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(54) **SYSTEM AND METHOD FOR REMOTE MOTOR AND SENSORY FUNCTION TESTING**

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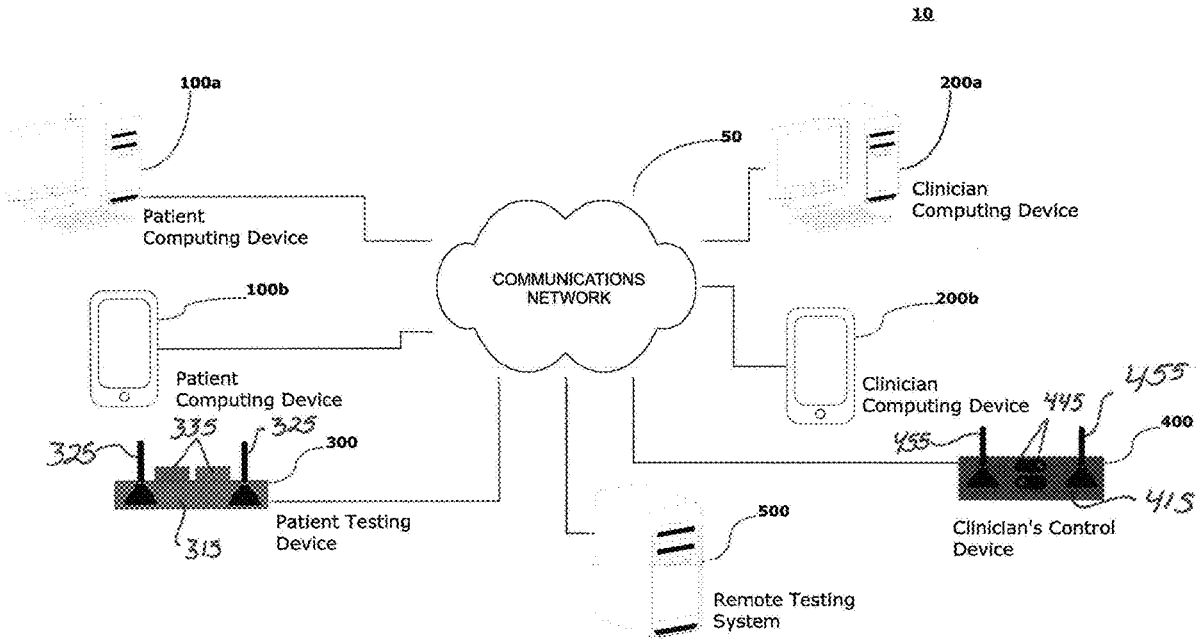
(57) **ABSTRACT**

A system for remote motor and sensory function testing may involve use of patent and clinician computing devices, a patient testing device, and a clinician control device. A Remote Testing System (RTS) may coordinate displays of information among the devices in support of a test. A clinician or the RTS may cause display of instructions for guiding a patient in using the patient testing device. A clinician may receive feedback from the patient's interaction during the test session, or during a later session. The clinician control device may be used to control functioning of the patient testing device, in support of the test. The clinician control device may provide haptic or other feedback during the test session or during a later session. The system may track patient performance across multiple sessions and initiate follow-up test sessions as a result of data gathered in one or more prior test sessions.



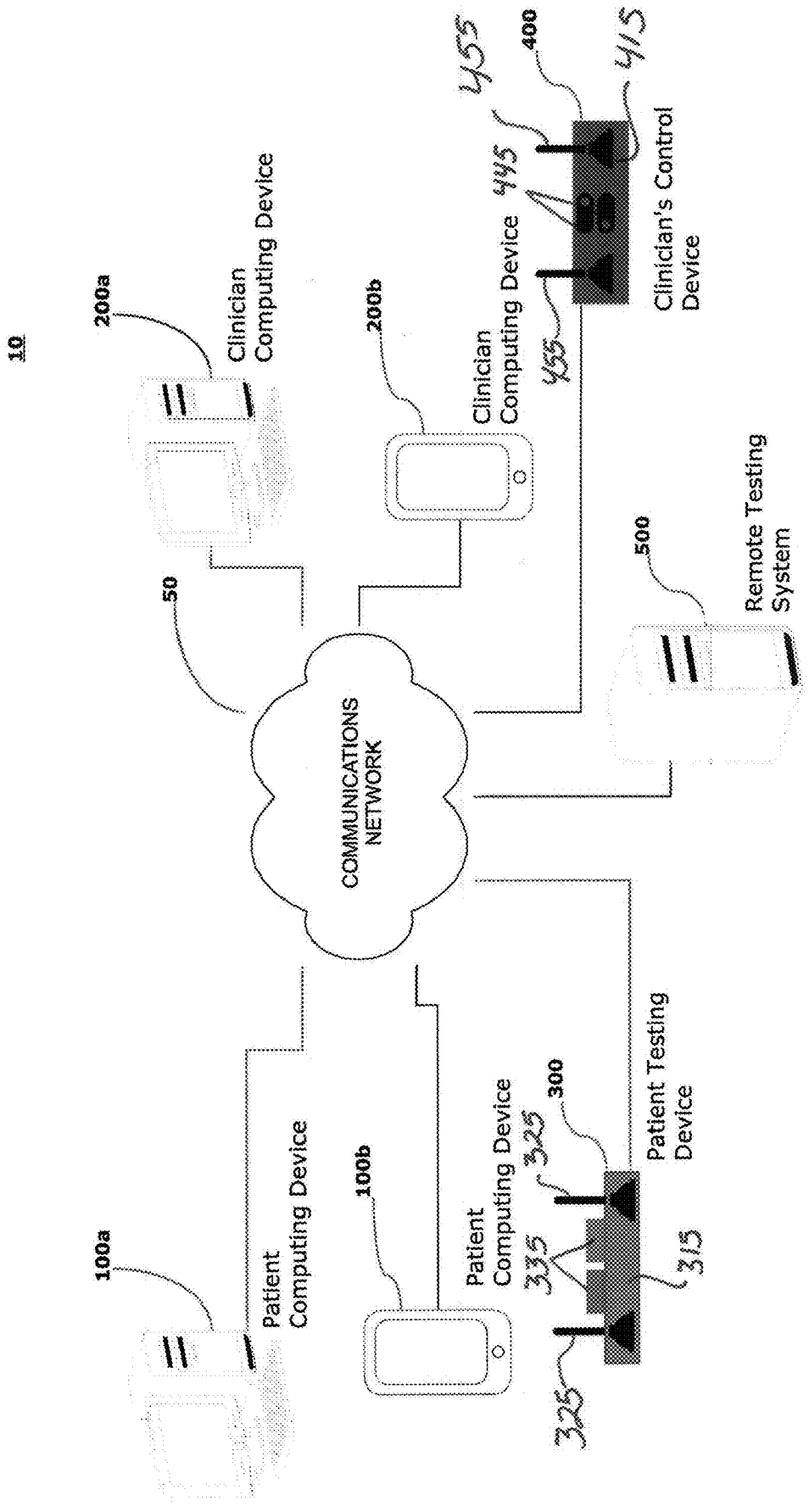

10
200a
Clinician Computing Device
200b
Clinician Computing Device
455
400
415
445
Clinician's Control Device
455
50
COMMUNICATIONS NETWORK
500
Remote Testing System
100a
Patient Computing Device
100b
Patient Computing Device
335
325
300
Patient Testing Device
315
325

Fig. 1

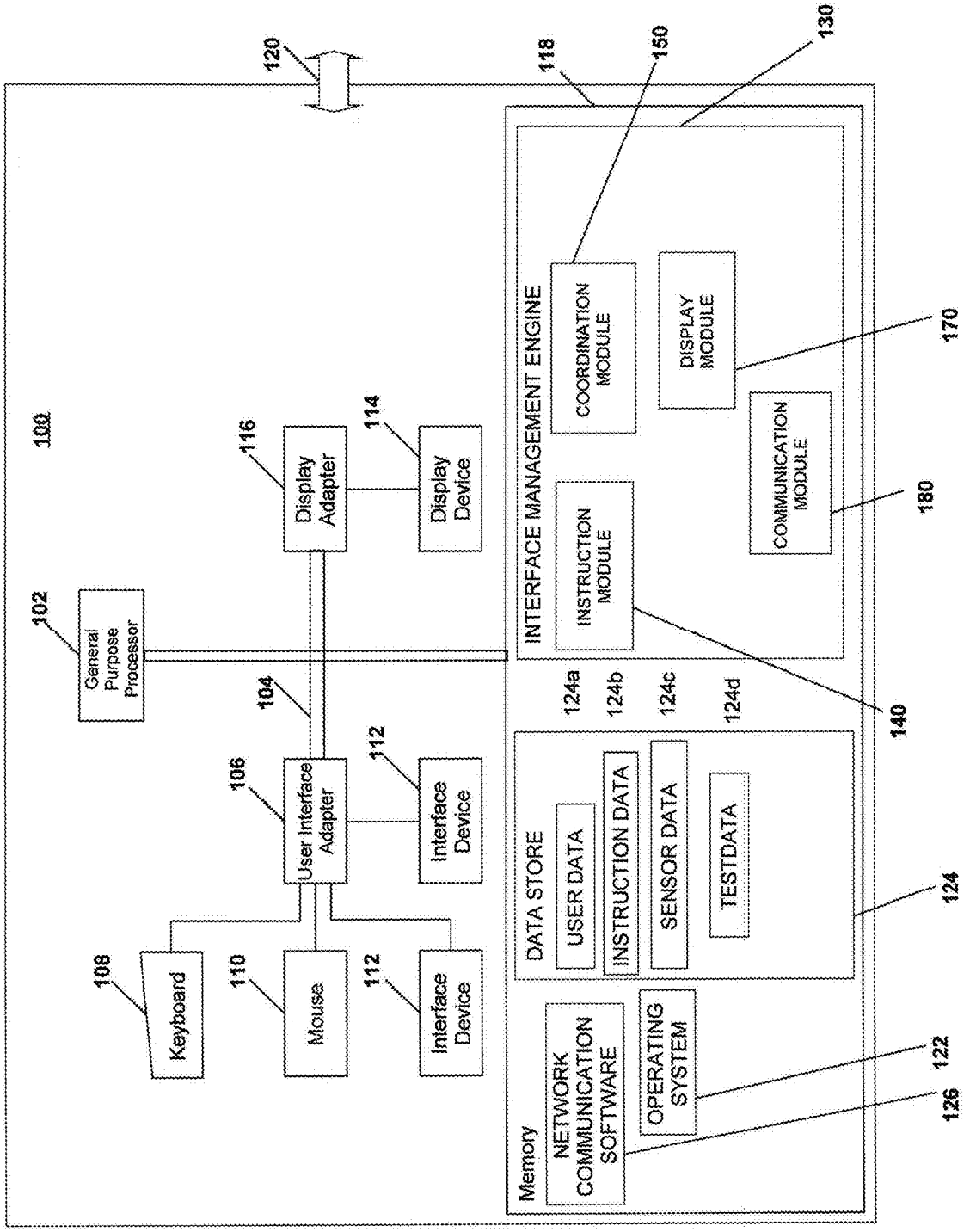
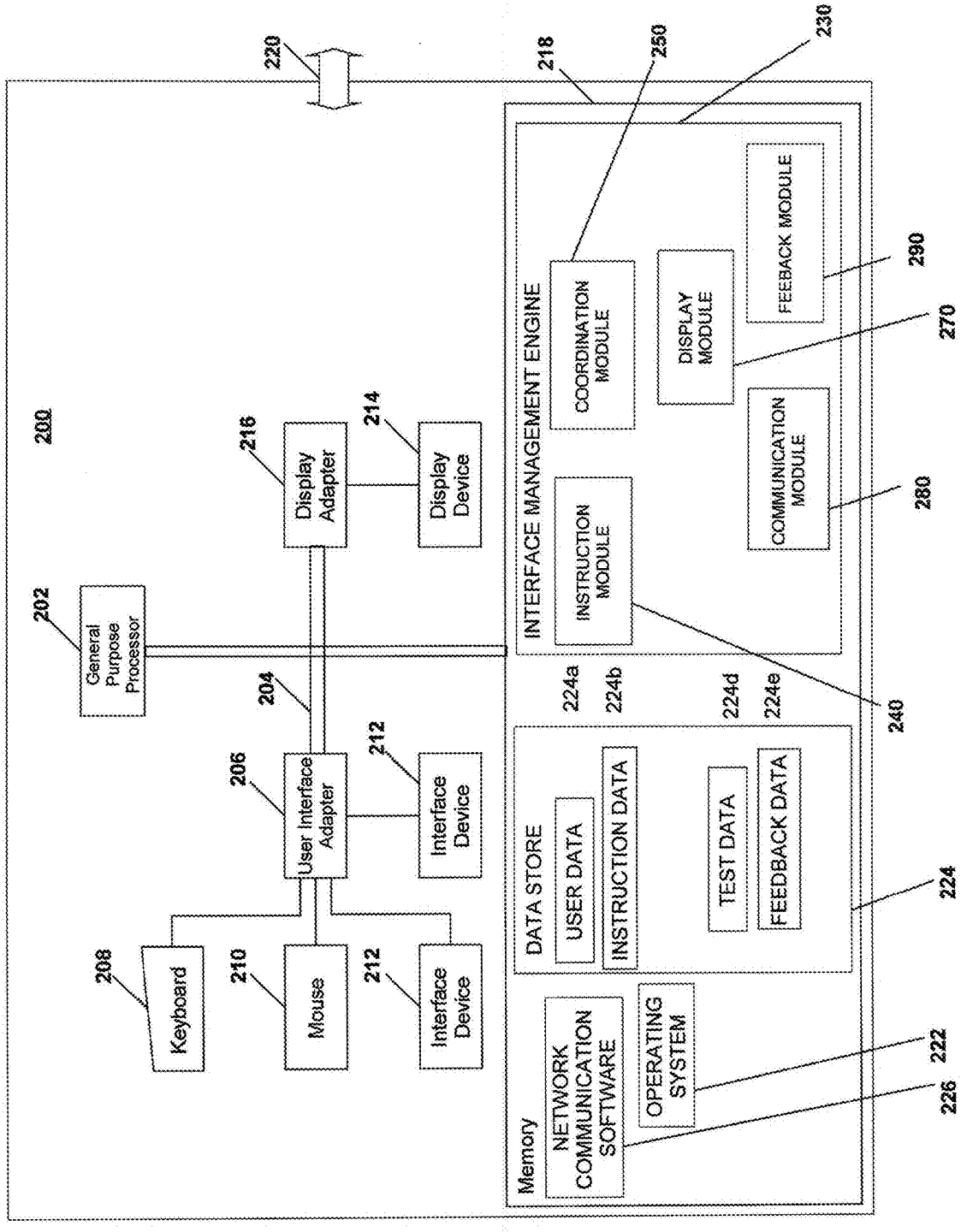

