



- (51) International Patent Classification:
A61B 8/12 (2006.01) G06F 3/041 (2006.01)
G06F 3/048 (2006.01)
- (21) International Application Number:
PCT/US2012/065293
- (22) International Filing Date:
15 November 2012 (15.11.2012)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
61/560,677 16 November 2011 (16.11.2011) US
- (71) Applicant: VOLCANO CORPORATION [US/US];
3661 Valley Centre Drive, Suite 200, San Diego, California 92130 (US).
- (72) Inventors: MERRITT, Fergus J.; 3729 Falkirk Way, El Dorado Hills, California 95762 (US). COHEN, Asher; 1614 24th St., Apt. B, Sacramento, California 95816 (US). DE JONG, Duane; 9264 Balboa Park Way, Elk Grove,

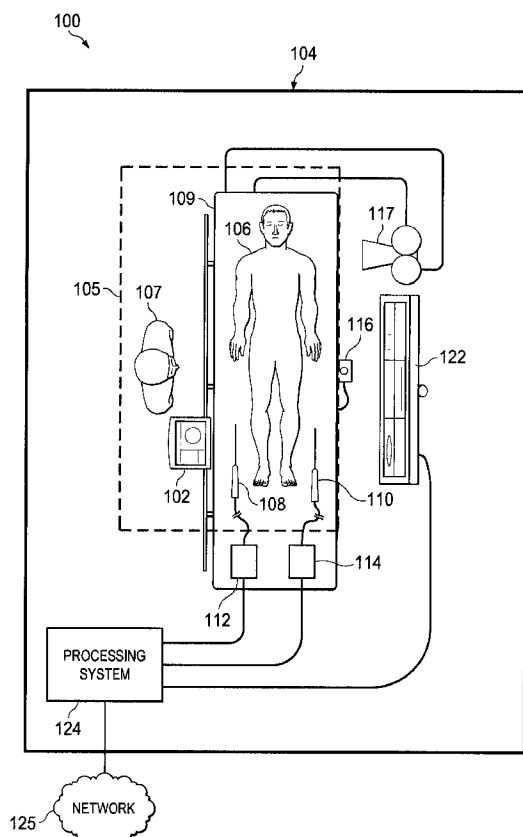
California 95624 (US). LITZZA, Gerald L.; 3581 Buena Vista Drive, Sacramento, California 95864 (US). CHELINE, Aaron J.; 361 Rockmont Circle, Sacramento, California 95835 (US).

(74) Agents: WEBB, Gregory P. et al.; Haynes and Boone, LLP, IP Section, 2323 Victory Avenue, Suite 700, Dallas, Texas 75219 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

[Continued on next page]

(54) Title: MEDICAL MEASURING SYSTEM AND METHOD



(57) Abstract: A method of performing measurements on medical images with a bedside controller includes receiving, through a touch-sensitive display on the bedside controller, a user measurement input on an image displayed on the display, the user measurement input including a start point defined by a point of initial contact with the touch-sensitive display and an end point defined by a point of last contact with the touch-sensitive display. The method also includes selecting a measurement mode based on a shape of the user measurement input and calculating a measurement value associated with the user measurement input based on the measurement mode.

WO 2013/074800 A1



(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,

SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

MEDICAL MEASURING SYSTEM AND METHOD

TECHNICAL FIELD

Embodiments of the present disclosure relate generally to the field of medical devices
5 and, more particularly, to a medical measuring system and associated methods of use.

BACKGROUND

This application claims the benefit of U.S. provisional patent application 61/560,677,
filed November 16, 2011, entitled "MEDICAL SENSING CONTROL SYSTEM AND
10 METHOD," the entirety of which is incorporated by reference herein.

