbewegung zu erstellen, wobei das sensorische Nutzermodul (105) Audio- und Video-Erfassung- und Weiterleitungsfunktionen beinhaltet, um nutzerbezogene Informationen jeweils zu erfassen und an einen *Responder* bzw. Helfer weiterzuleiten;

ein sensorisches *Responder*-Modul (106) zur Erfassung von multimodalen *Responder*-Daten, die auf *Responder*-Bewegungen bezogen sind;

ein Datenanalyse-Modul (107), das von einem Prozessor ausgeführt wird, um Folgendes zu

bewerkstelligen:

- vergleichen der multimodalen Nutzerdaten mit vorbestimmten historischen Nutzerdaten und statistischen Normdaten für Nutzer, um mindestens eine Anomalie als erste Anomalie in der Nutzerbewegung zu identifizieren, und
- vergleichen der multimodalen Nutzerdaten mit multimodalen *Responder*-Daten (104), um mindestens eine Anomalie als zweite Anomalie in der Nutzerbewegung zu identifizieren,

wobei das Datenanalyse-Modul (107) dazu angepasst ist, die vom sensorischen Nutzermodul (105) erfassten multimodalen Nutzerdaten und die vom sensorischen *Responder*-Modul (106) erfassten multimodalen *Responder*-Daten zu analysieren, um Ergebnisse (108) zu erzeugen; wobei die Ergebnisse (108) Metriken umfassen, die mit einem Grad (*degree*) oder einem Ausmaß (*extent*) der ersten und/oder zweiten Anomalie in den Ergebnissen (108) in Bezug stehen; ein *Responder-Interface*-Modul (103) und ein Nutzer-*Interface*-Modul (101), die angepasst sind, um die computergenerierte Version der Nutzerbewegung mit Hervorhebungen von Bewegungen vorbestimmter Abschnitte eines Nutzerkörpers anzuzeigen,

wobei das *Responder-Interface*-Modul (103) angepasst ist, um ferner die erste Anomalie in der Nutzerbewegung in der computergenerierten Version der Nutzerbewegung hervorzuheben, wobei mindesten eines unter dem *Responder-Interface*-Modul (103) und dem Nutzer-*Interface*-Modul (101) Optionen zur Auswahl eines Bereichs der vorbestimmten historischen Nutzerdaten für den Vergleich der multimodalen Nutzerdaten mit den vorbestimmten historischen Nutzerdaten bereitstellt, wobei das *Responder-Interface*-Modul (103) angepasst ist, um ferner einer Echtzeit-Version der multimodalen Nutzerdaten der Nutzerbewegung, überlagert über der computergenerierten Version der Nutzerbewegung anzuzeigen; und wobei das Nutzer-*Interface*-Modul (101) ferner angepasst ist, um Folgendes zu bewerkstelligen:

- hervorheben der ersten Anomalie in der Nutzerbewegung in der computergenerierten Version der Nutzerbewegung; und
- anzeigen der Echtzeit-Version der multimodalen Nutzerdaten der Nutzerbewegung, überlagert über der computergenerierten Version der Nutzerbewegung.

2. Das System nach Anspruch 1, wobei das sensorische Nutzermodul (105) ein Mikrofon-Array beinhaltet, um die auf Sprache bezogenen multimodalen Nutzerdaten zu erfassen.

5 3. Das System nach irgendeinem der Ansprüche 1 bis 2, wobei jeder Nutzer ein Patient und jeder *Responder* ein Gesundheitsdienstleister ist; und/oder ferner umfassend ein sensorisches *Responder*-Modul (106), zur Erfassung der multimodalen *Responder*-Daten für einen *Responder*, der sich an einem von einem Nutzer fernen Ort befindet.

10 4. Das System nach Anspruch 1, wobei das *Responder-Interface*-Modul (103) ferner angepasst ist, um ferner die Echtzeit-Version der multimodalen Nutzerdaten der Nutzerbewegung neben der computergenerierten Version der Nutzerbewegung anzuzeigen.

15 5. Das System nach irgendeinem der vorhergehenden Ansprüche, wobei das Nutzer-*Interface*-Modul (101) angepasst ist, um ferner die Echtzeit-Version der multimodalen Nutzerdaten der Nutzerbewegung neben der computergenerierten Version der Nutzerbewegung anzuzeigen.

20 6. Das System nach irgendeinem der vorhergehenden Ansprüche, wobei das *Responder-Interface*-Modul (103), verglichen mit dem Nutzer-*Interface*-Modul (101), an einem fernen Ort angeordnet ist.

25 7. Ein nicht flüchtiger, computerlesbarer Träger, auf dem ein computerausführbares Programm zur Bereitstellung von interaktiver virtueller Pflege gespeichert ist, wobei das computerausführbare Programm, wenn es in einem interaktiven virtuellen Pflegesystem (100) nach irgendeinem der Ansprüche 1 bis 6 ausgeführt wird, dazu konfiguriert ist, die folgenden Schritte durchzuführen:

30 erfassen (301), an einem sensorischen Nutzermodul (105), von multimodalen Nutzerdaten, die auf Nutzerbewegungen bezogen sind, durch die Verwendung einer Tiefenkamera, um die multimodalen Nutzerdaten zu erfassen; durchführen, durch das sensorische Nutzermodul (105), einer Echtzeit-Digitalisierung der Nutzerbewegung, basierend auf einer Interpretation der Nutzerbewegung, um eine computergenerierte Version der Nutzerbewegung zu erstellen, erfassen und weiterleiten, jeweils durch Audio- und Video-Erfassungs- und - Weiterleitung-Funktionen, die im sensorischen Nutzermodul (105) enthalten sind, von nutzerbezogenen Informationen an einen *Responder* bzw. Helfer; bereitstellen eines *Responder-Interface*-Mo-

duls (103) und eines Nutzer-*Interface*-Moduls (101), um die computergenerierte Version der Nutzerbewegung mit Hervorhebungen von Bewegungen vorbestimmter Abschnitte eines Nutzerkörpers anzuzeigen, wobei das *Responder-Interface*-Modul ferner dazu dient, eine erste Anomalie in der Nutzerbewegung in der computergenerierten Version der Nutzerbewegung hervorzuheben, wobei mindestens eines unter dem *Responder-Interface*-Modul (103) und dem Nutzer-*Interface*-Modul (101) Optionen zur Auswahl eines Bereichs von vorbestimmten historischen Nutzerdaten für den Vergleich der multimodalen Nutzerdaten mit den vorbestimmten historischen Nutzerdaten bereitstellt; vergleichen (308), durch ein Datenanalyse-Modul (107), das von einem Prozessor ausgeführt wird, der multimodalen Nutzerdaten mit den vorbestimmten historischen Nutzerdaten und statistischen Normdaten für Nutzer, um mindestens eine Anomalie als erste Anomalie in der Nutzerbewegung zu identifizieren, die Ergebnisse (108) erzielt; anzeigen, am *Responder-Interface*-Modul (103), einer Echtzeit-Version der multimodalen Nutzerdaten der Nutzerbewegung, überlagert über der computergenerierten Version der Nutzerbewegung; hervorheben, an einem Nutzer-*Interface*-Modul (101), der ersten Anomalie in der Nutzerbewegung in der computergenerierten Version der Nutzerbewegung; und anzeigen, am Nutzer-*Interface*-Modul (101), der Echtzeit-Version der multimodalen Nutzerdaten der Nutzerbewegung, überlagert über der computergenerierten Version der Nutzerbewegung; erfassen, durch ein sensorisches *Responder*-Modul (106), von multimodalen *Responder*-Daten, die auf *Responder*-Bewegungen bezogen sind; analysieren der vom sensorischen Nutzermodul (105) erfassten multimodalen Nutzerdaten und der vom sensorischen *Responder*-Modul (106) erfassten multimodalen *Responder*-Daten, um Ergebnisse (108) zu erzeugen, indem die multimodalen Nutzerdaten mit den multimodalen *Responder*-Daten verglichen werden, um mindestens eine Anomalie als eine zweite Anomalie in der Nutzerbewegung zu identifizieren; und erzeugen von Metriken, die mit einem Grad (*degree*) oder einem Ausmaß (*extent*) der ersten und/oder zweiten Anomalie in den Ergebnissen (108) in Bezug stehen.