100
120
118
150
130
INTERFACE MANAGEMENT ENGINE
COORDINATION MODULE
DISPLAY MODULE
INSTRUCTION MODULE
COMMUNICATION MODULE
170
180
140
124a
124b
124c
124d
DATA STORE
USER DATA
INSTRUCTION DATA
SENSOR DATA
TESTDATA
124
Memory
NETWORK COMMUNICATION SOFTWARE
OPERATING SYSTEM
122
126
102
General Purpose Processor
104
116
Display Adapter
114
Display Device
106
User Interface Adapter
112
Interface Device
108
Keyboard
110
Mouse
112
Interface Device

Fig. 2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220
218
250
230
INTERFACE MANAGEMENT ENGINE
COORDINATION MODULE
DISPLAY MODULE
FEEBACK MODULE
290
270
INSTRUCTION MODULE
COMMUNICATION MODULE
280
240
224a
224b
224d
224e
DATA STORE
USER DATA
INSTRUCTION DATA
TEST DATA
FEEDBACK DATA
224
Memory
NETWORK COMMUNICATION SOFTWARE
OPERATING SYSTEM
222
226
202
General Purpose Processor
216
Display Adapter
214
Display Device
204
206
User Interface Adapter
212
Interface Device
208
Keyboard
210
Mouse
212
Interface Device

Fig. 3

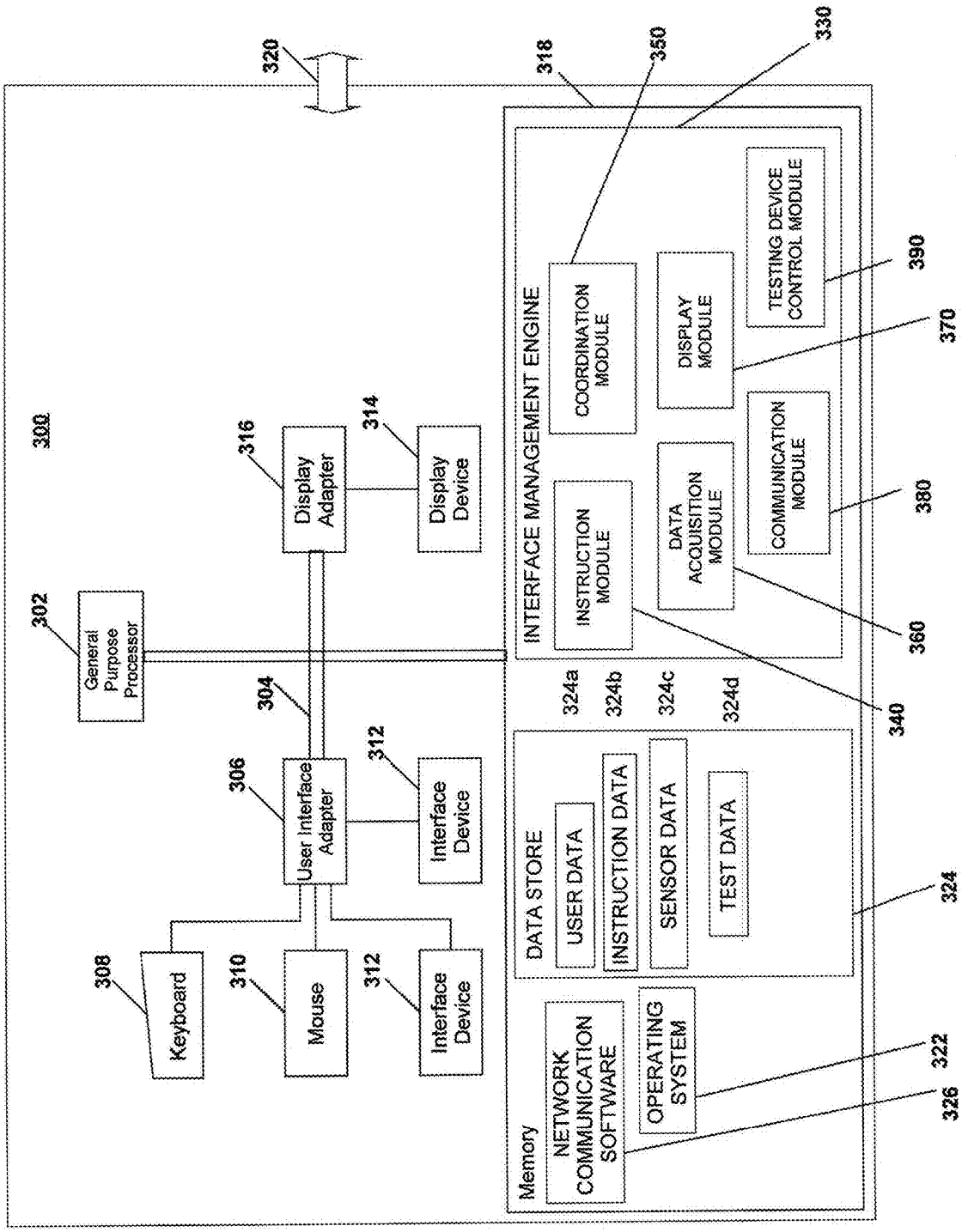
300
320
318
350
330
INTERFACE MANAGEMENT ENGINE
COORDINATION MODULE
DISPLAY MODULE
TESTING DEVICE CONTROL MODULE
INSTRUCTION MODULE
DATA ACQUISITION MODULE
COMMUNICATION MODULE
390
370
380
360
340
324a
324b
324c
324d
DATA STORE
USER DATA
INSTRUCTION DATA
SENSOR DATA
TEST DATA
324
Memory
NETWORK COMMUNICATION SOFTWARE
OPERATING SYSTEM
322
326
General Purpose Processor
302
Display Adapter
316
Display Device
314
User Interface Adapter
306
304
Interface Device
312
Keyboard
308
Mouse
310
Interface Device
312

Fig. 4

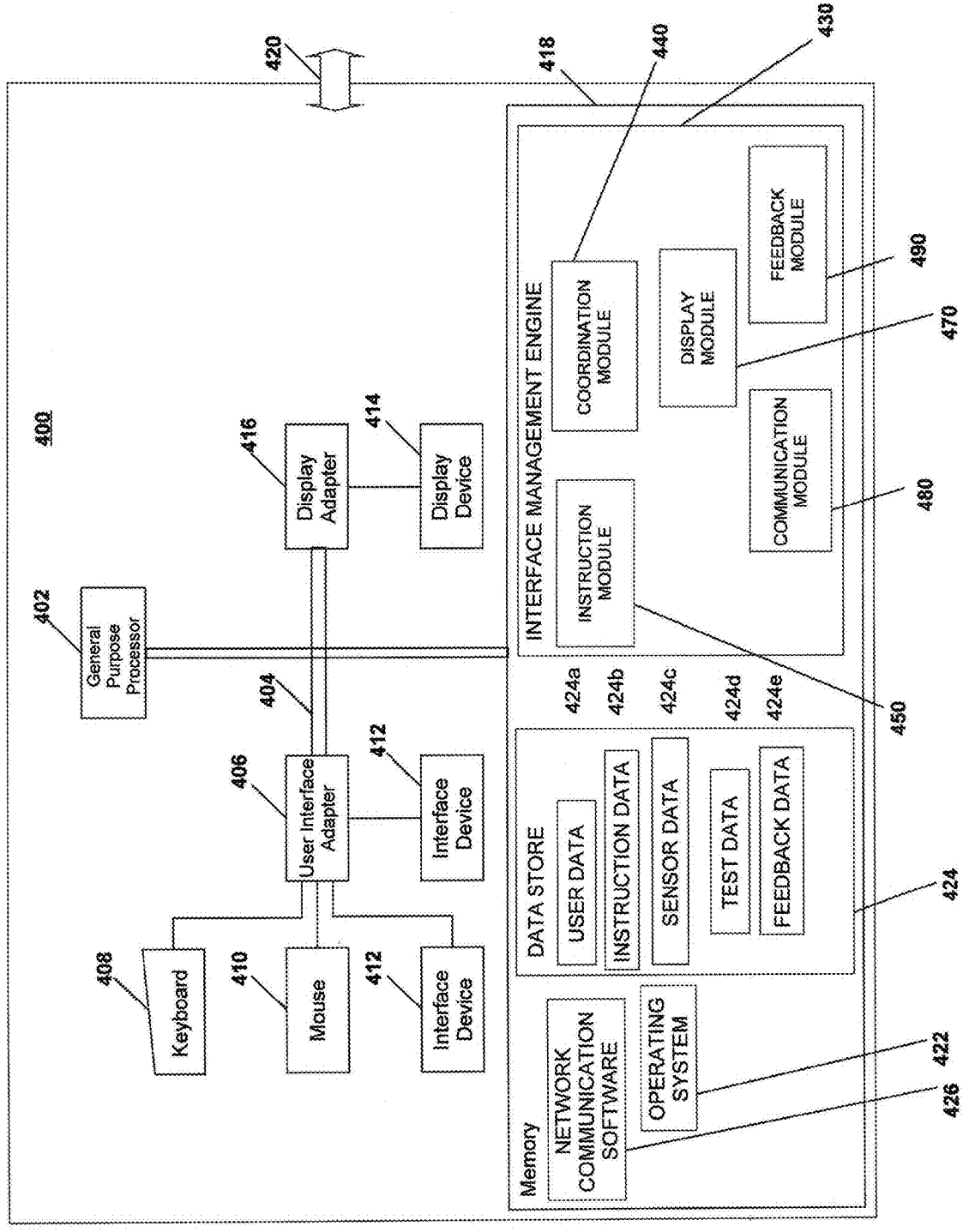
400
420
418
440
430
INTERFACE MANAGEMENT ENGINE
COORDINATION MODULE
DISPLAY MODULE
FEEDBACK MODULE
490
470
INSTRUCTION MODULE
COMMUNICATION MODULE
480
450
402
General Purpose Processor
416
Display Adapter
414
Display Device
404
406
User Interface Adapter
412
Interface Device
408
Keyboard
410
Mouse
412
Interface Device
424a
424b
424c
424d
424e
DATA STORE
USER DATA
INSTRUCTION DATA
SENSOR DATA
TEST DATA
FEEDBACK DATA
424
Memory
NETWORK COMMUNICATION SOFTWARE
OPERATING SYSTEM
422
426

Fig. 5

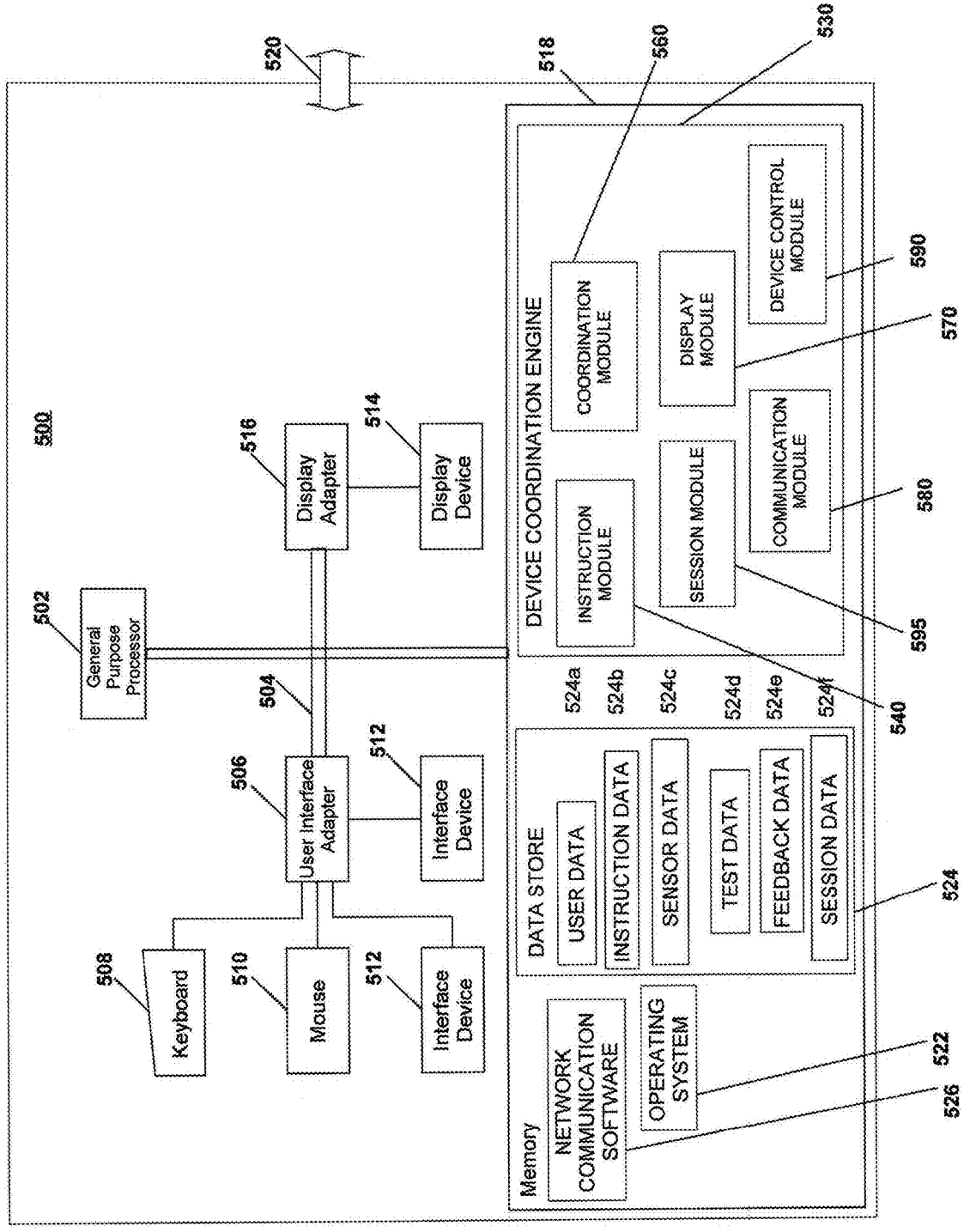
500
520
518
560
530
DEVICE COORDINATION ENGINE
COORDINATION MODULE
DISPLAY MODULE
DEVICE CONTROL MODULE
590
570
INSTRUCTION MODULE
SESSION MODULE
COMMUNICATION MODULE
580
595
540
524a
524b
524c
524d
524e
524f
DATA STORE
USER DATA
INSTRUCTION DATA
SENSOR DATA
TEST DATA
FEEDBACK DATA
SESSION DATA
524
Memory
NETWORK COMMUNICATION SOFTWARE
OPERATING SYSTEM
522
526
General Purpose Processor
502
Display Adapter
516
Display Device
514
User Interface Adapter
504
506
Interface Device
512
Keyboard
508
Mouse
510
Interface Device
512