Innovations in diagnosing and verifying the level of success of treatment of disease
have progressed from solely external imaging processes to include internal diagnostic
processes. In addition to traditional external image techniques such as X-ray, MRI, CT scans,
fluoroscopy, and angiography, small sensors may now be placed directly in the body. For
15 example, diagnostic equipment and processes have been developed for diagnosing
vasculature blockages and other vasculature disease by means of ultra-miniature sensors
placed upon the distal end of a flexible elongate member such as a catheter, or a guide wire
used for catheterization procedures. For example, known medical sensing techniques include
intravascular ultrasound (IVUS), forward looking IVUS (FL-IVUS), fractional flow reserve
20 (FFR) determination, a coronary flow reserve (CFR) determination, optical coherence
tomography (OCT), trans-esophageal echocardiography, and image-guided therapy.
Traditionally, many of these procedures are carried out by a multitude of physicians and
clinicians, where each performs an assigned task. For example, a physician may stand next to
a patient in the sterile field and guide the insertion and pull back of an imaging catheter. A
25 clinician near the physician may control the procedure workflow with a controller, for
example by starting and stopping the capture of images. Further, after images have been
captured, a second clinician in an adjacent control room working at a desktop computer may
select the images of interest and make measurements on them. Typically, the physician in the
catheter lab must instruct the clinician in the control room on how to make such
30 measurements. This may lengthen the time of the procedure, increase the cost of the
procedure, and may lead to measurement errors due to miscommunication or clinician
inexperience. Further, when making measurements on medical sensing images, a clinician
may typically have to select a measurement mode prior to making any measurements,

reducing the efficiency of the medical sensing workflow.

Accordingly, while the existing devices and methods for conducting medical sensing workflows have been generally adequate for their intended purposes, they have not been entirely satisfactory in all respects.

5

SUMMARY

In one exemplary aspect, the present disclosure is directed to a method of performing measurements on medical images with a bedside controller. The method includes receiving, through a touch-sensitive display on the bedside controller, a user measurement input on an image displayed on the display, the user measurement input including a start point defined by a point of initial contact with the touch-sensitive display and an end point defined by a point of last contact with the touch-sensitive display. The method also includes selecting a measurement mode based on a shape of the user measurement input and calculating a measurement value associated with the user measurement input based on the measurement mode.

15

In some instances, the method of performing measurements may include selecting one of a diameter measurement mode and an area measurement mode based on the shape of the user measurement input.

In another exemplary aspect, the present disclosure is directed to a bedside controller. The bedside controller includes a housing, the housing including self-contained mounting structure, a touch-sensitive display disposed within a surface of the housing and configured to display images and receive user input on the surface, a processor disposed within the housing, and a communication module disposed within the housing, communicatively coupled to the processor, and configured to transmit and receive medical data from a processing system. The bedside controller also includes a non-transitory computer readable storage module disposed within the housing, communicatively coupled to the processor, and including a plurality of instructions stored therein and executable by the processor. The plurality of instructions include instructions for receiving, through the touch-sensitive display, a user measurement input on an image displayed on the display, instructions for selecting a measurement mode based on a shape of the user measurement input, and instructions for calculating a measurement value associated with the user measurement input based on the measurement mode.

20

25

30

In another exemplary aspect, the present disclosure is directed to a medical measuring

system. The medical procedure workflow system includes a medical sensor device configured to gather medical data from a patient and a processing system communicatively coupled to the medical sensor device and operable to receive the medical data from the medical sensor device, the processing system being further operable to transform the medical data into medical images representative of the patient. The system also includes a bedside controller communicatively coupled to the processing system and operable to receive the medical images from the processing system and display the medical images on a touch-sensitive display, the bedside controller being further configured to receive, through the touch-sensitive display, a user measurement input on a medical image displayed on the display, select a measurement mode based on a shape of the user measurement input, and calculate a measurement value associated with the user measurement input based on the measurement mode.

In some instances, the bedside controller may be configured to receive the user measurement input while in a sterile field surrounding the patient. Additionally, the bedside controller may be configured to select one of a diameter measurement mode and an area measurement mode based on the shape of the user measurement input.

In yet another exemplary aspect, the present disclosure is directed to a method of conducting a medical workflow with a touch-sensitive bedside controller. The method includes initiating a medical workflow using a graphical user interface on the bedside controller, positioning an imaging tool within a patient's body based on images captured by the imaging tools and displayed on the bedside controller, controlling the commencement and termination of a recordation of images captured by the imaging tool using the graphical user interface on the bedside controller, navigating through the recorded images to identify an image of interest using the graphical user interface on the bedside controller, and performing measurements on the image of interest using the graphical user interface on the bedside controller.