8. Der nicht flüchtige, computerlesbare Träger nach Anspruch 7, der ferner den Schritt ausführt, der darin besteht, die auf Sprache bezogenen multimodalen Nutzerdaten durch ein Mikrofon-Array zu erfassen.

9. Der nicht flüchtige, computerlesbare Träger nach Anspruch 7 oder 8, der ferner den Schritt ausführt, der darin besteht, die Echtzeit-Version der multimodalen Nutzerdaten der Nutzerbewegung neben der computergenerierten Version der Nutzerbewegung anzuzeigen.

Revendications

1. Un système de soins virtuel interactif (100), comprenant :

un module sensoriel utilisateur (105) pour acquérir des données utilisateur multimodales relatives à un mouvement d'utilisateur, sachant que le module sensoriel utilisateur (105) inclut une caméra de profondeur pour acquérir les données utilisateur multimodales, et sachant que le module sensoriel utilisateur (105) est adapté pour fournir une numérisation en temps réel du mouvement d'utilisateur, en se basant sur une interprétation du mouvement d'utilisateur par le module sensoriel utilisateur (105), et pour produire une version générée par ordinateur du mouvement d'utilisateur, sachant que le module sensoriel utilisateur (105) inclut des capacités de capture et de relais audio et vidéo afin de capturer et de transmettre respectivement des informations liées à un utilisateur à un répondeur ;
un module sensoriel de répondeur (106) pour acquérir des données de répondeur multimodales relatives à un mouvement de répondeur ;
un module d'analyse de données (107) exécuté par un processeur, pour

- comparer les données utilisateur multimodales avec des données utilisateur historiques prédéterminées et des données statistiques de norme (*statistical norm data*) prédéterminées pour utilisateurs afin d'identifier au moins une anomalie, étant une première anomalie dans le mouvement d'utilisateur, et
- comparer les données utilisateur multimodales avec les données de répondeur multimodales (104) afin d'identifier au moins une anomalie, étant une deuxième anomalie dans le mouvement d'utilisateur,

sachant que le module d'analyse de données (107) est adapté pour analyser les données utilisateur multimodales capturées par le module sensoriel utilisateur (105) et les données de répondeur multimodales capturées par le module sensoriel de répondeur (106) afin de générer des résultats (108) ;

sachant que les résultats (108) comprennent des métriques liées à un degré ou à une étendue de la première et/ou de la deuxième anomalie dans les résultats (108) ;

un module d'interface de répondeur (103) et un module d'interface utilisateur (101) adaptés pour afficher la version générée par ordinateur du mouvement d'utilisateur avec des mises en évidence de mouvements de portions prédéterminées d'un corps d'utilisateur,

sachant que le module d'interface de répondeur (103) est adapté en outre pour mettre en évidence la première anomalie dans le mouvement d'utilisateur dans la version générée par ordinateur du mouvement d'utilisateur, sachant qu'au moins un parmi le module d'interface de répondeur (103) et le module d'interface utilisateur (101) fournit des options pour sélectionner une plage des données utilisateur historiques prédéterminées pour une comparaison des données utilisateur multimodales avec les données utilisateur historiques prédéterminées, sachant que le module d'interface de répondeur (103) est adapté en outre pour afficher une version en temps réel des données utilisateur multimodales du mouvement d'utilisateur superposée sur la version générée par ordinateur du mouvement d'utilisateur ; et

sachant que le module d'interface utilisateur (101) est en outre adapté pour

- mettre en évidence la première anomalie dans le mouvement d'utilisateur dans la version générée par ordinateur du mouvement d'utilisateur ; et

- afficher la version en temps réel des données utilisateur multimodales du mouvement d'utilisateur superposée sur la version générée par ordinateur du mouvement d'utilisateur.

2. Le système d'après la revendication 1, sachant que le module sensoriel utilisateur (105) inclut un réseau de microphones pour acquérir les données utilisateur multimodales liées à la parole.
3. Le système d'après une quelconque des revendications de 1 à 2, sachant que chaque utilisateur est un patient et chaque répondeur est un prestataire de soins de santé ; et/ou comprenant en outre un module sensoriel de répondeur (106) pour acquérir les données de répondeur multimodales pour un répondeur disposé à un endroit éloigné d'un utilisateur.
4. Le système d'après la revendication 1, sachant que le module d'interface de répondeur (103) est en outre adapté pour en outre afficher la version en temps

réel des données utilisateur multimodales du mouvement d'utilisateur de manière adjacente à la version générée par ordinateur du mouvement d'utilisateur.

5. Le système d'après une quelconque des revendications précédentes, sachant que le module d'interface utilisateur (101) est adapté pour en outre afficher la version en temps réel des données utilisateur multimodales du mouvement d'utilisateur de manière adjacente à la version générée par ordinateur du mouvement d'utilisateur.

6. Le système d'après une quelconque des revendications précédentes, sachant que le module d'interface de répondeur (103) est disposé dans un endroit éloigné par rapport au module d'interface utilisateur (101).

7. Un support non transitoire lisible par ordinateur sur lequel est mémorisé un programme exécutable par ordinateur afin de fournir des soins virtuel interactif, le programme exécutable par ordinateur, quand il est exécuté dans un système de soins virtuel interactif d'après une quelconque des revendications de 1 à 6, étant configuré pour mettre en oeuvre les étapes suivantes, consistant à :

acquérir (301), auprès d'un module sensoriel utilisateur (105), des données utilisateur multimodales relatives à un mouvement d'utilisateur, en utilisant une caméra de profondeur pour acquérir les données utilisateur multimodales ; effectuer, par le module sensoriel utilisateur (105), une numérisation en temps réel du mouvement d'utilisateur, en se basant sur une interprétation du mouvement d'utilisateur pour produire une version générée par ordinateur du mouvement d'utilisateur, capturer et transmettre, respectivement par des capacités de capture et de relais audio et vidéo incluses dans le module sensoriel utilisateur (105), des informations liées à un utilisateur à un répondeur ;

fournir un module d'interface de répondeur (103) et un module d'interface utilisateur (101) pour afficher la version générée par ordinateur du mouvement d'utilisateur avec des mises en évidence de mouvements de portions prédéterminées d'un corps d'utilisateur, sachant que le module d'interface de répondeur sert en outre à mettre en évidence une première anomalie dans le mouvement d'utilisateur dans la version générée par ordinateur du mouvement d'utilisateur, sachant qu'au moins un parmi le module d'interface de répondeur (103) et le module d'interface utilisateur (101) présente des options pour sélectionner une plage des données utili-