Fig. 6

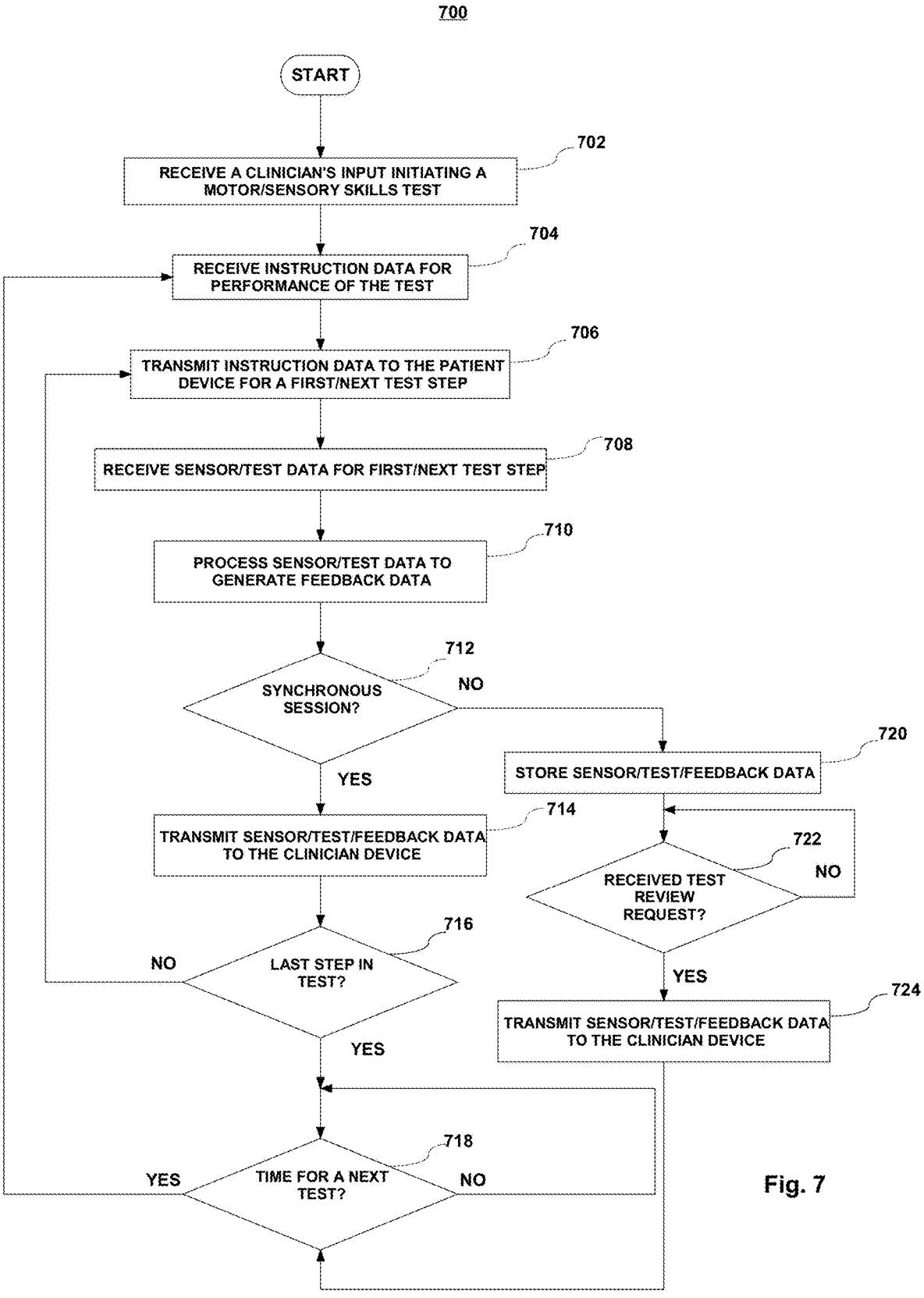
700
START
RECEIVE A CLINICIAN'S INPUT INITIATING A MOTOR/SENSORY SKILLS TEST
702
RECEIVE INSTRUCTION DATA FOR PERFORMANCE OF THE TEST
704
TRANSMIT INSTRUCTION DATA TO THE PATIENT DEVICE FOR A FIRST/NEXT TEST STEP
706
RECEIVE SENSOR/TEST DATA FOR FIRST/NEXT TEST STEP
708
PROCESS SENSOR/TEST DATA TO GENERATE FEEDBACK DATA
710
SYNCHRONOUS SESSION?
712
NO
YES
STORE SENSOR/TEST/FEEDBACK DATA
720
TRANSMIT SENSOR/TEST/FEEDBACK DATA TO THE CLINICIAN DEVICE
714
RECEIVED TEST REVIEW REQUEST?
722
NO
YES
LAST STEP IN TEST?
716
NO
YES
TRANSMIT SENSOR/TEST/FEEDBACK DATA TO THE CLINICIAN DEVICE
724
TIME FOR A NEXT TEST?
718
YES
NO

Fig. 7

SYSTEM AND METHOD FOR REMOTE MOTOR AND SENSORY FUNCTION TESTING

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of priority of U.S. Provisional Patent Application No. 63/254,888, filed Oct. 12, 2021, the entire disclosure of which is hereby incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates generally to computerized systems, and more specifically, to a computerized system and method permitting a clinician to remotely monitor and test a patient's motor and sensory functions.

DISCUSSION OF RELATED ART

[0003] It is often difficult for patients with motor and/or sensory function problems to meet in person, e.g., at a hospital or other care facility, with a physician, nurse or other clinician for the purpose of testing of the patient's motor and sensory functions, which may be necessary for diagnosis and/or management of chronic conditions or disease states.

[0004] Some solutions may exist that use mobile device monitoring for some form of limited clinical assessment, but they are generally "once and done" types of tools that do not provide adequate tools for long-term condition/disease management over time.

[0005] What is needed is a way for a clinician to conduct a motor function and sensory examination when the patient is not physically present with the clinician that provides adequate tools for long-term condition/disease management over multiple sessions in a prolonged period of time.

BRIEF DESCRIPTION OF THE FIGURES

[0006] For a better understanding of the present invention, reference may be made to the accompanying drawings in which:

[0007] FIG. **1** is a system diagram showing an exemplary network computing environment in which the present invention may be employed;

[0008] FIG. **2** is a schematic block diagram illustrating an exemplary and non-limiting embodiment of a Patient Computing Device in accordance with the present invention;

[0009] FIG. **3** is a schematic block diagram illustrating an exemplary and non-limiting embodiment of a Clinician Computing Device in accordance with the present invention;

[0010] FIG. **4** is a schematic block diagram illustrating an exemplary and non-limiting embodiment of a Patient Testing Device in accordance with the present invention;

[0011] FIG. **5** is a schematic block diagram illustrating an exemplary and non-limiting embodiment of a Clinician Control Device in accordance with the present invention;

[0012] FIG. **6** is a schematic block diagram illustrating an exemplary and non-limiting embodiment of a computerized Remote Testing System in accordance with the present invention; and

[0013] FIG. **7** is a flow diagram illustrating operation of the system in accordance with an exemplary and non-limited embodiment of the present invention.

SUMMARY

[0014] The present invention provides a system and method allowing for remote testing of a patient's motor and/or sensory functions when the patient is not physically present with a clinician. Further, the system and method provide tools for long-term condition/disease management by actions taken during multiple sessions over a prolonged period of time.

[0015] A system for remote motor and sensory function testing comprises a memory operatively comprising a non-transitory data processor-readable medium, a data processor operatively connected to the memory, and user interface management instructions embodied in data processor-executable code stored in the memory. The user interface management instructions are executable by the data processor to provide an interface management engine configured to: cause display of instructions for performance of at least one of a motor function test and a sensory test at a remotely located computing device, the instructions comprising instructions for a test involving interacting with a patient testing device by physical contact with the patient testing device, the patient testing device comprising at least one sensor for gathering sensor data as a result of the physical contact; receive sensor data corresponding to the physical contact with the patient testing device; process the sensor data to generate feedback data, the feedback data indicating the patient's interaction with the patient testing device; and transmit the feedback data via a communications network.

[0016] The system may include instructions to store the feedback data in the memory, and the instructions to transmit the feedback data via the communications network may involves retrieving the feedback data from the memory, and wherein the said instructions cause the transmitting in response to a request for transmission of the feedback data at a time after completion of the at least one of the motor function test and the sensory test. Displays of instructions at a patient computing device for using a patient testing device and at a clinician computing device for using a clinician control device may be coordinated in concert in support of performance of the at least one of the motor function test and the sensory test. The instructions may cause display first instruction data at a first time for a first test and display of second instruction data at a second time for a second test, and the causing of display of second instruction data at the second time for the second test may be a result of sending of the second instruction data at the second time as determined automatedly according to data gathered during the first test.

DETAILED DESCRIPTION

[0017] The present invention provides a computerized system that permits a clinician to conduct or review a motor function and/or sensory examination when the patient is not physically present with the clinician. The system may provide for repeated testing of a single patient over time, and may incorporates machine learning or other techniques to analyze results over time and passively transmit/push a personalized testing and/or care plan specific to the user, based on past results over a plurality of testing sessions of that same patient, to provide for long-term condition/disease management for that patient.

[0018] Accordingly, the present invention may be used by neurologists or other healthcare providers within and outside of health systems, by people with motor function and/or sensory impairments.

[0019] More particularly, the present invention provides a computerized system including patient testing device hardware for receiving inputs from a patient/user, and a graphical user interface that is controlled in concert with the patient testing device to allow a clinician (physician, nurse, etc.) to remotely conduct a motor function and sensory examination by having the patient (user) in a remote location position the patient's hands (or other body parts) in contact with a device that contains one or more joysticks, touchpoints, etc. relevant to conducting of the desired motor function and sensory examination tests. The graphical user interface may be included in the patient testing device, or may be provided in a distinct separate device (such as a conventional smartphone, tablet, laptop or personal computer device) that is controlled in concert with the patient testing device hardware.

[0020] For example, one or more joysticks of the patient testing device hardware may allow the user to push and pull their hands in different directions, which may send signals to the centrally-located computerized system and ultimately resulting signals or information to the clinician's device to deliver feedback as to how well the user is performing one or more specified functions.

[0021] By way of further example, the patient testing device's touchpoints may similarly allow the clinician to deliver hot or cold signals (to provided warmed or cooled surfaces at the touchpoints of the patient testing device) to the user for sensory testing. The system, via the graphical user interface, may then ask the patient if he/she can sense the hot or cold sensation. These touchpoints can also be positioned on different body parts, such as legs or arms.

[0022] In certain embodiments, the patient testing device hardware may run embedded software and be tethered via Bluetooth to a tablet computer or phone running custom software that controls the data communication between the user and clinician.

[0023] Similarly, the present invention provides a computerized system including optional clinician control device hardware for receiving inputs from a clinician, and/or a graphical user interface that is controlled in concert with the clinical control device and/or the patient testing device to allow the clinician to remotely conduct a motor function and sensory examination by having the patient (user) in the remote location position the patient's hands (or other body parts) in contact with the patient testing device to conduct the desired motor function and sensory examination tests. The graphical user interface may be included in the clinician control device, or may be provided in a distinct separate device (such as a conventional smartphone, tablet, laptop or personal computer device) that is controlled in concert with the clinician control and/or patient testing device hardware.

[0024] Accordingly, there may be a centrally-located computerized system in data communication providing graphical user interfaces to computerized devices physically located with the clinician and/or with the person/patient, and in data communication with patient testing device hardware physically located with the patient and/or clinician control device hardware physically located with the clinician.

[0025] In certain embodiments, the data forwarded to the physician computing device allows for the physician computing device to provide real-time feedback to the clinician, e.g., by displaying a representation of an intensity of by the patient's hand, as if the user were squeezing the clinician's hand, in a manner corresponding to the patient's squeezing input at the patient testing device.

[0026] In certain other embodiments, the system may provide haptic feedback to the clinician via clinician control device, to provide an opportunity for the clinician to haptically feel a recreation of the patient's input, e.g., equivalent pressure or tension. For example, data forwarded to the clinician control device may allow the clinician control device to provide real-time feedback to the clinician, e.g., by squeezing the clinician's hand, as if the user were squeezing the clinician's hand, in a manner corresponding to the patient's squeezing input at the patient testing device.

[0027] Additionally, the patient/user can use the patient testing device to perform motor and sensory function tests without the clinician's active involvement in a single joint session (in other words, patient and clinician sessions may be asynchronous), and data may be stored by the system for future use and analysis by the clinician. Accordingly, the clinician can select a specific date/time a user performed a test, and then receive/review associated data at another time, including haptic feedback from the clinician control device, according to how the data was recorded by the patient testing device during the user's actual time of taking the test.

[0028] Accordingly, remote motor function and sensory examination may be conducted using software and peripherals, in combination with a virtual (video, chat, call) communication channel.

[0029] In some embodiments, the testing device can be configured to be used as a stand-alone product for the patient/user to monitor the patient's own motor and sensory functions and track progress to report/discuss with a clinician at a later date.

[0030] The clinician control device and/or the Remote Testing System may be configured to transmit/push a personalized testing and/or care plan specific to the user, based on past results over a plurality of testing sessions, after analyzing data from a plurality of testing sessions.

[0031] The Remote Testing System may analyze test results, e.g., using artificial intelligence and/or machine learning techniques, and the results and/or result trends may trigger follow-up actions through artificial intelligence and notify the patient/user when to engage with a clinician and/or provide instructions for a next best step, etc. More particularly, as patients use the system and more data is collected from test performance over one or more sessions (such as how well the patient is performing, the duration of the test, where there is difficulty, etc.) suitable algorithms learn, not only from the patient's data but from data of other users of the system, and incorporate the clinical profile of the patient to perform an analysis for triggering follow-up actions. The outcome of this analysis can be used to make informed decisions on what test a specific patient should do next, when the patient might need to reach out to the patient's physician, and/or give the patient and/or the clinician guidance on next steps.

[0032] According to illustrative embodiment(s) of the present invention, various views are illustrated in FIGS. **1-5** and like reference numerals are used consistently throughout to refer to like and corresponding parts of the invention for all of the various views and figures of the drawings.

[0033] The following detailed description of the invention contains many specifics for the purpose of illustration. Any one of ordinary skill in the art will appreciate that many variations and alterations to the following details are within scope of the invention. Accordingly, the following implementations of the invention are set forth without any loss of generality to, and without imposing limitations upon, the claimed invention.

System Environment

[0034] An exemplary embodiment of the present invention is discussed below for illustrative purposes. FIG. **1** is a system diagram showing an exemplary network computing environment **10** in which the present invention may be employed. As shown in FIG. **1**, the exemplary network environment **10** includes certain conventional computing hardware and software for communicating via a communications network **50**, such as the Internet, etc., using a Patient Computing Devices **100***a*, **100***b* and Clinician Computing Devices **200***a*, **200***b*, each of which may be, for example, one or more personal computers/PCs, laptop computers, tablet computers, smartphones, or other computing system hardware, including computerized/networked communication hardware/software/functionality, such as computer-based servers, kiosks and the like, or other so-called "connected" communication devices having communication capabilities for communicating data via the network and for delivering messages, in any form, to the user, such as smart watches, activity trackers, headphones, ear buds, televisions, or any other computerized and/or internet-of-things type device. By way of example, the term "messages" is used in a broad non-limiting fashion to include messages deliverable a user via such a communication device, such as an e-mail message, a text/SMS or similar "i-message", as well as notifications such as a telephone ring, beep/tone or other audible alert, calendar reminders, alert messages and other displayable textual or graphic notifications designed to notify and/or communicate information to a user of the communication device.