In some instances, the performing measurements may include touching and releasing portions of the image of interest as it is displayed on the bedside controller to make one of an area measurement and a diameter measurement.

In a further exemplary aspect, the present disclosure is directed to a bedside controller. The bedside controller include a housing, a touch-sensitive display disposed within a surface of the housing and configured to display images and receive user input on the surface, and a processor disposed within the housing. The bedside controller also

includes a communication module disposed within the housing, communicatively coupled to the processor, and configured to transmit and receive medical data and a non-transitory computer readable storage module disposed within the housing, communicatively coupled to the processor, and including a plurality of instructions stored therein and executable by the processor. The plurality of instructions include instructions for rendering a graphical user interface (GUI) on the touch-sensitive display, instructions for displaying images of a patient as they are being captured by an imaging tool disposed within the patient's body, and instructions for initiating and terminating a recordation of the images based on user input to the GUI. The plurality of instructions also include instructions for displaying the recorded images within the GUI so that a user may identify an image of interest and instructions for making a measurement on the image of interest based on a user measurement input to the GUI.

In another exemplary aspect, the present disclosure is directed to a bedside controller. The bedside controller includes an integrally formed housing and self-contained mounting structure disposed on the housing. The mounting structure includes a mounting channel defined in the housing and a retaining clamp disposed above the mounting channel and configured to releasably secure a mounting platform within the mounting channel such that the bedside controller is mounted to the mounting platform. The bedside controller also includes a touch-sensitive display disposed within a surface of the housing and configured to display images and receive user input on the surface, a processor disposed within the housing, a communication module disposed within the housing, communicatively coupled to the processor, and configured to transmit and receive medical data, and a battery disposed within the integrally formed housing and electrically coupled to the touch-sensitive display, the processor, and the communication module.

In some instances, the self-contained mounting structure may be configured to releasably secure the bedside controller to the bed rail in such a manner that the display of the bedside controller is generally parallel with a top surface of a table associated with the bed rail.

In yet another exemplary aspect, the present disclosure is directed to a method of releasably mounting a bedside controller to a mounting platform associated with a patient undergoing an intravascular workflow. The method includes pivoting a retaining clamp to an open position, the retaining clamp being disposed on the bedside controller such that it extends over a mounting channel defined in a housing of the bedside controller, positioning

the bedside controller such that the mounting platform extends through the mounting channel, and releasing the retaining clamp such that it engages the mounting platform to releasably secure the mounting platform within the mounting channel, thereby mounting the bedside controller to the mounting platform. The method also includes viewing intravascular medical information associated with the patient displayed on a touch-sensitive display of the bedside controller and inputting user inputs on the touch-sensitive display to manipulate the medical information displayed on the touch-sensitive display.

BRIEF DESCRIPTION OF THE DRAWINGS

10 Figure 1 is a schematic drawing depicting a medical sensing system including a bedside controller according to one embodiment of the present disclosure.

 Figure 2 is a schematic drawing depicting a medical sensing system including a wireless bedside controller according to another embodiment of the present disclosure.

 Figure 3A is a diagrammatic perspective view of a bedside controller.

15 Figure 3B is a diagrammatic rear perspective view of the bedside controller of Figure 3A.

 Figure 3C is a diagrammatic perspective view of the bedside controller of Figure 3A mounted to a bed rail.

 Figure 4 is a functional block diagram of the bedside controller of Figures 3A and 3B
20 according to aspects of the present disclosure.

 Figure 5 is a diagrammatic perspective view of a multi-modality mobile processing system with the bedside controller of Figures 3A and 3B attached thereto.

 Figure 6 is a diagrammatic perspective view of the bedside controller of Figures 3A and 3B releasably mounted on an IV pole.

25 Figure 7 is a high-level flowchart illustrating a method of conducting a medical sensing workflow with a bedside controller according to various aspects of the present disclosure.

 Figure 8 is high-level flowchart of a method that describes a measurement workflow conducted on a bedside controller according to various aspects of the present disclosure.