sateur historiques prédéterminées pour une comparaison des données utilisateur multimodales avec les données utilisateur historiques prédéterminées ;
 comparer (308), par un module d'analyse de données (107) exécuté par un processeur, les données utilisateur multimodales avec les données utilisateur historiques prédéterminées et des données statistiques de norme (*statistical norm data*) prédéterminées pour utilisateurs afin d'identifier au moins une anomalie, étant la première anomalie dans le mouvement d'utilisateur à générer des résultats (108) ;
 afficher auprès du module d'interface de répondeur (103), une version en temps réel des données utilisateur multimodales du mouvement d'utilisateur superposée sur la version générée par ordinateur du mouvement d'utilisateur ;
 mettre en évidence, auprès d'un module d'interface utilisateur (101), la première anomalie dans le mouvement d'utilisateur dans la version générée par ordinateur du mouvement d'utilisateur ; et
 afficher, auprès d'un module d'interface utilisateur (101), la version en temps réel des données utilisateur multimodales du mouvement d'utilisateur superposée sur la version générée par ordinateur du mouvement d'utilisateur ;
 acquérir, par un module sensoriel de répondeur (106), des données de répondeur multimodales relatives à un mouvement de répondeur ;
 analyser les données utilisateur multimodales capturées par le module sensoriel utilisateur (105) et les données de répondeur multimodales capturées par le module sensoriel de répondeur (106) afin de générer des résultats (108) en comparant les données utilisateur multimodales avec les données de répondeur multimodales afin d'identifier au moins une anomalie, étant une deuxième anomalie dans le mouvement d'utilisateur ; et
 générer des métriques liées à un degré ou à une étendue de la première et/ou de la deuxième anomalie dans les résultats (108).

- 45
8. Le support non transitoire lisible par ordinateur d'après la revendication 7, en outre mettant en oeuvre l'étape consistant à acquérir les données utilisateur multimodales liées à la parole par un réseau de microphones.
- 50
9. Le support non transitoire lisible par ordinateur d'après la revendication 7 ou 8, en outre mettant en oeuvre l'étape consistant à
- 55