[0035] In accordance with a certain aspect of the present invention, one or more of the Patient Computing Devices and/or Clinician Computing Devices **100***a*, **100***b*, **200***a*, **200***b* is a smartphone, tablet computer, smart watch or other computing device configured to store and execute an "app" or other purpose-specific application software in accordance with the present invention, although this is not required in all embodiments.

[0036] In accordance with another aspect of the present invention, the exemplary network environment **10** includes a Patient Testing Device **300** usable by a patient and capable of delivering stimuli to the user and/or receiving input from the user, that is relevant to a clinician's testing/assessment of the patient's motor and sensory functions, which may be necessary for diagnosis and/or management of chronic conditions or disease states. The Patient Testing Device **300** is further capable of capturing associated data operation of the Patient Testing Device **300** (e.g., the results of testing the patient's motor and sensory functions) and electronically communicating such data or related data to another device, e.g., via the communications network **50**. By way of example, the Patient Testing Device **300** may include a discrete housing **315** such that the device is configured as a discrete, stand-alone device. The housing **315** may support one or more joysticks or levers **325** that are user-manipulable in fashions relevant to testing the of patient's motor functions. Further, for example, the Patient Testing Device **300** may include one or more touchpads **330** that may be selectively heated above or cooled below an ambient temperature in fashions relevant to testing of the patient's sensory functions.

[0037] By way of example, a touchpad may be caused to be heated by causing a flow of electricity through an associated resistive heating element adjacent the touchpad **330** that warms as a result of the flow of electricity. By way of further example, a touchpad may be caused to be cooled by causing a flow of cooled/refrigerated fluid to be circulated through passages adjacent the touchpad **330**, or by releasing a liquid in a chamber adjacent the touchpad **330** that evaporates or sublimes upon release to result in cooling of the touchpad by absorbing heat from the touchpad by a process using the latent heat of vaporization of the liquid. Alternatively, for example, a Peltier semiconductor device may be used to provide a heating or cooling effect by suitable application of electrical current, as will be appreciated by those skilled in the art.

[0038] The Patient Testing Device **300** may include any suitable sensors, devices, structures, control circuitry and/or other mechanisms for delivering the controlled stimuli and/or receiving the desired inputs from the patient, and for communicating associated data as desired. By way of example, the Patient testing Device **300** may include tactile or haptic sensors, squeeze points, or audio output ports to provide a way of connecting noise canceling headphones for output used in hearing testing instead of and/or in addition to one or more joysticks and touchpads capable of delivering stimuli to the user, and/or receiving input from the user, that is relevant to a clinician's testing/assessment of the patient's motor and sensory functions.

[0039] In accordance with another aspect of the present invention, the exemplary network environment **10** includes a Clinician Control Device **400** usable by a clinician and capable of receiving inputs from a clinician to cause delivering of stimuli to the user via the Patient Testing Device **300**, and/or delivering outputs/feedback to the clinician as a result of the patient's inputs provided at the Patient Testing Device **300**, that are relevant to a clinician's testing/assessment of the patient's motor and sensory functions.

[0040] The Clinician Control Device **400** is further capable of capturing data associated with operation of the Clinician Control Device **400** (e.g., the results of the clinician's inputs to the Clinician Control Device) and of processing received data to provide feedback/stimuli and/or control operation of the Clinician Control Device **400** (e.g., to provide haptic feedback to the clinician via devices of the Clinician Control Device **400**), and electronically communicating such data or related data to another device, e.g., via the communications network **50**.

[0041] By way of example, the Clinician Control Device **400** may include a discrete housing **415** such that the device is configured as a discrete, stand-alone device.

[0042] The housing **415** may support one or more switches **445** that may be user-manipulable in fashions relevant to testing of the patient's motor and/or sensory functions at the Patient Testing Device **300**. By way of example, one or more switches **445** may be provided to selectively cause a touchpad **330** to be heated or cooled at the Patient Testing Device **300**.

[0043] Further, the housing **415** may support one or more joysticks or levers **455** that may be user-manipulable in fashions relevant to testing of the patient's motor and/or sensory functions and/or may be driven to provide haptic feedback to a user at the Clinician Control Device **400** based on patient input at the Patient Testing Device **300**. By way of example, movement and/or pressure exerted by a Patient on the joysticks **325** of the Patient Testing Device **300** may be effectively replicated by driving/actuation of the joysticks/levers, a clamp, or other device at the Clinician Control Device, so that the clinician at the Clinician Control Device **400** can effectively feel/experience the actions of the patient at the Patient Testing Device **300**. Accordingly, in addition to real-time sessions between the patient and the clinician, the system may provide for an asynchronous mode of interaction by which the patient interaction is recorded in a cloud computing infrastructure that can be used for later playback on the clinician device. Accordingly, instead of the clinician simply reviewing a textual test result report electronically, the clinician can interact with the Clinician Control Device to experience the patient's input and the associated test results as if they were happening in real-time.

[0044] The Clinician Control Device **400** may include any suitable sensors, devices, structures, control circuitry and/or other mechanisms for delivering the desired feedback/outputs and/or receiving the desired inputs from the clinician, and for communicating associated data as desired. By way of example, the Clinician Control Device **400** may include buttons or potentiometers to deliver signals to be used for various sensory tests including feeling feedback, hearing testing, etc. instead of and/or in addition to one or more joysticks/levels and switches capable of delivering feedback/output to the user, and/or receiving input from the user, that is relevant to a clinician's testing/assessment of the patient's motor and sensory functions.

[0045] In certain embodiments, each of the Patient Testing Device **300** and/or the Clinician Control Device **400** may include a graphical user interface or other display that are controlled in concert with a graphical user interface of other display of the Patient Testing Device **300** and/or the Clinician Control Device **400** and/or one or more of the Patient Computing Devices **100***a*, **100***b* and/or the Clinician Computing Devices **200***a*, **200***b*, to facilitate the clinician and/or patient in performing a remotely conducted motor function and sensory examination.

[0046] In some embodiments, one or both of the PTD **300** and Clinician Computing Device **400** are not discrete, standalone devices. Instead, for example, some or all of the hardware and/or software of a Patient Computing Device **100***a*, **100***b* and a Patient Testing Device **300** may be integrated into a single device. For non-limiting illustrative purposes only, hardware, software and functionality of the Patient Computing Devices **100***a*, **100***b* and the Patient Testing Device **300** are discussed with reference to an exemplary combined device **300** of FIG. **4**. Similarly, some or all of the hardware and/or software of a Clinician Computing Device **200***a*, **200***b* and a Clinician Control Device **300***b* may be integrated into a single device. For non-limiting illustrative purposes only, hardware, software and functionality of the Clinician Computing Devices **200***a*, **200***b* and the Clinician Control Device **400** are discussed with reference to an exemplary combined device **400** of FIG. **5**.

[0047] In accordance with another aspect of the present invention, the exemplary network environment **10** further includes a Remote Testing System (RTS) **500**. By way of example, the RTS **500** may be implements as a software-based process as a web/cloud-based service using conventional hardware and software and additional software providing the functionality described herein. In certain embodiments, the RTS **500** may be modified to include software in accordance with the present invention to provide hardware, software and/or functionality described herein a residing elsewhere in the exemplary network computing environment **10**, or its hardware, software and/or functionality may be incorporated into one or more of the other devices described herein.

[0048] Hardware and software for enabling communication of data by such systems via such communications networks are well known in the art and beyond the scope of the present invention, and thus are not discussed in detail herein.

Patient Computing Device

[0049] FIG. **2** is a schematic block diagram illustrating an exemplary Patient Computing Device (PCD) **100** (e.g., **100***a*, **100***b*) in accordance with an exemplary embodiment of the present invention. In certain embodiments, the PCD **100** may be a general-purpose computer including conventional computing hardware and software that is caused, e.g., under control of the RTS **500**, to cause display information and/or receive inputs from a patient/user in accordance with the present invention. The exemplary PCD **100** is a special-purpose computer system that includes conventional computing hardware storing and executing both conventional software enabling operation of a general-purpose computing system, such as operating system software, network communications software, and also specially-configured computer software for configuring the general purpose hardware as a special-purpose computer system for carrying out at least one method in accordance with the present invention. By way of example, the communications software may include conventional web server software, and the operating system software may include iOS, Android, Windows, Linux software.

[0050] Referring again to FIG. **2**, a block diagram of an exemplary PCD **100** according to some embodiments is shown. In some embodiments, the PCD **100** may, for example, execute, process, facilitate, and/or otherwise be associated with the embodiments described above.

[0051] Accordingly, the exemplary PCD **100** of FIG. **2** includes a general-purpose processor, such as a microprocessor (CPU), **102** and a bus **104** employed to connect and enable communication between the processor **102** and the components of the presentation system in accordance with known techniques. According to some embodiments, the processor **102** may be or include any type, quantity, and/or configuration of processor that is or becomes known. In some embodiments, the processor **102** may comprise multiple inter-connected processors, microprocessors, and/or micro-engines. According to some embodiments, the processor **102** (and/or the system **100** and/or other components thereof) may be supplied power via a power supply (not shown), such as a battery, an Alternating Current (AC) source, a Direct Current (DC) source, an AC/DC adapter, solar cells, and/or an inertial generator.

[0052] The exemplary PCD **100** includes a user interface adapter **106**, which connects the processor **102** via the bus **104** to one or more interface devices, such as a keyboard **108**, mouse **110**, and/or other interface devices **112**, which can be any user interface device, such as a touch sensitive screen, digitized entry pad, etc. The bus **104** also connects a display device **114**, such as an LCD screen or monitor, to the processor **102** via a display adapter **116**.

[0053] The bus **104** also connects the processor **102** to memory **118**, which can include a hard drive, a solid-state drive, an optical drive, a diskette drive, a tape drive, etc. The memory **118** may comprise any appropriate information storage system that is or becomes known or available, including, but not limited to, units and/or combinations of magnetic storage systems (e.g., a hard disk drive), optical storage systems, and/or semiconductor memory systems, such as RAM systems, Read Only Memory (ROM) systems, Single Data Rate Random Access Memory (SDR-RAM), Double Data Rate Random Access Memory (DDR-RAM), and/or Programmable Read Only Memory (PROM).

[0054] The memory **118** may, according to some embodiments, store one or more software components. Any or all of the exemplary instructions and data types described herein and other practicable types of data may be stored in any number, type, and/or configuration of memory systems that is or becomes known. The memory **118** may, for example, comprise one or more data tables or files, databases, table spaces, registers, and/or other storage structures. In some embodiments, multiple databases and/or storage structures (and/or multiple memory systems) may be utilized to store information associated with the system **100**. According to some embodiments, the memory **118** may be incorporated into and/or otherwise coupled to the system **100** (e.g., as shown) or may simply be accessible to the system **100** (e.g., externally located and/or situated).

[0055] The PCD **100** may communicate with other computers or networks of computers, for example via a communications channel, network card, modem or transceiver (collectively, "transceiver") **120**. In some embodiments, the transceiver **120** may comprise any type or configuration of communication system that is or becomes known or practicable. The transceiver **120** may, for example, comprise a Network Interface Card (NIC), a telephonic system, a cellular network system, a router, a hub, a modem, and/or a communications port or cable. According to some embodiments, the transceiver **120** may also or alternatively be coupled to the processor **102**. In some embodiments, the transceiver **120** may comprise an IR, RF, Bluetooth™, Near-Field Communication (NFC), and/or Wi-Fi® network system coupled to facilitate communications between the processor **102** and another system (not shown). The PCD **100** may be associated with such other computers in a local area network (LAN) or a wide area network (WAN), and may operate as a server in a client/server arrangement with another computer, etc. Such configurations, as well as the appropriate communications hardware and software, are known in the art.

[0056] The PCD **100** is specially-configured in accordance with the present invention. Accordingly, as shown in FIG. **2**, the PCD **100** includes computer-readable, processor-executable instructions stored in the memory **118** for carrying out the methods described herein. Further, the memory **118** stores certain data, e.g., in one or more databases or other data stores **124** shown logically in FIG. **2** for illustrative purposes, without regard to any particular embodiment in one or more hardware or software components.

[0057] Further, as will be noted from FIG. **2**, the PCD **100** includes, in accordance with the present invention, a data store **124** and an Interface Management Engine (IME) **130**, shown schematically as stored in the memory **118**, which includes a number of additional modules providing functionality in accordance with the present invention, as discussed in greater detail below. These modules may be implemented primarily by specially-configured software including microprocessor—executable instructions stored in the memory **118** of the PCD **100**. Optionally, other software may be stored in the memory **118** and and/or other data may be stored in the data store **124** or memory **118**. Further, the IME **130** includes one or more modules shown logically in FIG. **2** for illustrative purposes, without regard to any particular embodiment in one or more hardware or software components.

[0058] It should be noted that some of the wording and form of description herein is done to meet applicable statutory requirements. Although the terms "step", "block", "module", "engine", etc. might be used herein to connote different logical components of methods or systems employed and/or for ease of illustration, the terms should not be interpreted as implying any particular order among or between various steps herein disclosed unless and except when the order of individual steps is explicitly described, or be interpreted as implying any distinct structure separate and apart from other structures of the system.

[0059] The IME **130** is operable to store and/or receive instruction data that may be used to gather, store and/or transmit user data, to display text or other instructional cues to a patient, e.g., according to instructions received from a Clinician and/or Clinician Computing Device **200***a*, **200***b* and/or a centralized Remote Testing System **500**, to communicate test or related data to a Clinician Computing Device **200***a*, **200***b* and/or to a centralized Remote Testing System **500**, and in some embodiments, to gather test data resulting from the patient's interactions with a Patient Testing Device **300**, as discussed in greater detail below.

[0060] In part, the PCD **100** stores User Data **124***a* in the data store **124**, e.g., in a database cluster. The User Data **124***a* identifies the user and includes any relevant user-identified and user-associated data, such as contact and communication information, including information for transmitting data to and/or otherwise interfacing with the user's Patient Testing Device **300**, if needed. By way of example, some or all of this information may be provided by or gathered from the user by direct input or by data communication via the network **50** or via a local communication channel (e.g., via Bluetooth) with the user's Patient Testing Device **300**.

[0061] Further, the PCD **100** stores Instruction Data **124***b* in the data store **124**. The Instruction Data **124***b* may be stored in the device as part of pre-configuration, e.g., with a suitable software "app", or may be received as a transmission from another device, such as a Remote Testing System **500** or a Clinician Computing Device **200***a*, **200***b*. For example, the Instruction Data **124***b* may include instructions to cause display of graphical or textual instructional cues, or to reproduce audible cues, etc., to provide instructions to the user/patient for operation of the Patient Testing device **300** in accordance with requirements of a sensory and/or motor skills test.

[0062] The IME **130** includes an Instruction Module (IM) **140** that is operable to receive and/or retrieve User Data **124***a* and/or Instruction Data **124***b* from the data store **124** and to display (e.g., using the Display Module **170**) or otherwise provide suitable instructions via the hardware (e.g., Display Device **114**) of the PCD **100** for guiding the patient to use the Patient Testing Device **300** as desired as part of a sensory and/or motor skills test.