30 Figures 9-11 are partial screen images illustrating various aspects of the method of Figure 8.

DETAILED DESCRIPTION

For the purposes of promoting an understanding of the principles of the present disclosure, reference will now be made to the embodiments illustrated in the drawings, and
5 specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the disclosure is intended. Any alterations and further modifications in the described devices, instruments, methods, and any further application of the principles of the disclosure as described herein are contemplated as would normally occur to one skilled in the art to which the disclosure relates. In particular, it is fully contemplated
10 that the features, components, and/or steps described with respect to one embodiment may be combined with the features, components, and/or steps described with respect to other embodiments of the present disclosure.

Figure 1 is a schematic drawing depicting a medical sensing system 100 including a bedside controller 102 according to one embodiment of the present disclosure. In general, the
15 medical sensing system 100 provides for coherent integration and consolidation of multiple forms of acquisition and processing elements designed to be sensitive to a variety of methods used to acquire and interpret human biological physiology and morphological information. More specifically, in system 100, the bedside controller 102 is a touch-enabled, integrated computing device for the acquisition, control, interpretation, measurement, and display of
20 multi-modality medical sensing data. In the illustrated embodiment, the bedside controller 102 is a tablet-style touch-sensitive computer that provides user controls and diagnostic images on a single surface. In the medical sensing system 100, the bedside controller 102 is operable to present workflow control options and patient image data via graphical user interfaces (GUIs) corresponding to a plurality of medical sensing modalities. The bedside
25 controller 102 will be described in greater detail in association with Figures 3A, 3B, and 4.

In the illustrated embodiment, the medical sensing system 100 is deployed in a catheter lab 104. The catheter lab 104 may be used to perform on a patient 106 any number of medical sensing procedures alone or in combination such as, by way of example and not
30 limitation, angiography, intravascular ultrasound (IVUS), virtual histology (VH), forward looking IVUS (FL-IVUS), intravascular photoacoustic (IVPA) imaging, fractional flow reserve (FFR) determination, coronary flow reserve (CFR) determination, optical coherence tomography (OCT), computed tomography, intracardiac echocardiography (ICE), forward-looking ICE (FLICE), intravascular palpography, transesophageal ultrasound, or any other

medical sensing modalities known in the art. In addition to controlling medical sensing systems, the bedside controller may be used to cooperate with and control medical treatment systems such as, for example but without limitation, those used for stent placement, coil embolism, ablation therapy, kidney stone treatments, basket placement in a cystoscopy, tumor removal, and chemical therapies. The catheter lab 104 further includes a sterile field 105 that encompasses the portions of the catheter lab surrounding the patient 106 on a procedure table 109 and a clinician 107, who may perform any number of medical sensing procedures or treatments. As shown in Figure 1, the bedside controller 102 may be positioned within the sterile field 105 and may be utilized by the clinician 107 to control a workflow of a medical sensing procedure or treatment being performed on the patient 106. For example, the clinician 107 may initiate the procedure workflow, watch real-time IVUS images captured during the procedure, and make measurements on the IVUS images all using the bedside controller 102 inside of the sterile field 105. In alternative embodiments, the bedside controller 102 may be utilized outside of the sterile field 105, for instance, in other locations within the catheter lab 104 or in a control room adjacent to the catheter lab. A method of utilizing the bedside controller 102 to control a medical sensing workflow or treatment workflow will be discussed in greater detail in association with Figures 7 and 8.

In the embodiment illustrated in Figure 1, the medical sensing system 100 additionally includes a number of interconnected medical sensing-related tools in the catheter lab 104 to facilitate a multi-modality workflow procedure, such as an IVUS catheter 108, an IVUS patient isolation module (PIM) 112, an OCT catheter 110, and OCT PIM 114, an electrocardiogram (ECG) device 116, an angiogram system 117, a boom display 122, and a multi-modality processing system 124. The bedside controller 102, PIMs 112 and 114, ECG device 116, angiography system 117, and boom display 122 are communicatively coupled to the processing system 124. In one embodiment, the processing system 124 is a computer workstation with the hardware and software to acquire, process, and display multi-modality medical sensing data, but in other embodiments, the processing system may be any other type of computing system operable to process medical sensing data. For example, during an IVUS workflow, the processing system 124 is operable to accept raw IVUS data from the IVUS PIM 112, transform it into IVUS images, and make the images available to the bedside controller 124, so that they may be displayed to the clinician 107 for analysis. In the embodiments in which the processing system 124 is a computer workstation, the system includes at least a processor such as a microcontroller or a dedicated central processing unit