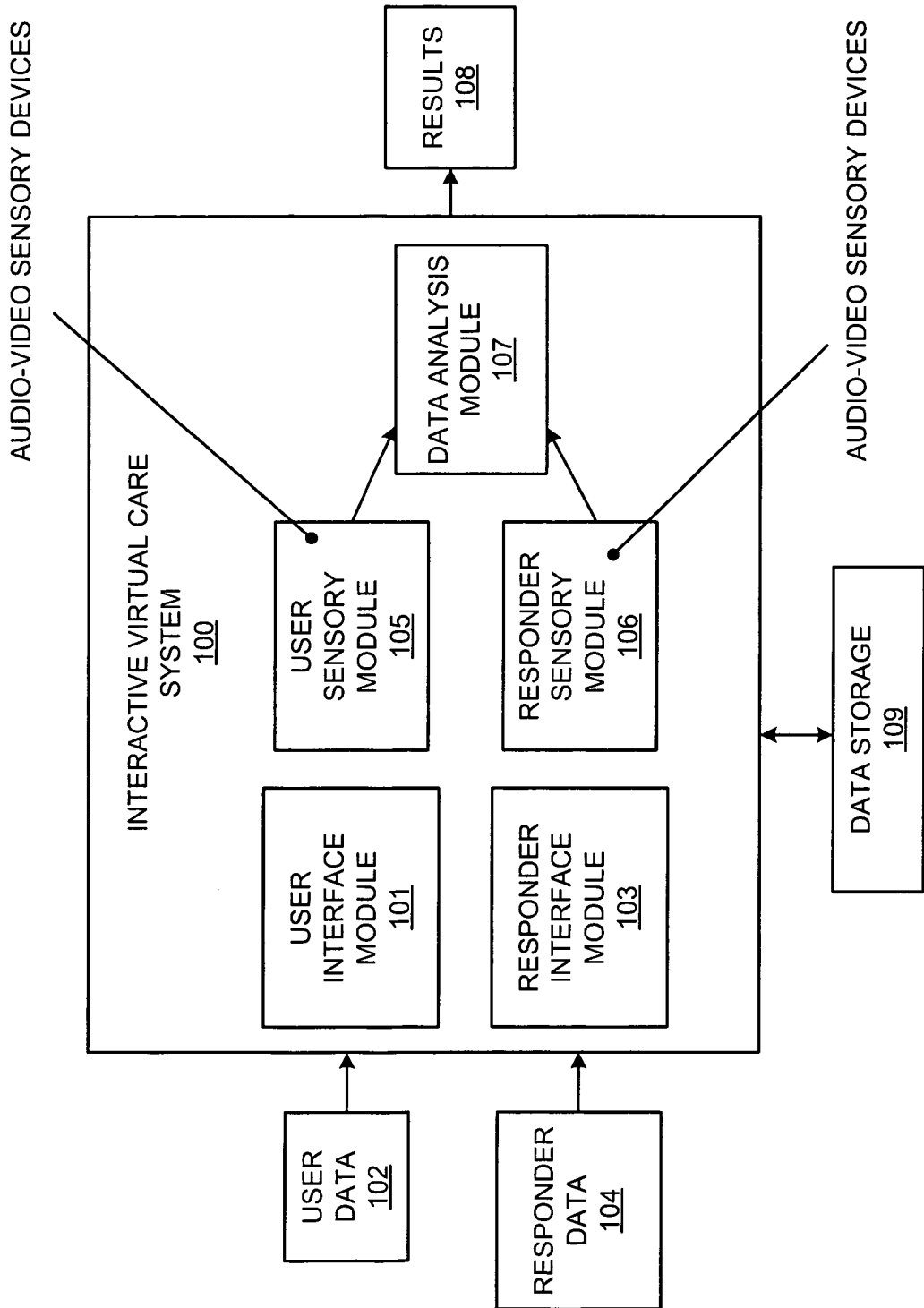


FIG. 1

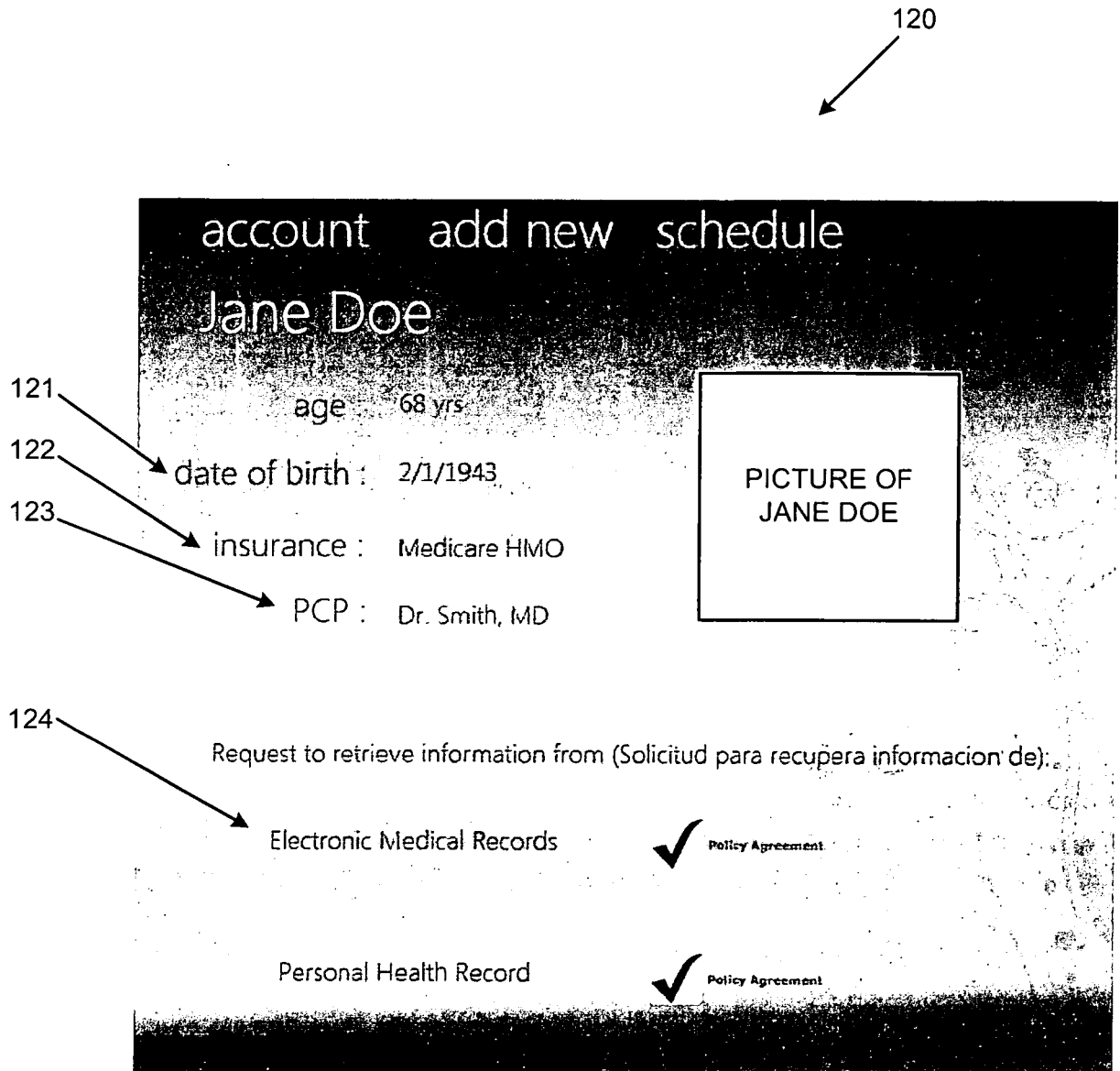


FIG. 2

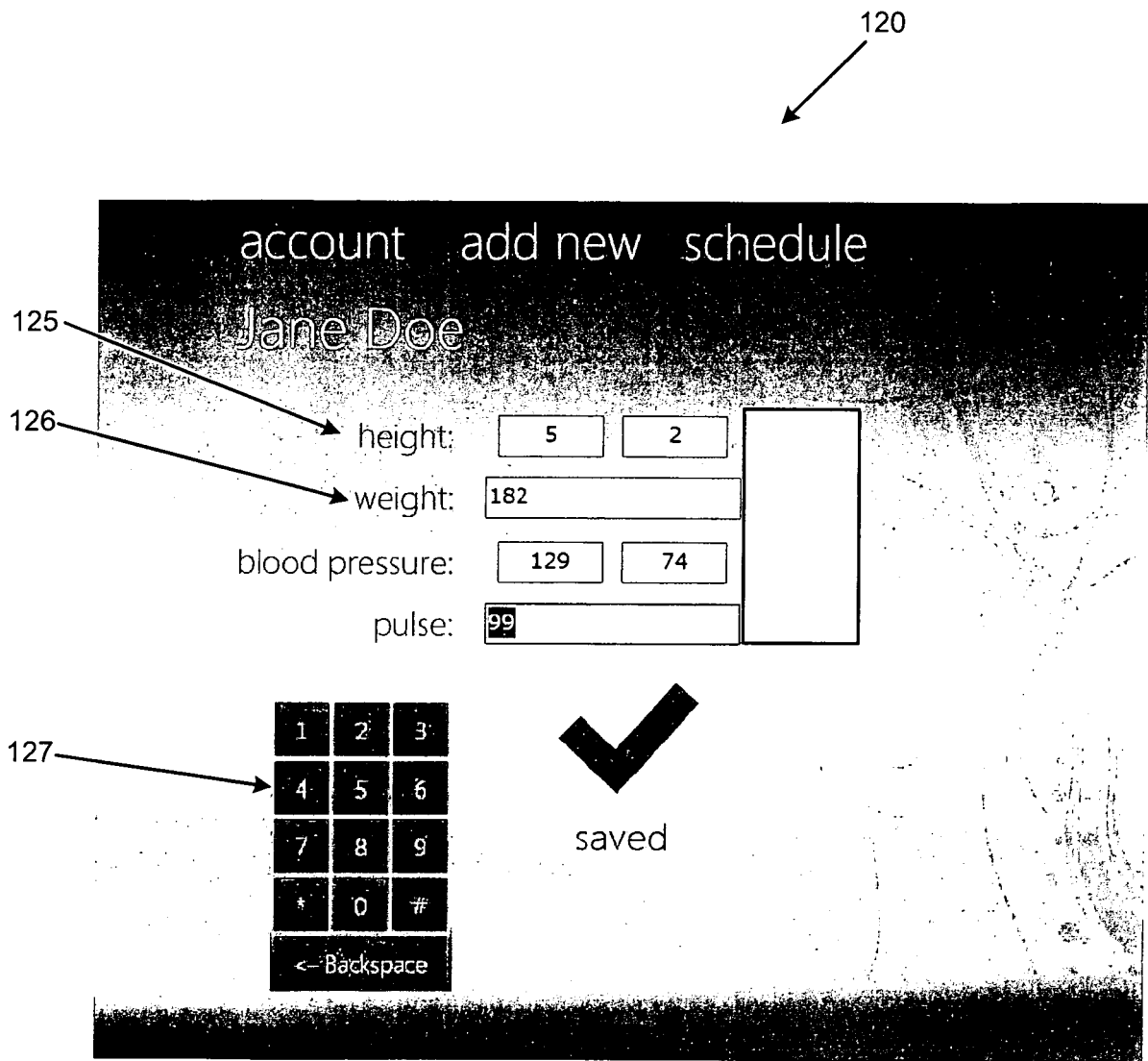


FIG. 3

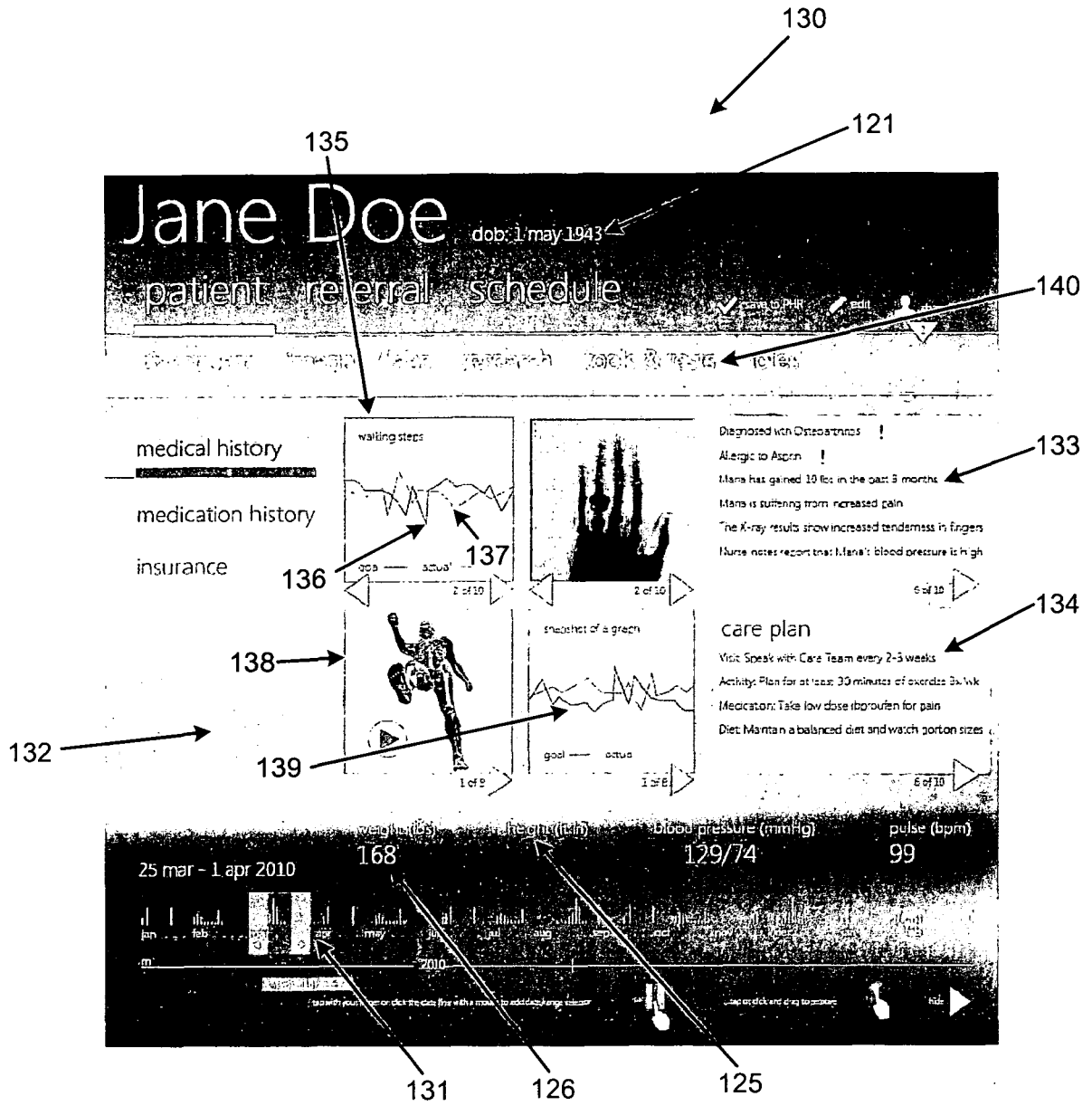


FIG. 4

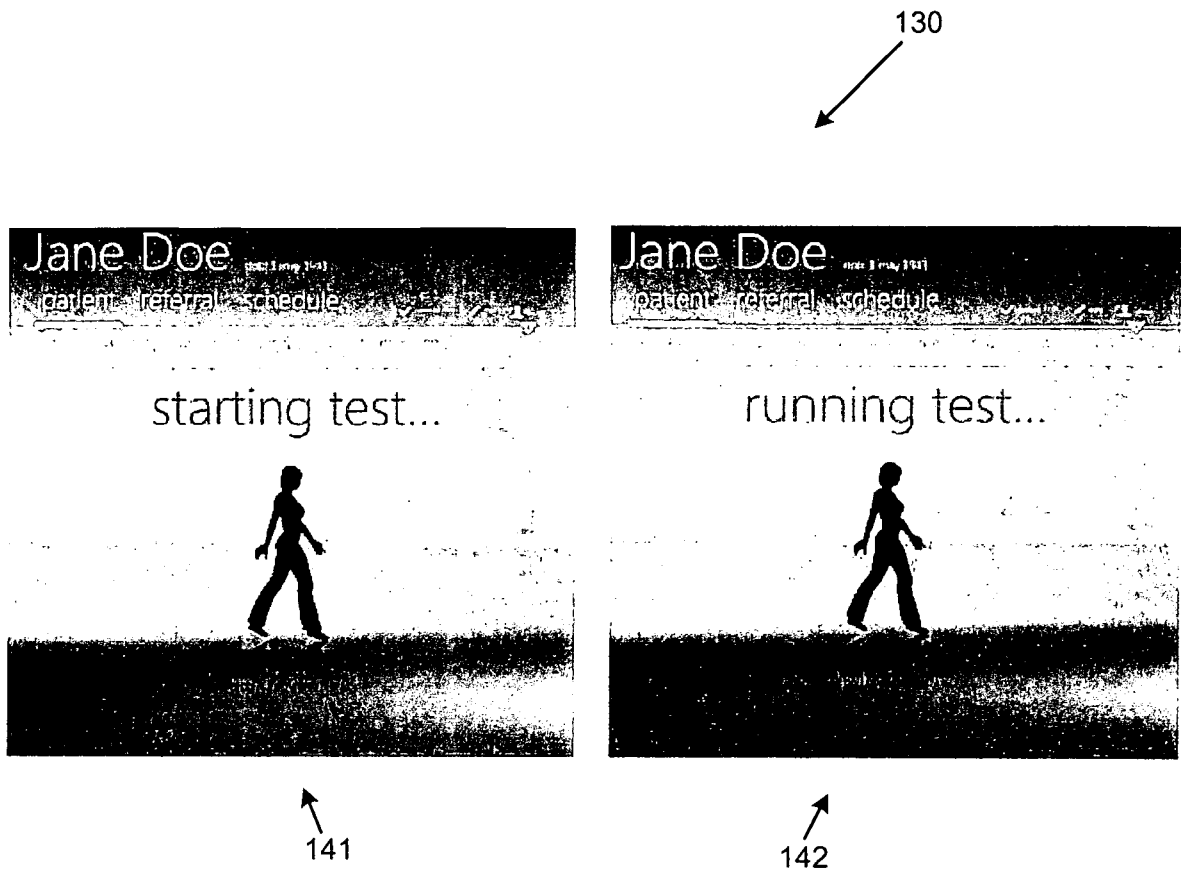


FIG. 5

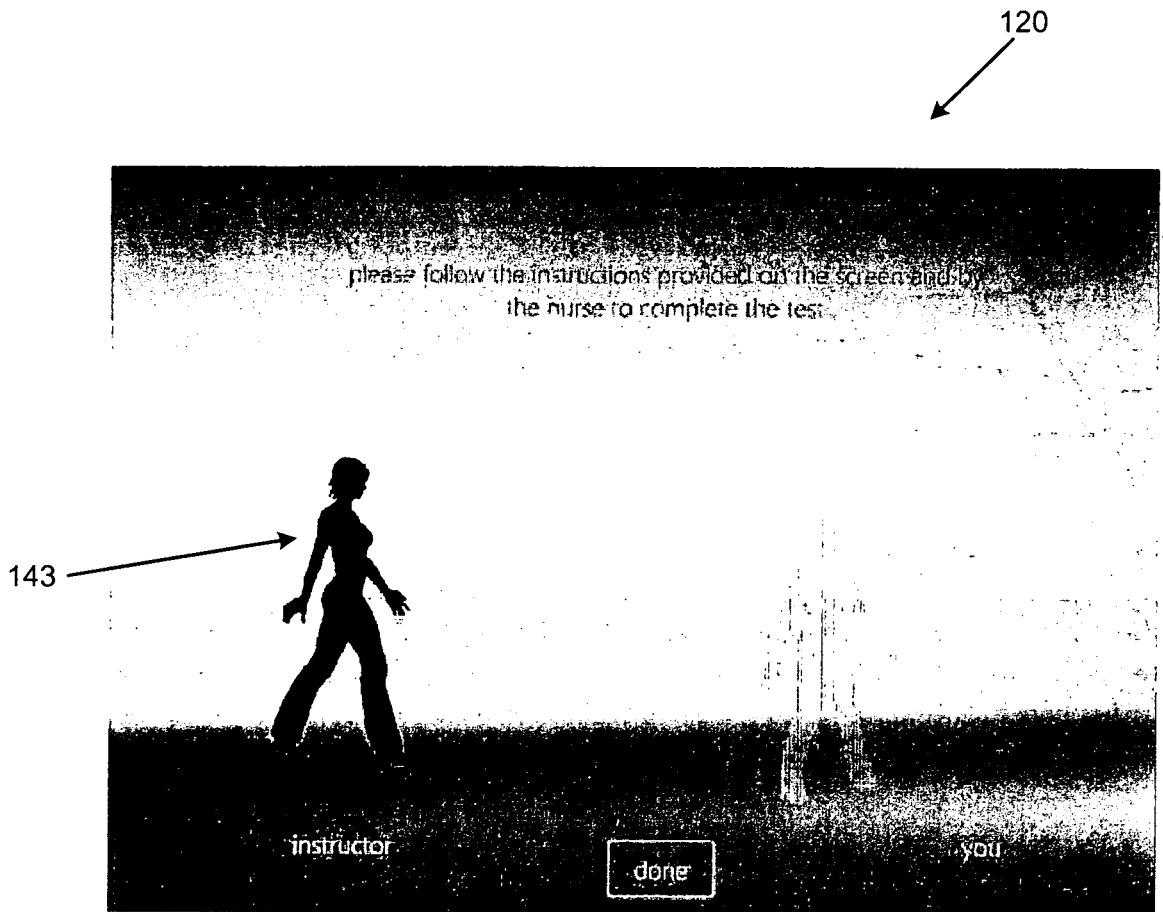