[0063] The IME **130** further includes a Coordination Module (CM) **150** that is operable to receive data from an external computing device, such as the Remote Testing System **500**, Clinician Computing Device **200**, or even the Clinician Control Device **400**, to synchronize or otherwise coordinate the operation of the Clinician Computing Device **200** and/or Clinician Control Device **400** with operation of the Patient Computing Device **100** and/or the Patient Testing Device **300**. For example, a clinician may operate a switch at the Clinician Control Device **400** and/or provide input at the Clinician Computing Device **200** to initiate the performance of a particular motor and/or sensory skill test, and the Coordination Module may detect, track or otherwise be informed of such event and may act in concert with the Instruction Module **140** and/or the Display Module **170** to cause corresponding instructions, from the Instruction Data **124**, to be displayed, at an appropriate time, to the user to cause the user to take action to interact with the Patient Testing Device in a manner suitable for performance of the test, e.g., based on instructions displayed or otherwise delivered via the PCD **100**.

[0064] In certain embodiments, the IME **130** further includes a Communication Module (COM) **180**. The COM **180** is operable to communicate data via the network **50**, e.g., to send and/or receiving instructions, data, test results, etc. In certain embodiments, the COM **180** is operable to communicate with a nearby Patient Testing Device **300**, such as via a Bluetooth short-range wireless connection, and store Test Data **124***d* and communicate such data or related data to an external computing device.

[0065] Accordingly, the PCD **100** may be configured to operate as a distinct, separate device for delivering communications to a patient in coordination with actions taken at a Clinician Computing Device **200** or Clinician Control Device **400**, or under common control of a Remote Testing System **500**, to deliver instructions to a patient to guide the patient in taking a motor skills and/or sensory test.

Clinician Computing Device

[0066] FIG. **3** is a schematic block diagram illustrating an exemplary Clinician Computing Device (CCD) **200** (e.g., **200***a*, **200***b*) in accordance with an exemplary embodiment of the present invention. In certain embodiments, the CCD **200** may be a general-purpose computer including conventional computing hardware and software that is caused, e.g., under control of the RTS **500**, to cause display information and/or receive inputs from a clinician/user in accordance with the present invention. The exemplary CCD **100** is a special-purpose computer system that includes conventional computing hardware storing and executing both conventional software enabling operation of a general-purpose computing system, such as operating system software, network communications software, and also specially-configured computer software for configuring the general purpose hardware as a special-purpose computer system for carrying out at least one method in accordance with the present invention. By way of example, the communications software may include conventional web server software, and the operating system software may include iOS, Android, Windows, Linux software.

[0067] Referring again to FIG. **3**, a block diagram of an exemplary CCD **200** according to some embodiments is shown. In some embodiments, the CCD **200** may, for example, execute, process, facilitate, and/or otherwise be associated with the embodiments described above.

[0068] Accordingly, the exemplary CCD **200** of FIG. **3** includes a general-purpose processor, such as a microprocessor (CPU), **202** and a bus **204** employed to connect and enable communication between the processor **202** and the components of the presentation system in accordance with known techniques. According to some embodiments, the processor **202** may be or include any type, quantity, and/or configuration of processor that is or becomes known. In some embodiments, the processor **202** may comprise multiple inter-connected processors, microprocessors, and/or micro-engines. According to some embodiments, the processor **202** (and/or the system **200** and/or other components thereof) may be supplied power via a power supply (not shown), such as a battery, an Alternating Current (AC) source, a Direct Current (DC) source, an AC/DC adapter, solar cells, and/or an inertial generator.

[0069] The exemplary CCD **200** includes a user interface adapter **206**, which connects the processor **202** via the bus **204** to one or more interface devices, such as a keyboard **208**, mouse **220**, and/or other interface devices **212**, which can be any user interface device, such as a touch sensitive screen, digitized entry pad, etc. The bus **204** also connects a display device **214**, such as an LCD screen or monitor, to the processor **202** via a display adapter **216**.

[0070] The bus **204** also connects the processor **202** to memory **218**, which can include a hard drive, a solid-state drive, an optical drive, a diskette drive, a tape drive, etc. The memory **218** may comprise any appropriate information storage system that is or becomes known or available, including, but not limited to, units and/or combinations of magnetic storage systems (e.g., a hard disk drive), optical storage systems, and/or semiconductor memory systems, such as RAM systems, Read Only Memory (ROM) systems, Single Data Rate Random Access Memory (SDR-RAM), Double Data Rate Random Access Memory (DDR-RAM), and/or Programmable Read Only Memory (PROM).

[0071] The memory **218** may, according to some embodiments, store one or more software components. Any or all of the exemplary instructions and data types described herein and other practicable types of data may be stored in any number, type, and/or configuration of memory systems that is or becomes known. The memory **218** may, for example, comprise one or more data tables or files, databases, table spaces, registers, and/or other storage structures. In some embodiments, multiple databases and/or storage structures (and/or multiple memory systems) may be utilized to store information associated with the system **200**. According to some embodiments, the memory **218** may be incorporated into and/or otherwise coupled to the system **200** (e.g., as shown) or may simply be accessible to the system **200** (e.g., externally located and/or situated).

[0072] The CCD **200** may communicate with other computers or networks of computers, for example via a communications channel, network card, modem or transceiver (collectively, "transceiver") **220**. In some embodiments, the

transceiver **220** may comprise any type or configuration of communication system that is or becomes known or practicable. The transceiver **220** may, for example, comprise a Network Interface Card (NIC), a telephonic system, a cellular network system, a router, a hub, a modem, and/or a communications port or cable. According to some embodiments, the transceiver **220** may also or alternatively be coupled to the processor **202**. In some embodiments, the transceiver **220** may comprise an IR, RF, Bluetooth™, Near-Field Communication (NFC), and/or Wi-Fi® network system coupled to facilitate communications between the processor **202** and another system (not shown). The PCD **200** may be associated with such other computers in a local area network (LAN) or a wide area network (WAN), and may operate as a server in a client/server arrangement with another computer, etc. Such configurations, as well as the appropriate communications hardware and software, are known in the art.

[0073] The CCD **200** is specially-configured in accordance with the present invention. Accordingly, as shown in FIG. **2**, the CCD **200** includes computer-readable, processor-executable instructions stored in the memory **218** for carrying out the methods described herein. Further, the memory **218** stores certain data, e.g., in one or more databases or other data stores **224** shown logically in FIG. **3** for illustrative purposes, without regard to any particular embodiment in one or more hardware or software components.

[0074] Further, as will be noted from FIG. **3**, the CCD **200** includes, in accordance with the present invention, a data store **224** and an Interface Management Engine (IME) **230**, shown schematically as stored in the memory **218**, which includes a number of additional modules providing functionality in accordance with the present invention, as discussed in greater detail below. These modules may be implemented primarily by specially-configured software including microprocessor—executable instructions stored in the memory **218** of the CCD **200**. Optionally, other software may be stored in the memory **218** and and/or other data may be stored in the data store **224** or memory **218**. Further, the IME **230** includes one or more modules shown logically in FIG. **3** for illustrative purposes, without regard to any particular embodiment in one or more hardware or software components.

[0075] The IME **230** is operable to store and/or receive instruction data that may be used to gather, store and/or transmit user data, to display text or other instructional cues to a clinician, e.g., according to instructions or other data received from a Patient Computing Device **100***a*, **100***b* and/or a centralized Remote Testing System **500**, to communicate instruction, test or other related data to a Patient Computing Device **100***a*, **100***b* and/or to a centralized Remote Testing System **500**, and in some embodiments, to receive test data resulting from the patient's interactions with a Patient Testing Device **300**, as discussed in greater detail below.

[0076] In part, the CCD **200** stores User Data **224***a* in the data store **224**, e.g., in a database cluster. The User Data **224***a* identifies the patient and/or clinician user and includes any relevant user-identified and user-associated data, such as contact and communication information, including information for transmitting data to and/or otherwise interfacing with the user's Patient Computing Device **100** and/or Patient Testing Device **300**, if needed. By way of example, some or all of this information may be provided by or gathered from the user by direct input or by data communication via the network **50** or via a local communication channel (e.g., via Bluetooth) with the clinician's Clinician Control Device **300**.

[0077] Further, the CCD **200** stores Instruction Data **224***b* in the data store **224**. The Instruction Data **224***b* may be stored in the device as part of pre-configuration, e.g., with a suitable software "app", or may be received as a transmission from another device, such as a Remote Testing System **500** or a Patient Computing Device **100***a*, **100***b*. For example, the Instruction Data **224***b* may include instructions to cause display of graphical or textual instructional cues, or to reproduce audible cues, etc., to provide instructions to the clinician via the CCD **200** and/or the Clinician Control Device **300** and/or to the Patient Computing Device **100***a*, **100***b* and/or to the user/patient via the Patient Testing device **300** in accordance with requirements of a sensory and/or motor skills test.

[0078] The IME **230** includes an Instruction Module (IM) **240** that is operable to receive and/or retrieve User Data **224***a* and/or Instruction Data **224***b* from the data store **224** and to display (e.g., using the Display Module **270**) or otherwise provide suitable instructions via the hardware (e.g., Display Device **214**) of the CCD **200** for guiding the clinician to use the Clinician Computing Device **200** and/or the Clinician Control Device **300** and/or for guiding the patient to use the Patient Computing Device **100** and/or the Patient Testing Device **300** as desired as part of a sensory and/or motor skills test.

[0079] The IME **230** further includes a Coordination Module (CM) **250** that is operable to send data to and/or receive data from an external computing device, such as the Remote Testing System **500**, Patient Computing Device **100**, the Patient Testing Device **300** and/or the Clinician Control Device **400**, to synchronize or otherwise coordinate the operation of the CCD **200** and/or Clinician Control Device **400** with operation of the PCD **100** and/or the Patient Testing Device **300**. For example, a clinician may operate a switch at the Clinician Control Device **400** and/or provide input at the CCD **200** to initiate the performance of a particular motor and/or sensory skill test, and the Coordination Module **250** may detect, track or otherwise be informed of such event and may act in concert with the Instruction Module **240** and/or the Display Module **270** to cause corresponding instructions, e.g., from the Instruction Data **224**, to be displayed, at an appropriate time, to the clinician and/or patient/user to cause the patient to take action to interact with the Patient Testing Device **300** in a manner suitable for performance of a motor or sensory skills test, e.g., based on instructions displayed or otherwise delivered via the CCD **200**.

[0080] In certain embodiments, the IME **230** further includes a Communication Module (COM) **280**. The COM **280** is operable to communicate data via the network **50**, e.g., to send and/or receiving instructions, data, test results, etc. In certain embodiments, the COM **280** is operable to communicate with a nearby Clinician Control Device **400**, such as via a Bluetooth short-range wireless connection, and store Test Data **224***d* and communicate such data or related data to an external computing device.

[0081] Additionally, in certain embodiments, the IME **230** further includes a Feedback Module (FM) **290**. Acting in concert with the COM **280**, the FM **290** is operable to receive Test Data **224** via the network **50** and to create/

generate corresponding feedback data, to store such Feedback Data **224***e* in the data store **224**, and to transmit a suitable feedback control signal to the Clinician Control Device **400** (or the CCD **200**) to cause the Clinician Control Device **400** (or CCD **200**) to operate to provide feedback to the clinician as a function of input provided by the patient to the Patient Testing Device **300**. For example, a control signal may be used to cause display on a display device **214** of the CCD **200** to show a chart, graph, metric or other indicator of hand gripping force exerted by the patient on the joystick(s) of the PTD **300**. By way of alternative example, a control signal may be used to provide haptic feedback on the Clinician Control Device **400** cause operation of the joystick (s)/levers **455** to provide mechanical/force feedback corresponding to the hand gripping force exerted by the patient on the joystick(s) of the PTD **300**.

[0082] Accordingly, the CCD **200** may be configured to operate as a distinct, separate device for transmitting communications to a patient in coordination with actions taken at the Clinician Computing Device **200** or Clinician Control Device **400**, or under common control of a Remote Testing System **500**, to deliver instructions to a patient to guide the patient in using the PCD **100** and/or Patient Testing Device **300** in taking a motor skills and/or sensory test.

Patient Testing Device

[0083] FIG. **4** is a schematic block diagram illustrating an exemplary and non- limiting embodiment of a Patient Testing Device (PTD) **300** in accordance with the present invention. In certain embodiments, the PTD **300** is a special-purpose device that may be used as a stand-alone device, or as a peripheral or other device associated with and used to communicate with a PCD **100** or other general-purpose computing device, such as a smartphone or tablet computing device. In such an embodiment, the PTD **300** may include primarily the housing **315** and joysticks/levers **325**, touchpads and associated heating/cooling hardware and/or such other devices/mechanisms/sensors for performing the desired motor and/or sensory skills tests and such other data gathering, storage and communication components as may be desired, e.g., for communicating associated data to a PCD **100** or to another computing device. Accordingly, the PTD **300** may not include general-purpose computing hardware of a type similar to that described above in relating to the PCD **100**. Rather, the PTD **300** may communication with the PCD **100** including such hardware and software.

[0084] Alternatively, however, as shown in the example of FIG. **4**, the PTD **300** does include such general-purpose computing hardware and software. In such a case, the PCD **100** and the PTD **300** may be effective integrated into a single device, and it may be possible to operate the system satisfactorily without use of the PCD **100**. In such a case, structure at, and functions performed, by the PCD **100** may be provided at or be performed by the PTD **300** instead of the PCD **100**.

[0085] Accordingly, the exemplary PTD **300** is a special-purpose device that includes conventional computing hardware storing and executing both conventional software enabling operation of a general-purpose computing system, such as operating system software, network communications software, etc. as described above and also specially-configured hardware and computer software for configuring the PTD **300** as a special-purpose device in accordance with the present invention. The PTD **300** is caused, e.g., under control of the RTS **500**, to display information and/or receive inputs from a patient/user in accordance with the present invention.

[0086] Accordingly, the exemplary PTD **300** of FIG. **4** includes a general-purpose processor, such as a microprocessor (CPU), **302** and a bus **304** employed to connect and enable communication between the processor **302** and the components of the presentation system in accordance with known techniques. According to some embodiments, the processor **302** may be or include any type, quantity, and/or configuration of processor that is or becomes known. In some embodiments, the processor **302** may comprise multiple inter-connected processors, microprocessors, and/or micro-engines. According to some embodiments, the processor **302** (and/or the system **300** and/or other components thereof) may be supplied power via a power supply (not shown), such as a battery, an Alternating Current (AC) source, a Direct Current (DC) source, an AC/DC adapter, solar cells, and/or an inertial generator.

[0087] The exemplary PTD **300** includes a user interface adapter **306**, which connects the processor **302** via the bus **304** to one or more interface devices, such as a keyboard **308**, mouse **310**, and/or other interface devices **312**, which can be any user interface device, such as a touch sensitive screen, digitized entry pad, etc. The bus **304** also connects a display device **314**, such as an LCD screen or monitor, to the processor **302** via a display adapter **316**.

[0088] The bus **304** also connects the processor **302** to memory **318**, which can include a hard drive, a solid-state drive, an optical drive, a diskette drive, a tape drive, etc. The memory **318** may comprise any appropriate information storage system that is or becomes known or available, including, but not limited to, units and/or combinations of magnetic storage systems (e.g., a hard disk drive), optical storage systems, and/or semiconductor memory systems, such as RAM systems, Read Only Memory (ROM) systems, Single Data Rate Random Access Memory (SDR-RAM), Double Data Rate Random Access Memory (DDR-RAM), and/or Programmable Read Only Memory (PROM).