FIG. 6

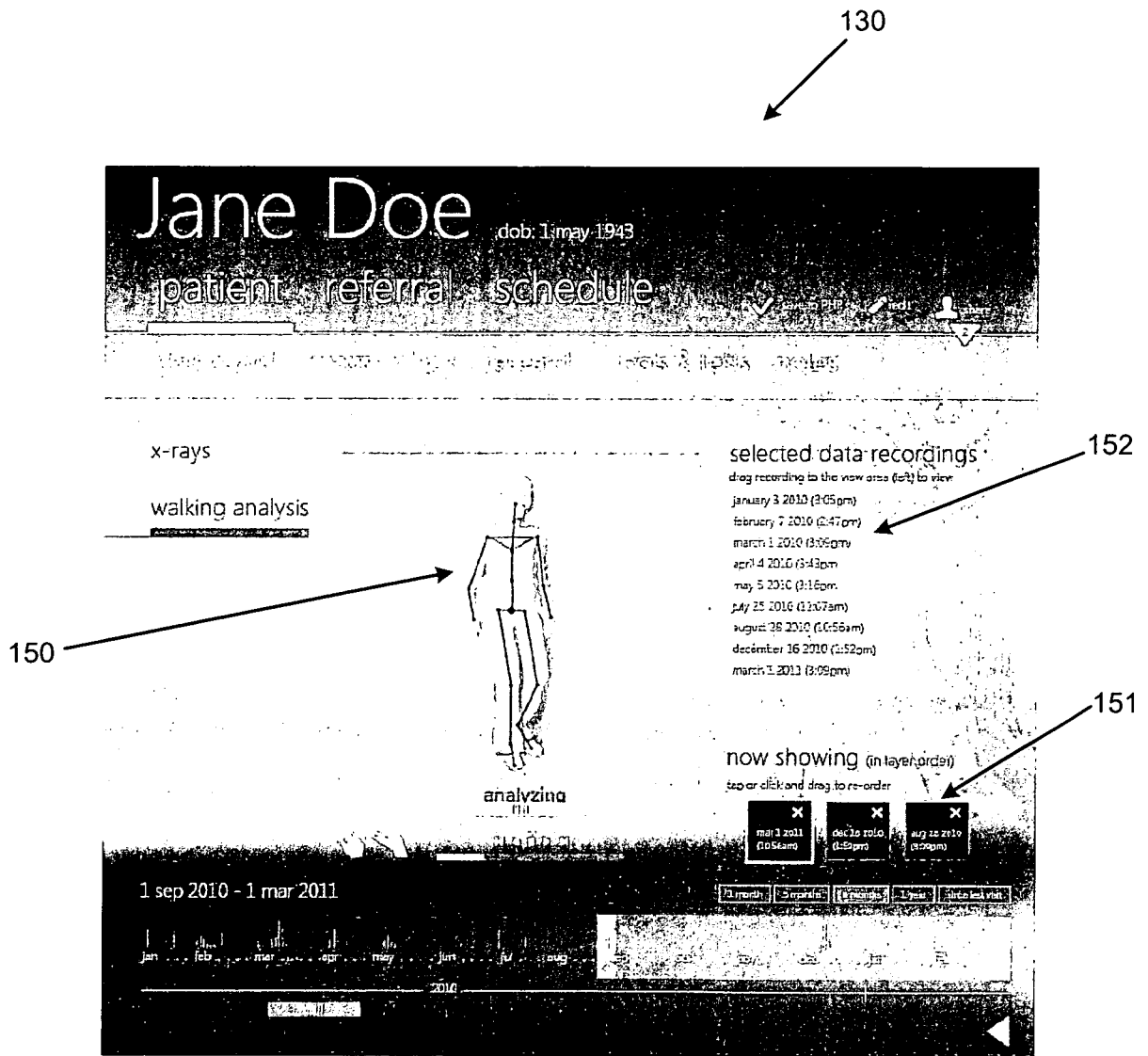


FIG. 7

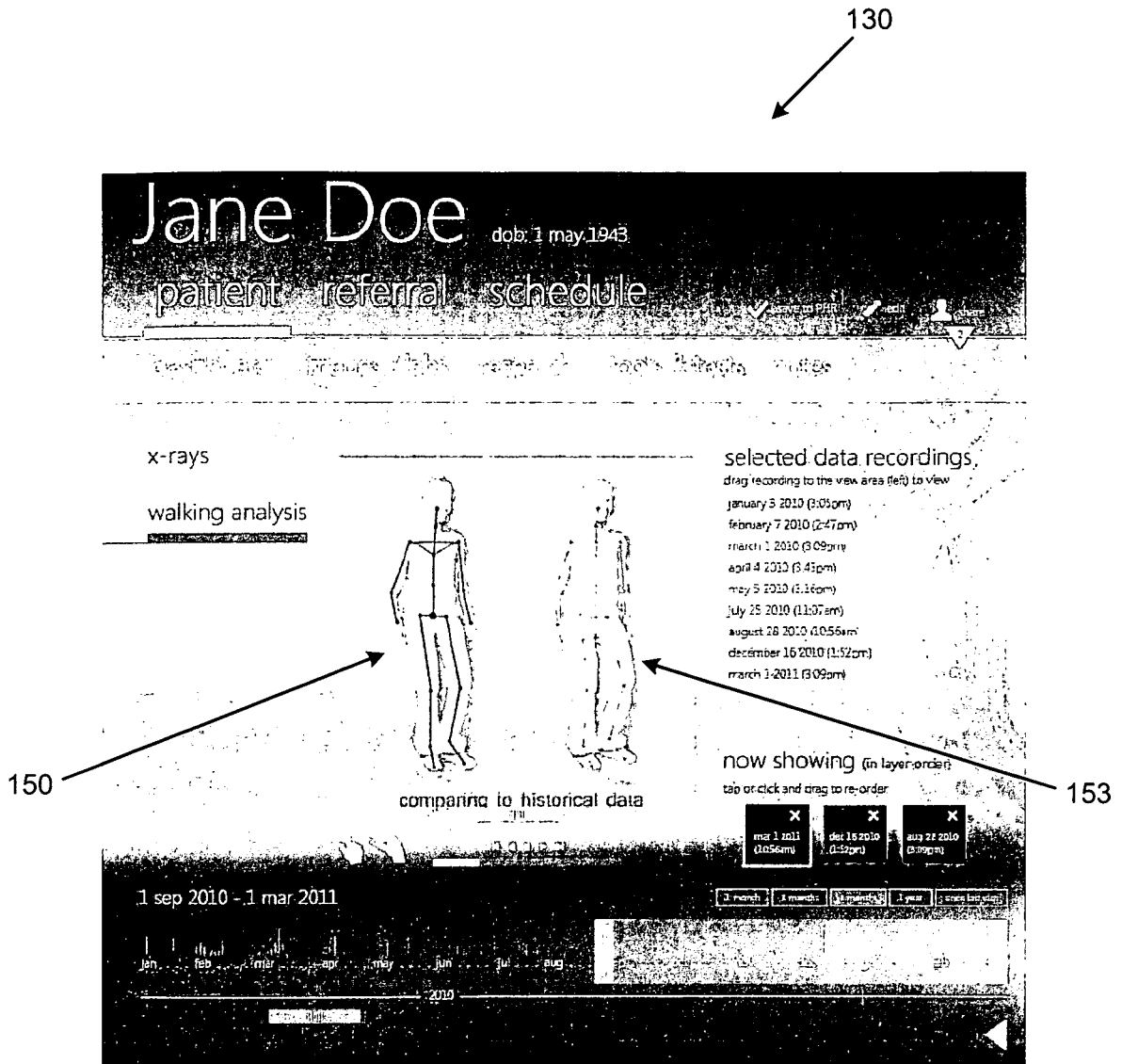


FIG. 8

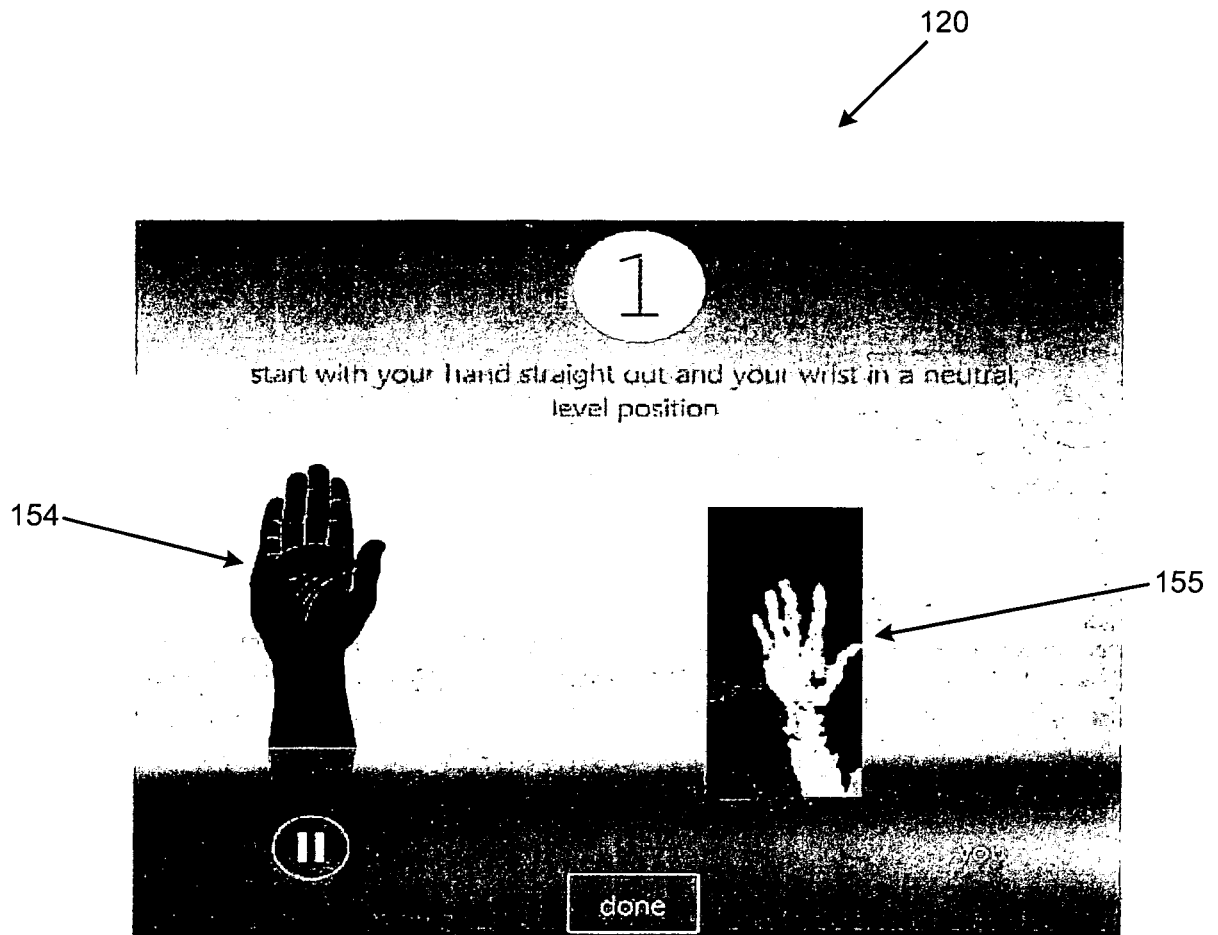


FIG. 9

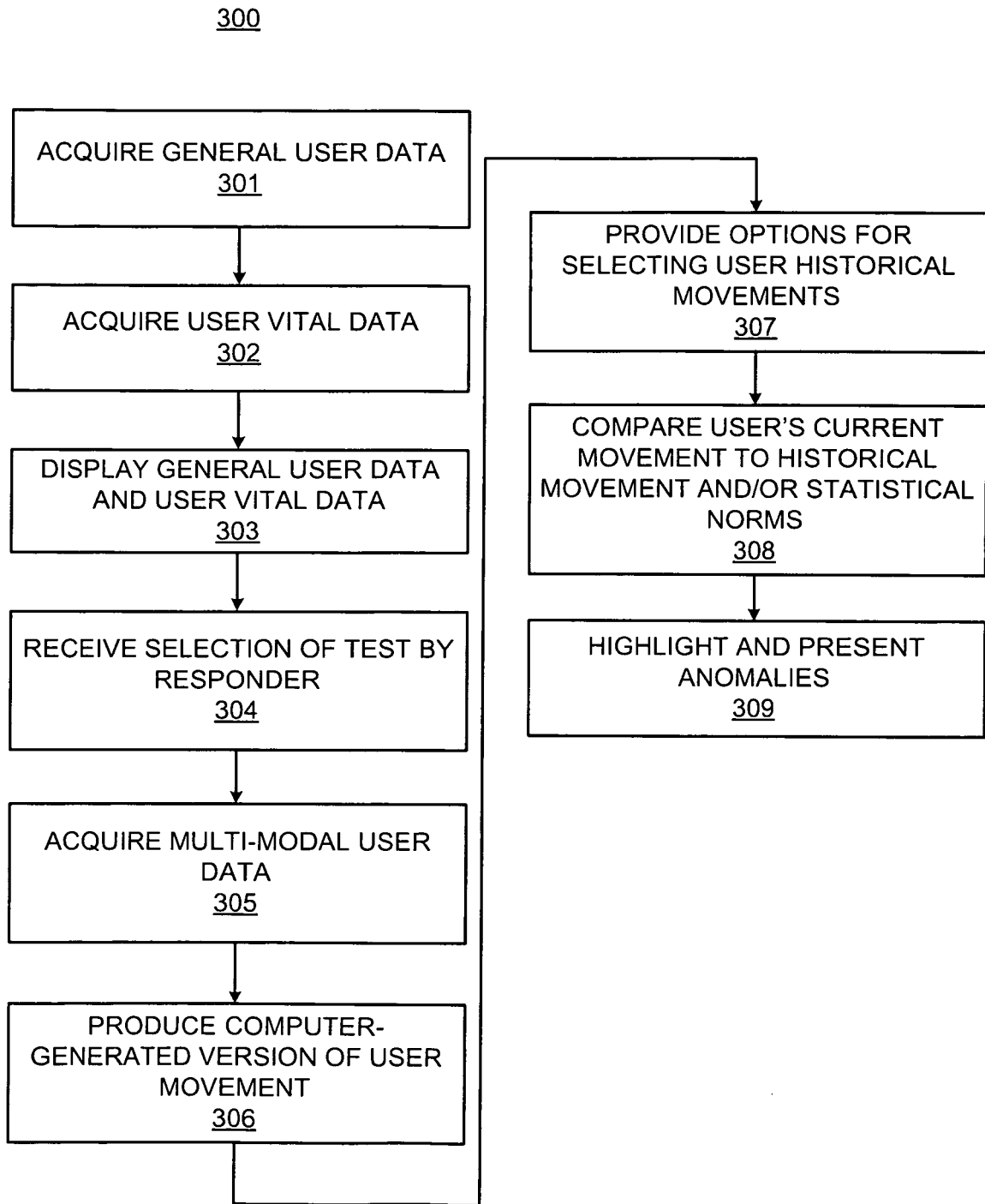


FIG. 10

400

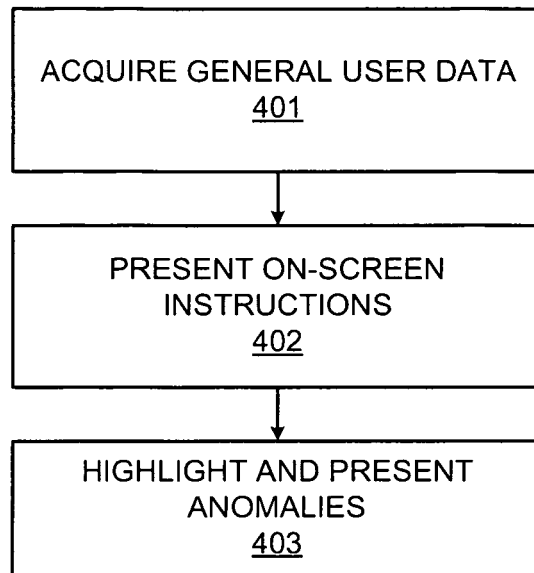


FIG. 11

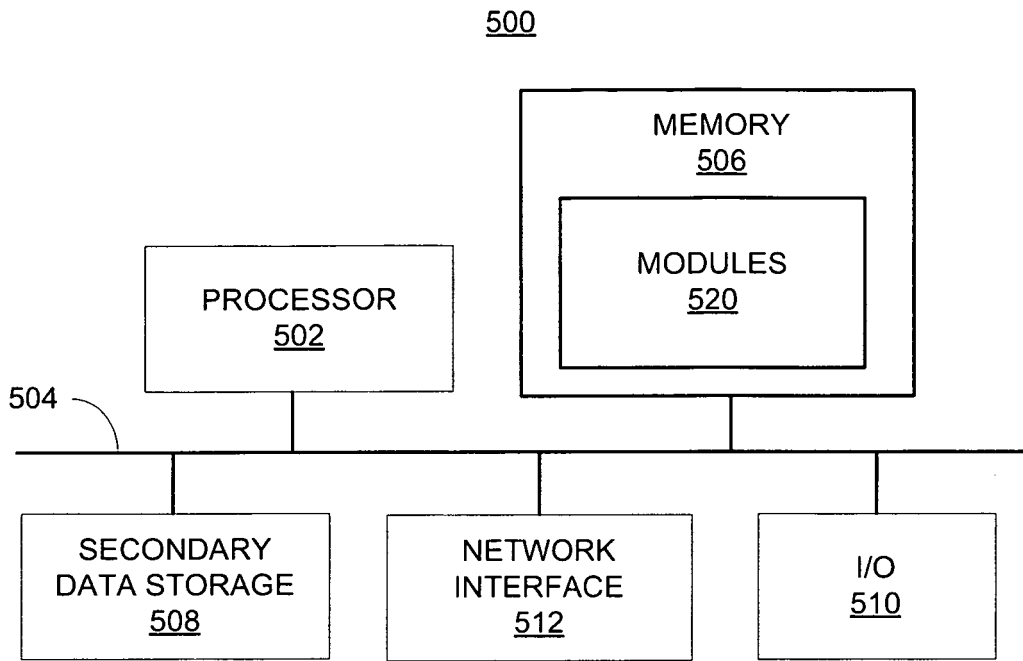


FIG. 12

REFERENCES CITED IN THE DESCRIPTION

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专利名称(译)	互动虚拟护理		
公开(公告)号	EP2560141B1	公开(公告)日	2018-03-14
申请号	EP2012005871	申请日	2012-08-14
[标]申请(专利权)人(译)	埃森哲环球服务有限公司		