[0089] The memory **318** may, according to some embodiments, store one or more software components. Any or all of the exemplary instructions and data types described herein and other practicable types of data may be stored in any number, type, and/or configuration of memory systems that is or becomes known. The memory **318** may, for example, comprise one or more data tables or files, databases, table spaces, registers, and/or other storage structures. In some embodiments, multiple databases and/or storage structures (and/or multiple memory systems) may be utilized to store information associated with the system **300**. According to some embodiments, the memory **318** may be incorporated into and/or otherwise coupled to the system **300** (e.g., as shown) or may simply be accessible to the system **300** (e.g., externally located and/or situated).

[0090] The PTD **300** may communicate with other computers or networks of computers, for example via a communications channel, network card, modem or transceiver (collectively, "transceiver") **320**. In some embodiments, the transceiver **320** may comprise any type or configuration of communication system that is or becomes known or practicable. The transceiver **320** may, for example, comprise a Network Interface Card (NIC), a telephonic system, a cellular network system, a router, a hub, a modem, and/or a communications port or cable. According to some embodi-

ments, the transceiver **320** may also or alternatively be coupled to the processor **302**. In some embodiments, the transceiver **320** may comprise an IR, RF, Bluetooth™, Near-Field Communication (NFC), and/or Wi-Fi® network system coupled to facilitate communications between the processor **302** and another system (not shown). The PTD **300** may be associated with such other computers in a local area network (LAN) or a wide area network (WAN), and may operate as a server in a client/server arrangement with another computer, etc. Such configurations, as well as the appropriate communications hardware and software, are known in the art.

[0091] The PTD **300** is specially-configured in accordance with the present invention. Accordingly, as shown in FIG. **2**, the PTD **300** includes computer-readable, processor-executable instructions stored in the memory **318** for carrying out the methods described herein. Further, the memory **318** stores certain data, e.g., in one or more databases or other data stores **324** shown logically in FIG. **4** for illustrative purposes, without regard to any particular embodiment in one or more hardware or software components.

[0092] Further, as will be noted from FIG. **4**, the PTD **300** includes, in accordance with the present invention, a data store **324** and an Interface Management Engine (IME) **330**, shown schematically as stored in the memory **318**, which includes a number of additional modules providing functionality in accordance with the present invention, as discussed in greater detail below. These modules may be implemented primarily by specially-configured software including microprocessor—executable instructions stored in the memory **318** of the PTD **300**. Optionally, other software may be stored in the memory **318** and and/or other data may be stored in the data store **324** or memory **318**. Further, the IME **330** includes one or more modules shown logically in FIG. **4** for illustrative purposes, without regard to any particular embodiment in one or more hardware or software components.

[0093] The IME **330** is operable to store and/or receive instruction data that may be used to gather, store and/or transmit user data, to display text or other instructional cues to a patient, e.g., according to instructions or other data received from a CCD **200** and/or a centralized Remote Testing System **500**, to communicate instruction, test or other related data to the patient and/or to a centralized Remote Testing System **500**, and in some embodiments, to receive test data resulting from the patient's interactions with the PTD **300**, as discussed in greater detail below.

[0094] In part, the PTD **300** stores User Data **324***a* in the data store **324**, e.g., in a database cluster. The User Data **324***a* identifies the patient user and includes any relevant user-identified and user-associated data, such as contact and communication information, including information for transmitting data to and/or otherwise interfacing with the user's PTD **300**. By way of example, some or all of this information may be provided by or gathered from the user by direct input or by data communication via the network **50**.

[0095] Further, the PTD **300** stores Instruction Data **324***b* in the data store **324**. The Instruction Data **324***b* may be stored in the device as part of pre-configuration, e.g., with a suitable software "app", or may be received as a transmission from another device, such as a Remote Testing System **500** or a Patient Computing Device **100***a*, **100***b*. For example, the Instruction Data **324***b* may include instructions to cause display of graphical or textual instructional cues, or to reproduce audible cues, etc., to provide instructions to the patient via the PTD **300** and/or the Patient Computing Device **100***a*, **100***b* in accordance with requirements of a sensory and/or motor skills test.

[0096] The IME **330** includes an Instruction Module (IM) **340** that is operable to receive and/or retrieve User Data **224***a* and/or Instruction Data **324***b* from the data store **324** and to display (e.g., using the Display Module **370**) or otherwise provide suitable instructions via the hardware (e.g., Display Device **314**) of the PTD **300** for guiding the patient to use the PTD **300** as desired as part of a sensory and/or motor skills test.

[0097] The IME **330** further includes a Coordination Module (CM) **350** that is operable to send data to and/or receive data from an external computing device, such as the Remote Testing System **500**, Patient Computing Device **100**, CCD **200** and/or the Clinician Control Device **400**, to synchronize or otherwise coordinate the operation of the CCD **200** and/or Clinician Control Device **400** with operation of the PTD **300**. For example, a clinician may operate a switch at the Clinician Control Device **400** and/or provide input at the CCD **200** to initiate the performance of a particular motor and/or sensory skill test, and the Coordination Module **350** may detect, track or otherwise be informed of such event and may act in concert with the Instruction Module **340** and/or the Display Module **370** to cause corresponding instructions, e.g., from the Instruction Data **324**, to be displayed, at an appropriate time, to the patient/user to cause the patient to take action to interact with the PTD **300** in a manner suitable for performance of a motor or sensory skills test, e.g., based on instructions displayed or otherwise delivered via the PTD **300**.

[0098] In certain embodiments, the IME **330** further includes a Communication Module (COM) **380**. The COM **380** is operable to communicate data via the network **50**, e.g., to send and/or receiving instructions, data, test results, etc. In certain embodiments, the COM **380** is operable to communicate with a nearby PCD **100**, such as via a Bluetooth short-range wireless connection, and store Test Data **224***d* and communicate such data or related data to an external computing device.

[0099] Additionally, in accordance with the present invention, the Interface Device **312** of FIG. **4** further includes the joysticks **325** and the touchpads **335** of FIG. **1**, as well as associated hardware and/or software, such as a resistive heater and associated circuitry, refrigerants, cooling fluids and associated valves and control circuitry, etc. Further, the IME **330** further includes a Testing Device Control Module (DTCM) **395** for controlling such valves and circuitry and/or any other associated mechanisms as needed, for actuating portions of the PTD **300** in accordance with a desired motor or sensory skills test. Additionally, the IME **330** further includes a Data Acquisition Module (DAM) **360** for gathering data from the joysticks **325**, touchpads **335** and any other associated sensors or mechanisms as desired in accordance with a desired motor or sensory skills test. The DAM **360** also acts to store acquired data as Sensor Data **324***c* in the data store **324** and to interpret the Sensor Data **324***c* and create and store associated Test Data **324***d*.

[0100] Acting in concert with the DAM **360**, the COM **380** is operable to transmit associated Sensor Data **324***c* and/or Test Data **324***d* via the network **50** and to transmit a suitable feedback control signal to the Clinician Control Device **400**

(or the CCD **200**) to cause the Clinician Control Device **400** (or CCD **200**) to operate to provide feedback to the clinician as a function of input provided by the patient to the PTD **300**. For example, a control signal may be used to cause display on a display device **314** of the CCD **200** to show a chart, graph, metric or other indicator of hand gripping force exerted by the patient on the joystick(s) of the PTD **300**. By way of alternative example, a control signal may be used to provide haptic feedback on the Clinician Control Device **400** cause operation of the joystick(s)/levers **455** to provide mechanical/force feedback corresponding to the hand gripping force exerted by the patient on the joystick(s) of the PTD **300**.

[0101] Accordingly, the PTD **300** may be configured to operate as a device separate from the PCD **100**, or as a single integrated device with the PCD **100**'s functionality, for operation in coordination with actions taken at the Clinician Computing Device **200** or Clinician Control Device **400**, or under common control of a Remote Testing System **500**, to deliver instructions to a patient to guide the patient in using the PCD **100** and/or PTD **300** in taking a motor skills and/or sensory test.

Clinician Control Device

[0102] FIG. **5** is a schematic block diagram illustrating an exemplary and non-limiting embodiment of a Clinician Control Device (ClinConDev) **400** in accordance with the present invention. In certain embodiments, the ClinConDev **400** is a special-purpose device that may be used as a stand-alone device, or as a peripheral or other device associated with and used to communicate with a CCD **200** or other general-purpose computing device, such as a smartphone or tablet computing device. In such an embodiment, the ClinConDev **400** may include primarily the housing **415** and switches **445** (e.g., for controlling heating/cooling hardware and/or such other devices/mechanisms/sensors of the PTD **300** for performing the desired motor and/or sensory skills tests), feedback joysticks/levers **455**, and such other data gathering, storage and communication components as may be desired for communicating associated data to another computing device. Accordingly, the ClinConDev **400** may not include general-purpose computing hardware of a type similar to that described above in relating to the CCD **200**. Rather, the ClinConDev **400** may communicate with a CCD **200** that includes such hardware and software.

[0103] Alternatively, however, as shown in the example of FIG. **5**, the ClinConDev **400** does include such general-purpose computing hardware and software. In such a case, the CCD **200** and the ClinConDev **400** may be effectively integrated into a single device, and it may be possible to operate the system satisfactorily without use of the CCD **200**. In such a case, structure at, and functions performed by, the CCD **200** may be provided at or be performed by the ClinConDev **400** instead of the CCD **200**.

[0104] Accordingly, the exemplary ClinConDev **400** is a special-purpose device that may include conventional computing hardware storing and executing both conventional software enabling operation of a general-purpose computing system, such as operating system software, network communications software, etc. as described above and also specially-configured hardware and computer software for configuring the ClinConDev **400** as a special-purpose device in accordance with the present invention. The ClinConDev **400** is caused, e.g., under control of the RTS **500**, to display information and/or receive inputs from a clinician/user in accordance with the present invention.

[0105] Accordingly, the exemplary ClinConDev **400** of FIG. **5** includes a general-purpose processor, such as a microprocessor (CPU), **402** and a bus **404** employed to connect and enable communication between the processor **402** and the components of the presentation system in accordance with known techniques. According to some embodiments, the processor **402** may be or include any type, quantity, and/or configuration of processor that is or becomes known. In some embodiments, the processor **402** may comprise multiple inter-connected processors, microprocessors, and/or micro-engines. According to some embodiments, the processor **402** (and/or the system **400** and/or other components thereof) may be supplied power via a power supply (not shown), such as a battery, an Alternating Current (AC) source, a Direct Current (DC) source, an AC/DC adapter, solar cells, and/or an inertial generator.

[0106] The exemplary ClinConDev **400** includes a user interface adapter **406**, which connects the processor **402** via the bus **404** to one or more interface devices, such as a keyboard **408**, mouse **410**, and/or other interface devices **412**, which can be any user interface device, such as a touch sensitive screen, digitized entry pad, etc. The bus **404** also connects a display device **414**, such as an LCD screen or monitor, to the processor **402** via a display adapter **416**.

[0107] The bus **404** also connects the processor **402** to memory **418**, which can include a hard drive, a solid-state drive, an optical drive, a diskette drive, a tape drive, etc. The memory **418** may comprise any appropriate information storage system that is or becomes known or available, including, but not limited to, units and/or combinations of magnetic storage systems (e.g., a hard disk drive), optical storage systems, and/or semiconductor memory systems, such as RAM systems, Read Only Memory (ROM) systems, Single Data Rate Random Access Memory (SDR-RAM), Double Data Rate Random Access Memory (DDR-RAM), and/or Programmable Read Only Memory (PROM).

[0108] The memory **418** may, according to some embodiments, store one or more software components. Any or all of the exemplary instructions and data types described herein and other practicable types of data may be stored in any number, type, and/or configuration of memory systems that is or becomes known. The memory **418** may, for example, comprise one or more data tables or files, databases, table spaces, registers, and/or other storage structures. In some embodiments, multiple databases and/or storage structures (and/or multiple memory systems) may be utilized to store information associated with the system **400**. According to some embodiments, the memory **418** may be incorporated into and/or otherwise coupled to the system **400** (e.g., as shown) or may simply be accessible to the system **400** (e.g., externally located and/or situated).

[0109] The ClinConDev **400** may communicate with other computers or networks of computers, for example via a communications channel, network card, modem or transceiver (collectively, "transceiver") **420**. In some embodiments, the transceiver **420** may comprise any type or configuration of communication system that is or becomes known or practicable. The transceiver **420** may, for example, comprise a Network Interface Card (NIC), a telephonic system, a cellular network system, a router, a hub, a modem, and/or a communications port or cable. According to some embodiments, the transceiver **420** may also or alternatively

be coupled to the processor **402**. In some embodiments, the transceiver **420** may comprise an IR, RF, Bluetooth™, Near-Field Communication (NFC), and/or Wi-Fi® network system coupled to facilitate communications between the processor **402** and another system (not shown). The PTD **400** may be associated with such other computers in a local area network (LAN) or a wide area network (WAN), and may operate as a server in a client/server arrangement with another computer, etc. Such configurations, as well as the appropriate communications hardware and software, are known in the art.

[0110] The ClinConDev **400** is specially-configured in accordance with the present invention. Accordingly, as shown in FIG. **5**, the ClinConDev **400** includes computer-readable, processor-executable instructions stored in the memory **418** for carrying out the methods described herein. Further, the memory **418** stores certain data, e.g., in one or more databases or other data stores **424** shown logically in FIG. **5** for illustrative purposes, without regard to any particular embodiment in one or more hardware or software components.

[0111] Further, as will be noted from FIG. **4**, the ClinConDev **400** includes, in accordance with the present invention, a data store **424** and an Interface Management Engine (IME) **430**, shown schematically as stored in the memory **418**, which includes a number of additional modules providing functionality in accordance with the present invention, as discussed in greater detail below. These modules may be implemented primarily by specially-configured software including microprocessor—executable instructions stored in the memory **418** of the ClinConDev **400**. Optionally, other software may be stored in the memory **418** and/or other data may be stored in the data store **424** or memory **418**. Further, the IME **430** includes one or more modules shown logically in FIG. **5** for illustrative purposes, without regard to any particular embodiment in one or more hardware or software components.

[0112] The IME **430** is operable to store and/or receive instruction data that may be used to gather, store and/or transmit user data, to display text or other instructional cues to a patient, e.g., according to instructions or other data received from a CCD **200** and/or a centralized Remote Testing System **500**, to communicate instruction, test or other related data to the patient and/or to a centralized Remote Testing System **500**, and in some embodiments, to receive test data resulting from the patient's interactions with the ClinConDev **400**, as discussed in greater detail below.

[0113] In part, the ClinConDev **400** stores User Data **424***a* in the data store **424**, e.g., in a database cluster. The User Data **424***a* identifies the clinician and/or patient user and includes any relevant user-identified and user-associated data, such as contact and communication information, including information for transmitting data to and/or otherwise interfacing with the user's CCD **200**. By way of example, some or all of this information may be provided by or gathered from the user by direct input or by data communication via the network **50**.