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IPC分类号	G06T7/20 A61B5/11 A61B5/00		
CPC分类号	A61B5/0002 A61B5/112 A61B5/4803 A61B5/744 A61B2505/07 A61B34/25 G06T7/0014 G06T2207/10021 G06T2207/10028 G06T2207/30004 G16H10/60 G16H40/67 G16H50/50 G16H50/70 A61B3/0041 A61B5/0062 A61B5/0077 A61B5/11 A61B5/1118 A61B5/6898 A61B34/10 G06F19/00 G06F19/3418 G06K9/00342 G06K9/6202		
优先权	13/213930 2011-08-19 US		
其他公开文献	EP2560141A1		
外部链接	Espacenet		

摘要(译)

交互式虚拟护理系统可以包括用户感知模块，以获取与用户移动相关的多模态用户数据。数据分析模块可以将多模态用户数据与预定历史用户数据和/或统计规范数据进行比较，以便用户识别用户移动中的异常。

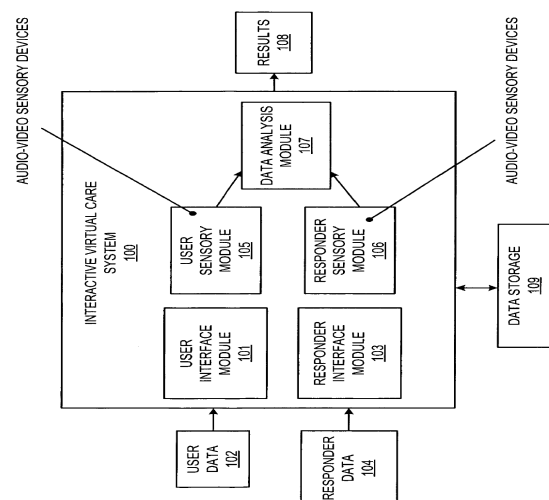


FIG. 1