[0114] Further, the ClinConDev **400** stores Instruction Data **424***b* in the data store **424**. The Instruction Data **424***b* may be stored in the device as part of pre-configuration, e.g., with a suitable software "app", or may be received as a transmission from another device, such as a Remote Testing System **500**. For example, the Instruction Data **424***b* may include instructions to cause display of graphical or textual instructional cues, or to reproduce audible cues, etc., to provide instructions to the clinician via the ClinConDev **400** and/or the CCD **200** in accordance with actions of the patient at the PCD **100** and/or PTD **300** and/or requirements of a sensory and/or motor skills test.

[0115] The IME **430** includes an Instruction Module (IM) **445** that is operable to receive and/or retrieve User Data **224***a* and/or Instruction Data **424***b* from the data store **424** and to display (e.g., using the Display Module **470**) or otherwise provide suitable instructions via the hardware (e.g., Display Device **414**) of the ClinConDev **400** for guiding the clinician to use the ClinConDev **400** as desired as part of a sensory and/or motor skills test.

[0116] The IME **430** further includes a Coordination Module (CM) **455** that is operable to send data to and/or receive data from an external computing device, such as the Remote Testing System **500**, PCD **100**, CCD **200** and/or the PTD **300**, to synchronize or otherwise coordinate the operation of the ClinConDev **400** and/or CCD **200** with the operation of the PCD **100** and/or the PTD **300**. For example, a clinician may operate a switch at the ClinConDev **400** and/or provide input at the CCD **200** to initiate the performance of a particular motor and/or sensory skill test, and the Coordination Module **455** may detect, track or otherwise be informed of such event and may act in concert with the Instruction Module **445** and/or the Display Module **470** to cause corresponding instructions, e.g., from the Instruction Data **424***b*, to be displayed, at an appropriate time, to the patient/user to cause the patient to take action to interact with the PCD **100** and/or the PTD **300** in a manner suitable for performance of a motor or sensory skills test, e.g., based on instructions displayed or otherwise delivered via the ClinConDev **400**.

[0117] In certain embodiments, the IME **430** further includes a Communication Module (COM) **480**. The COM **480** is operable to communicate data via the network **50**, e.g., to send and/or receiving instructions, data, test results, etc. In certain embodiments, the COM **480** is operable to communicate with a nearby CCD **200**, such as via a Bluetooth short-range wireless connection, and store Test Data **224***d* and communicate such data or related data to an external computing device.

[0118] Additionally, in accordance with the present invention, the Interface Device **412** of FIG. **5** further includes switches **445** that may be user-manipulable in fashions relevant to testing of the patient's motor and/or sensory functions at the Patient Testing Device **300**. By way of example, one or more switches **445** may be provided to selectively cause a touchpad **330** to be heated or cooled at the Patient Testing Device **300**.

[0119] Additionally, in accordance with the present invention, the Interface Device **412** of FIG. **5** further includes joysticks or levers **455** that may be user-manipulable in fashions relevant to testing of the patient's motor and/or sensory functions and/or may be driven to provide haptic feedback to a user at the ClinConDev **400** based on patient input at the PTD **300**, as well as associated hardware and/or software, such as a electric motors, actuators, etc. and control circuitry. Accordingly, movement and/or pressure exerted by a patient on the joysticks **325** of the PTD **300** may be effectively replicated by driving/actuation of the joysticks/levers, a clamp, or other device at the ClinConDev

400, so that the clinician at the ClinConDev **400** can effectively feel/experience the actions of the patient at the PTD **300**.

[0120] Additionally, the IME **430** further includes a Feedback Module (FM) **490**. Acting in concert with the COM **480**, the FM **490** is operable to receive Sensor Data and/or Test Data **224** via the network **50** and to create/generate corresponding feedback data, to store such Feedback Data **424***e* in the data store **424**, and to transmit a suitable feedback control signal to the ClinConDev **400** (or the CCD **200**) to cause the ClinConDev **400** (or CCD **200**) to operate to provide feedback to the clinician as a function of input provided by the patient to the PTD **300**. For example, a control signal may be used to cause display on a display device **414** of the ClinConDev **400** to show a chart, graph, metric or other indicator of hand gripping force exerted by the patient on the joystick(s) of the PTD **300**. By way of alternative example, a control signal may be used to provide haptic feedback on the ClinConDev **400** by causing operation of the joystick(s)/levers **455** to provide mechanical/force feedback corresponding to the hand gripping force exerted by the patient on the joystick(s) of the PTD **300**.

[0121] Accordingly, the ClinConDev **400** may be configured to operate as a device separate from the CCD **200**, or as a single integrated device with the CCD **200**'s functionality, for operation in coordination with actions taken at the PCT **100** PTD **300**, or under common control of a Remote Testing System **500**, to deliver instructions to a patient to guide the patient in using the PCD **100** and/or PTD **300** in taking a motor skills and/or sensory test.

Remote Testing System

[0122] FIG. **6** is a schematic block diagram illustrating an exemplary and non-limiting embodiment of a computerized Remote Testing System (RTS) **500** in accordance with the present invention. The RTS **500** is a special-purpose computer system that includes conventional computing hardware storing and executing both conventional software enabling operation of a general-purpose computing system, such as operating system software, network communications software, and specially-configured computer software for configuring the general purpose hardware as a special-purpose computer system for carrying out at least one method in accordance with the present invention. By way of example, the communications software may include conventional web server software, and the operating system software may include iOS, Android, Windows, Linux software.

[0123] Referring again to FIG. **6**, there is illustrated a block diagram of an exemplary RTS **500** according to some embodiments is shown. In some embodiments, the RTS **500** may, for example, execute, process, facilitate, and/or otherwise be associated with the embodiments described above.

[0124] Accordingly, the exemplary RTS **500** of FIG. **6** includes a general-purpose processor, such as a microprocessor (CPU), **502** and a bus **504** employed to connect and enable communication between the processor **502** and the components of the presentation system in accordance with known techniques. According to some embodiments, the processor **502** may be or include any type, quantity, and/or configuration of processor that is or becomes known. In some embodiments, the processor **502** may comprise multiple inter-connected processors, microprocessors, and/or micro-engines. According to some embodiments, the processor **502** (and/or the system **500** and/or other components thereof) may be supplied power via a power supply (not shown), such as a battery, an Alternating Current (AC) source, a Direct Current (DC) source, an AC/DC adapter, solar cells, and/or an inertial generator. In the case that the system **500** comprises a server, such as a blade server, necessary power may be supplied via a standard AC outlet, power strip, surge protector, and/or Uninterruptible Power Supply (UPS) system.

[0125] The exemplary RTS **500** includes a user interface adapter **506**, which connects the processor **502** via the bus **504** to one or more interface devices, such as a keyboard **508**, mouse **510**, and/or other interface devices **512**, which can be any user interface device, such as a touch sensitive screen, digitized entry pad, etc. The bus **504** also connects a display device **514**, such as an LCD screen or monitor, to the processor **502** via a display adapter **516**.

[0126] The bus **504** also connects the processor **502** to memory **518**, which can include a hard drive, a solid-state drive, an optical drive, a diskette drive, a tape drive, etc. The memory **518** may comprise any appropriate information storage system that is or becomes known or available, including, but not limited to, units and/or combinations of magnetic storage systems (e.g., a hard disk drive), optical storage systems, and/or semiconductor memory systems, such as RAM systems, Read Only Memory (ROM) systems, Single Data Rate Random Access Memory (SDR-RAM), Double Data Rate Random Access Memory (DDR-RAM), and/or Programmable Read Only Memory (PROM).

[0127] The memory **518** may, according to some embodiments, store one or more software components. Any or all of the exemplary instructions and data types described herein and other practicable types of data may be stored in any number, type, and/or configuration of memory systems that is or becomes known. The memory **518** may, for example, comprise one or more data tables or files, databases, table spaces, registers, and/or other storage structures. In some embodiments, multiple databases and/or storage structures (and/or multiple memory systems) may be utilized to store information associated with the system **500**. According to some embodiments, the memory **518** may be incorporated into and/or otherwise coupled to the system **500** (e.g., as shown) or may simply be accessible to the system **500** (e.g., externally located and/or situated).

[0128] The RTS **500** may communicate with other computers or networks of computers, for example via a communications channel, network card, modem or transceiver (collectively, "transceiver") **520**. In some embodiments, the transceiver **520** may comprise any type or configuration of communication system that is or becomes known or practicable. The transceiver **520** may, for example, comprise a Network Interface Card (NIC), a telephonic system, a cellular network system, a router, a hub, a modem, and/or a communications port or cable. According to some embodiments, the transceiver **520** may also or alternatively be coupled to the processor **502**. In some embodiments, the transceiver **520** may comprise an IR, RF, Bluetooth™, Near-Field Communication (NFC), and/or Wi-Fi® network system coupled to facilitate communications between the processor **502** and another system (not shown). The RTS **500** may be associated with such other computers in a local area network (LAN) or a wide area network (WAN), and may operate as a server in a client/server arrangement with

another computer, etc. Such configurations, as well as the appropriate communications hardware and software, are known in the art.

[0129] The RTS **500** is specially-configured in accordance with the present invention. Accordingly, as shown in FIG. **6**, the RTS **500** includes computer-readable, processor-executable instructions stored in the memory **518** for carrying out the methods described herein. Further, the memory **518** stores certain data, e.g., in one or more databases or other data stores **524** shown logically in FIG. **6** for illustrative purposes, without regard to any particular embodiment in one or more hardware or software components.

[0130] Further, as will be noted from FIG. **6**, the RTS **500** includes, in accordance with the present invention, a Device Coordination Engine (DCE) **530**, shown schematically as stored in the memory **518**, which includes a number of additional modules providing functionality in accordance with the present invention, as discussed in greater detail below. These modules may be implemented primarily by specially-configured software including microprocessor—executable instructions stored in the memory **518** of the RTS **500**. Optionally, other software may be stored in the memory **518** and and/or other data may be stored in the data store **524** or memory **518**. Further, the DCE **530** includes one or more modules shown logically in FIG. **6** for illustrative purposes, without regard to any particular embodiment in one or more hardware or software components.

[0131] As shown in FIG. **6**, the RTS **500** includes a data store **524** and a Device Coordination Engine (DCE) **530** in accordance with the present invention. The DCE is operable to receive User Data **524***a*, Instruction Data **524***b* Sensor Data **524***c*, Test Data **524***d* and/or Feedback Data **524***e* that may be used to coordinate communications among the PCD **100**, PTD **300**, CCD **200** and/or ClinConDev **400** to facilitate a clinician's control of, and/or a patient's participation in, a motor and/or sensory skills test, as discussed in greater detail below. The RTS **500** may store data in the data store **524**, e.g., in a database cluster, and may receive this data from one of more of the PCD **100**, PTD **300**, CCD **200** and/or ClinConDev **400** in accordance with actions of the patient at the PCD **100** and/or PTD **300**, the clinician at the CCD **200** and/or the ClinConDev **400** and/or requirements of a sensory and/or motor skills test.

[0132] The DCE **520** includes an Instruction Module **540**, Display Module **670**, Communication Module **680** and Device Control Module **690** (operable to control the PTD **300** and/or the ClinConDev **400**) similar to those described above. In certain embodiments, the Device Control Module **690** may be operable to receive raw Sensor Data (e.g., acquired by the DAM **360** of a PTD **300**) and to create/generate associated Feedback Data as a function of such Sensor Data, such that such Feedback Data can be provided to the CCD **200** and/or ClinConDev **400**. In other words, the DCM **590** may process and/or analyze Sensor data to generate appropriate Feedback Data **524***e* to be provided to the clinician via the CCD **200** and/or the ClinConDev **400**.

[0133] Notably, the DCE **530** further includes a Coordination Module (CM) **560** similar to that described above. In certain embodiments, the CM **560** of the DCE **530** may provide the ultimate control for coordinating actions at the PCD **100**, PTD **300**, CCD **200** and ClinConDev **400** with the assistance of their respective Coordination Module such that displays, device actuations, etc. at each device are coordination in time and in functionality so that such devices may act in tandem as needed in support of a motor and/or sensory skills test. In certain embodiments, the RTE **500** may act as an intermediary between such devices, issuing control communications to the various devices and/or relaying communications among such devices, e.g., in real time.

[0134] Additionally, the DCE **530** further includes a Session Module **560** similar to that described above. In certain embodiments, the Session Module **560** is operable to manage not only synchronous sessions, e.g., session in which the patient and clinician are participating concurrently in a real-time motor and/or sensory skills test via their respective devices, but also asynchronous session, e.g., sessions in which the patient and clinician are not participating concurrently in a real-time motor and/or sensory skills test via their respective devices. For example, in an asynchronous session, the Session Module **595** and Coordination Module **560** may cooperate to facilitate communications with the patient (e.g., including display of instructions) at the PCD **100** and/or the PTD **300** at a first time in a first session, and may also cooperate to facilitate communications with the clinician (e.g., including display of instructions, display of feedback via the CCD **200** and/or the ClinConDev **400**, providing of feedback via the ClinConDev **400**, etc.) at a second time in a second session after the first session. Accordingly, for example, feedback data forwarded to the clinician end allows for the ClinConDev **400** to provide real-time feedback to the clinician e.g., as if the user were squeezing the clinician's hand in the form of a display via the CCD **200** and/or ClinConDev **400** and/or via haptic feedback delivered via the ClinConDev **400** not only during a single patient/clinician session, but also at a later time. Accordingly, for example, a patient user can perform motor and sensory function tests without the participation of a clinician at the same time in the same session. More particularly, the data associated with the patient's interaction with the PTD **300** and/or the PCD **100** is stored, e.g., at the RTS **500** (or the CCD **200** or ClinConDev **400**) for future use and analysis. Additionally, the Session Module **595**, e.g., in cooperation with the CM **560** and the COM **580**, allows the clinician to view (via a display on the CCD **200** and/or ClinConDev **400**) a menu and select a specific date/time a patient user performed a test, and then to choose to receive the associate data (e.g., from data stored at the RTS **500** or another device), to view or otherwise receive feedback, including haptic feedback, at the CCD **200** and/or the ClinConDev **400** according to the patient's performance during an earlier session.

[0135] In certain embodiments, the Session Module **595**, acting in concert with the CM **560** and/or COM **580**, may include artificial intelligence or logic that is used to notify the patient/user when to engage with the PCD **100**, PTD **300** and/or a clinician for next steps. For example, the SM **595** may prompt the patient user to perform another test 1 week or 1 month after an initial session, or otherwise as determined by the system, e.g., to examine a trend in patient motor and/or sensor skills.

System Operation

[0136] FIG. **7** is a flow diagram **700** illustrating operation of the system in accordance with an exemplary and non-limited embodiment of the present invention. Exemplary operation of the exemplary system of FIGS. **1-6** is discussed below with reference to the flow diagram **700** of FIG. **7**. It should be appreciated that an exemplary method of opera-

tion in accordance with an exemplary embodiment of the present invention. For illustrative purposes, this exemplary embodiment involves the RTS **500** acting as an intermediate between patient devices and clinician devices. As noted above, in other embodiments, some or all of the functionality described with respect to the exemplary system of FIG. **1** may be performed by other devices within the system. **402**. Accordingly, it should be appreciated that the exemplary embodiment described above is for illustrative purposes only, and non-limiting.

[0137] Referring now to FIG. **7**, the exemplary method begins with receiving of a clinician's input initiating a motor and/or sensory skills test, as shown at **702**. In certain embodiments, this may involve receiving at the RTS **500** of a data communication or control signal transmitted via the network **50** from a CCD **200** and/or a ClinConDev **400**, or in response to clinician input at one of those devices. In other embodiments, this may involve data communication or exchange among components contained within a single device. For example, this may involve a data communication to initiate a motor and sensory skills test involving manipulation of joysticks and touching of heated and cooled touchpads on the PTD **300**.

[0138] Next, the exemplary method involves receiving of instruction data for performance of the associated test, as shown at **704**. In certain embodiments, this may involve receipt at the RTS **500** of a data communication or control signal transmitted via the network **50** from a CCD **200** and/or a ClinConDev **400**, or in response to clinician input at one of those devices. In other embodiments, this may involve retrieval of Instruction Data **224***b* from a data store or another device, or from a data stored within/associated with a single device.

[0139] Next, the exemplary method involves transmitting instruction data for performance of the associated test, as shown at **706**. In certain embodiments, this may involve receipt by and transmission from the RTS **500** of a data communication or control signal via the network **50** to a PCD **100** and/or a PTD **300**, e.g., form the CCD **200** or the ClinConDev **400**. In other embodiments, this may involve retrieval of Instruction Data from a data store within/associated with a single device, e.g., the RTS **500**, the PCD **100** or the PTD **300**.

[0140] Next, the exemplary method involves transmitting instruction data for performance of the associated test, as shown at **706**. In certain embodiments, this may involve receipt by (e.g., from the CCD **200** or the ClinConDev **400**) and transmission from the RTS **500** of a data communication or control signal via the network **50** to a PCD **100** and/or a PTD **300**. In other embodiments, this may involve retrieval of Instruction Data from a data store within/associated with a single device, e.g., the RTS **500**, the PCD **100** or the PTD **300**. For example, this may involve receipt of instruction data for display of instructions via the PCD **100** or PTD **300** providing instructions for the patient user to grasp one or more of the joysticks **325** and manipulate them in a defined fashion (e.g., to push and/or pull the joysticks separately with each hand and/or together with one hand), according to the test to be performed.

[0141] Next, the exemplary method involves receiving sensor data (e.g., raw data from the sensors) or test data (e.g., interpreted sensor data and/or test results determined as a function of sensor data) for a first (or next) step of the motor and/or sensor skills test, as shown at **708**. In certain embodiments, this may involve receipt (e.g., from the PCD **100** and/or the PTD **300**) of a data communication or control signal via the network **50** by the RTS **500**. In other embodiments, this may involve receipt of such data from a data store or via other data exchange within/associated with a single device, e.g., the RTS **500**, the PCD **100** or the PTD **300**. For example, this may involve receipt of raw sensor data captured by a Data Acquisition Module **360** of the PTD **300** as a result of manipulation of the joysticks **325** by the patient in a prescribed manner.

[0142] Next, the exemplary method involves processing sensor data (e.g., raw data from the sensors) or test data (e.g., interpreted sensor data and/or test results determined as a function of sensor data) to generate feedback data, as shown at **710**. In certain embodiments, this may involve processing, analyzing and/or interpreting of the sensor data and/or test result data. By way of example, this may be performed at the PCD **100** and/or the PTD **300** (e.g., by the Testing Device Control Module **290**), or at the CCD **200** and/or the ClinConDev **400** (e.g., by the Feedback Module **290**, **490**), or by the RTS **500** (e.g., by the Device Control Module **590**). This may involve receipt of such data from a data store or via other data exchange within/associated with a single device, or may involve receipt of data from another device and processing of that data to create the feedback data. The feedback data is usable by the CCD **200** and/or the ClinConDev **400** to control the device to provide textual, graphical, haptic or other feedback to the clinician via the CCD **200** and/or the ClinConDev **400**. For example, the Feedback Data may be configured to cause display of a message via the CCD **200** (e.g., to display numeric values or a chart of patient grip force according to the patient's manipulation of the joysticks **324** at the PTD **300**) or to cause driving of the joysticks/levers **455** at the ClinConDev **400** so that the clinician may grasp the levers and feel haptic feedback at the ClinConDev **400** reflecting the patient grip force according to the patient's manipulation of the joysticks **325** at the PTD **300**.

[0143] Next, it is determined if the session is a synchronous session, as shown at **712**. For example, this may be determined by the Session Module **595** of the RTS **500**. If the session is a synchronous session (meaning a clinician and patient are engaged in a test session with each other concurrently), then the sensor data, test data and/or feedback data may be transmitted to the clinician's device (e.g., CCD **200** and/or ClinConDev **400**) at that time, as shown at **714**. This may be determined by the Communication Module **580**.

[0144] It may then be determined if the completed step of the motor/sensory test is the last step of the test, as shown at **716**. This may be determined by the Instruction Module **540** and/or Coordination Module **570**. If it is not the last step, then method flow returns to **706**, and the next instruction for the next step (e.g., touching heated/cooled touchpads **335** of the PTD **300**) may be displayed/performed, etc. This continues until all steps of the prescribed tests have been completed, at which point it is determined if it is time for a next test, as shown at **718**.

[0145] If, however, it is determined at **712** that it is not a synchronous session (meaning that a clinician and patient are not engaged in a test session with each other concurrently), then the sensor data, test data and/or feedback data may be stored for later reference, e.g., in the data store **524** of the RTS **500**. This may be determined by the Session

Module **595**. It is then determined whether a test review request has been received, e.g., from a clinician via the CCD **200** and/or ClinConDev **400**, as shown at **722**. This may be determined by the Instruction Module **540** and/or Coordination Module **570**. When it is determined that that a test review request has been received, then the sensor data, test data and/or feedback data may be transmitted to the clinician's device (e.g., CCD **200** and/or ClinConDev **400**) at that time, as shown at **724**. It is then determined if it is time for a next test, as shown at **718**.

[0146] When it is determined that it is time for a next test at **718**, method flow continues to **704**, where instruction data is received for performance of next test. This may be determined by the Session Module **595**, acting in concert with one or more of the Instruction Module **540**, the Coordination Module **560** and/or Communication Module **580**. In certain embodiments, this may include the use of artificial intelligence or logic that is used to notify the patient/user when to engage with the PCD **100**, PTD **300** and/or a clinician for next steps. For example, the SM **595** may prompt the patient user to perform another test 1 week or 1 month after an initial session, or otherwise as determined by the system, e.g., to examine a trend in patient motor and/or sensor skills. Alternatively, this may be determined according to input provided by a clinician at one of the CCD **200** and/or the ClinConDev **400** to initiate a next test.

[0147] Accordingly, the present invention allows a clinician (physician, nurse, etc.) to remotely conduct a motor function and sensory examination by having the patient (user) in a remote location position the patient's hands (or other body parts) on a device that contains multiple joysticks and/or touchpoints. The joysticks allow the user to push and pull the patient's hands in different directions, which sends signals to the clinician end of the device and delivers feedback on how well the user is performing the motor and/or sensory skills function as part of the test. The data forwarded to the clinician's device allows for the system to provide real-time feedback to the clinician as if the user were squeezing the clinician's hand or otherwise directly interacting with the clinician, in the form of a numeric value, chart, graph, etc. with the option for the clinician to haptically feel exerted force corresponding to the force exerted by the patient, either during a concurrent session with the user, or at a later time after which the patient has interacted with the system. Additionally, the patient user can perform motor and sensory function tests without the clinician participating in a session. Further, since the data is stored for future use and analysis, the clinician can select a specific date/time a user performed a test, and then receive data, including haptic feedback from the device, relative to how it was recorded by the user.

[0148] Accordingly remote and asynchronous motor function and sensory skills examination is enabled, optionally in combination with a parallel virtual (e.g., text, video, chat, voice call, etc.) communication channel. The present invention can also be employed to provide a stand-alone product for the patient user to monitor the patient's own motor and sensory functions and track progress to report/discuss with clinicians at a later date, without a specific need for a clinician device.

[0149] While there have been described herein the principles of the invention, it is to be understood by those skilled in the art that this description is made only by way of example and not as a limitation to the scope of the invention. Accordingly, it is intended by the appended claims, to cover all modifications of the invention which fall within the true spirit and scope of the invention.

What is claimed is:

1. A system for remote motor and sensory function testing comprising:

a memory operatively comprising a non-transitory data processor-readable medium;

a data processor operatively connected to the memory; and

user interface management instructions embodied in data processor-executable code stored in the memory, said user interface management instructions being executable by the data processor to provide an interface management engine configured to:

cause display of instructions for performance of at least one of a motor function test and a sensory test at a remotely located computing device, the instructions comprising instructions for a test involving interacting with a patient testing device by physical contact with the patient testing device, the patient testing device comprising at least one sensor for gathering sensor data as a result of the physical contact;

receive sensor data corresponding to the physical contact with the patient testing device;

process the sensor data to generate feedback data, the feedback data indicating a patient's interaction with the patient testing device; and

transmit the feedback data via a communications network.

2. The system of claim **1**, wherein the remotely located computing device comprises a patient computing device separate from the patient testing device.

3. The system of claim **1**, wherein the remotely located computing device comprises the patient testing device, the patient testing device comprising:

at least one of a joystick and a temperature-controlled touchpad.

4. The system of claim **3**, wherein the remotely located computing device comprises a clinician computing device separate from the patient testing device.

5. The system of claim **1**, wherein the remotely located computing device comprises a clinician control device separate from the patient testing device, said clinician control device comprising at least one joystick, and wherein said clinician control device is operable to provide haptic feedback via the at least one joystick corresponding to input provided via the joystick at the patient testing device.

6. The system of claim **1**, further comprising instructions to:

store the feedback data in the memory;

wherein said instructions to transmit the feedback data via the communications network involves retrieving the feedback data from the memory, and wherein the said instructions cause the transmitting in response to a request for transmission of the feedback data at a time after completion of the at least one of the motor function test and the sensory test.

7. The system of claim **1**, wherein said instructions for a test involving interacting with a patient testing device by physical contact with the patient testing device comprise instructions to display instructions at a patient computing device for using a patient testing device and at a clinician computing device for using a clinician control device, said causing of display of instructions at the patient computing

device and the clinician computing device being coordinated in concert in support of performance of the at least one of the motor function test and the sensory test.

8. The system of claim **1**, wherein said instructions for causing display of instructions for performance of the at least one of the motor function test and the sensory test comprise causing display of first instruction data at a first time for a first test and causing display of second instruction data at a second time for a second test, and wherein the causing of display of second instruction data at the second time for the second test is a result of sending of the second instruction data at the second time as determined automatedly according to data gathered during the first test.

9. A computer-implemented method for controlling a display of a computerized device to perform remote motor and sensory function testing, the computerized device comprising a memory comprising a non-transitory data processor- readable medium, a data processor operatively connected to the memory, the display, and user interface management instructions embodied in data processor-executable code stored in the memory and executable by the data processor to provide an interface management engine, the method comprising:

receiving instruction data for performance of at least one of a motor function test and a sensory test;

displaying instructions for performing the at least one of a motor function test and a sensory test, the instructions comprising instructions to interact with a patient testing device by physical contact with the patient testing device, the patient testing device comprising at least one sensor for gathering sensor data as a result of the physical contact;

gathering sensor data corresponding to the physical contact with the patient testing device;

processing the sensor data to generate feedback data, the feedback data indicating the patient's interaction with the patient testing device and being operable to control a clinician control device to provide feedback corresponding to the patient's interaction; and

transmitting the feedback data via a communications network.

10. The method of claim **9**, further comprising:

storing the feedback data in the memory;

wherein said transmitting the feedback data via the communications network involves retrieving the feedback data from the memory, and wherein said transmitting is performed in response to a request for transmission of the feedback data at a time after completion of the at least one of the motor function test and the sensory test.

11. The method of claim **9**, wherein said transmitting the feedback data via the communications network comprises transmitting the feedback data to one of a clinician computing device and the clinician control device.

12. The method of claim **9**, wherein the patient testing device comprises at least one of a joystick and a temperature-controlled touchpad, and wherein said displaying instructions for performing the at least one of the motor function test and the sensory test comprises:

displaying instructions to perform at least one of manipulation of the at least one joystick and touching of the temperature-controlled touchpad.

13. The method of claim **9**, wherein the clinician control device comprises at least one joystick, and wherein said clinician control device is operable to provide haptic feedback via the at least one joystick corresponding to input provided via the joystick at the patient testing device.

14. The method of claim **9**, wherein said displaying instructions for performing the at least one of a motor function test and a sensory test comprises displaying instructions at a patient computing device distinct from the patient testing device.

15. The method of claim **9**, wherein said displaying instructions for performing the at least one of a motor function test and a sensory test comprises displaying instructions at a patient computing device for using the patient testing device, and displaying instructions at a clinician computing device for using a clinician control device, said displaying of instructions at the patient computing device and the clinician computing device being coordinated in concert in support of performance of the at least one of the motor function test and the sensory test.

16. The method of claim **9**, wherein said receiving instruction data for performance of the at least one of the motor function test and the sensory test comprises receiving first instruction data at a first time for a first test and receiving second instruction data at a second time for a second test, and wherein the receiving of second instruction data at the second time for the second test is a result of sending of the second instruction data at the second time as determined automatedly according to data gathered during the first test.

17. A computer program product for implementing a method of controlling a display of a computerized device to perform remote motor function and sensory function testing, the computer program product comprising a non-transitory computer-readable medium storing executable instructions that, when executed by a processor, cause a computerized system to perform a method comprising:

receiving instruction data for performance of at least one of a motor function test and a sensory test;

displaying instructions for performing the at least one of a motor function test and a sensory test, the instructions comprising instructions to interact with a patient testing device by physical contact with the patient testing device, the patient testing device comprising at least one sensor for gathering sensor data as a result of the physical contact;

gathering sensor data corresponding to the physical contact with the patient testing device;

processing the sensor data to generate feedback data, the feedback data indicating the patient's interaction with the patient testing device and being operable to control a clinician control device to provide feedback corresponding to the patient's interaction; and

transmitting the feedback data via a communications network.

18. The computer program product of claim **17**, further comprising instructions to perform the method comprising:

storing the feedback data in a memory;

wherein said transmitting the feedback data via the communications network involves retrieving the feedback data from the memory, and wherein said transmitting is performed in response to a request for transmission of the feedback data at a time after completion of the at least one of the motor function test and the sensory test.

19. The computer program product of claim **17**, wherein said displaying instructions for performing the at least one of a motor function test and a sensory test comprises displaying instructions at a patient computing device for using the

patient testing device, and displaying instructions at a clinician computing device for using a clinician control device, said displaying of instructions at the patient computing device and the clinician computing device being coordinated in concert in support of performance of the at least one of the motor function test and the sensory test.

20. The method of claim **17**, wherein said receiving instruction data for performance of the at least one of the motor function test and the sensory test comprises receiving first instruction data at a first time for a first test and receiving second instruction data at a second time for a second test, and wherein the receiving of second instruction data at the second time for the second test is a result of sending of the second instruction data at the second time as determined automatedly according to data gathered during the first test.

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