(CPU), a non-transitory computer-readable storage medium such as a hard drive, random access memory (RAM), and/or compact disk read only memory (CD-ROM), a video controller such as a graphics processing unit (GPU), and a network communication device such as an Ethernet controller. Further, the multi-modality processing system 124 is
5 communicatively coupled to a data network 125. In the illustrated embodiment, the data network 125 is a TCP/IP-based local area network (LAN), however in other embodiments, it may utilize a different protocol such as Synchronous Optical Networking (SONET), or may be a wide area network (WAN). The processing system 124 may connect to various resources via the network 125, such as a Digital Imaging and Communications in Medicine
10 (DICOM) system, a Picture Archiving and Communication System (PACS), and a Hospital Information System. U.S. Patent Application No. 61/473,570, entitled "MULTI-MODALITY MEDICAL SENSING SYSTEM AND METHOD" and filed on April 8, 2011, discloses a multi-modality processing system that processes medical sensing data and is hereby incorporated by reference in its entirety.

15 In the medical sensing system 100, the IVUS PIM 112 and OCT PIM 114 are operable to respectively receive medical sensing data collected from the patient 106 by the IVUS catheter 108 and OCT catheter 110 and are operable to transmit the received data to the processing system 124. In one embodiment, the IVUS PIM 112 and OCT PIM 114 transmit the medical sensing data over a Peripheral Component Interconnect Express (PCIe) data bus
20 connection, but, in other embodiments, they may transmit data over a USB connection, a Thunderbolt connection, a FireWire connection, or some other high-speed data bus connection. Additionally, the ECG device 116 is operable to transmit electrocardiogram signals or other hemodynamic data from patient 106 to the processing system 124. To aid the clinician in data capture, the bedside controller 102 is operable to display the ECG data along
25 side medical sensing data. Further, in some embodiments, the processing system 124 may be operable to synchronize data collection with the catheters 108 and 110 using ECG signals from the ECG 116. Further, the angiogram system 117 is operable to collect x-ray, computed tomography (CT), or magnetic resonance images (MRI) of the patient 106 and transmit them to the processing system 124. After the x-ray, CT, or MRI data has been processed into
30 human-readable images by the processing system 124, the clinician 107 may navigate the GUI on the bedside controller 124 to retrieve the images from the processing system 124 and display them on the controller. In some embodiments, the processing system 124 may co-register image data from angiogram system 117 (e.g. x-ray data, MRI data, CT data, etc.)

with sensing data from the IVUS and OCT catheters 108 and 110. As one aspect of this, the co-registration may be performed to generate three-dimensional images with the sensing data. Such co-registered 3-D images data may be viewable on the bedside controller 124. In one embodiment, a clinician may rotate, zoom, and otherwise manipulate such 3-D images on the
5 bedside controller 102 using simultaneous touch inputs (i.e. multitouch) and gestures.

Additionally, in the illustrated embodiment of Figure 1, medical sensing tools in system 100, are communicatively coupled to the processing system 124 via a wired connection such as a standard copper link or a fiber optic link. Specifically, the bedside controller 124 may be communicatively and/or electrically coupled to the processing system
10 124 via a Universal Serial Bus (USB) connection, a Power-over-Ethernet connection, a Thunderbolt connection, a FireWire connection, or some other high-speed data bus connection.

However, in an alternative embodiment, such as that shown in Figure 2, the medical sensing tools may communicate wirelessly. In that regard, Figure 2 is a schematic drawing
15 depicting a medical sensing system 200 including a wireless bedside controller 202 according to another embodiment of the present disclosure. The medical sensing system 200 is similar to the system 100 of Figure 1 but the medical sensing tools including the wireless bedside controller 202, a wireless IVUS PIM 204, and a wireless OCT PIM 206 communicate with a wireless network 208 via wireless networking protocols. For example, the bedside controller
20 202 may send and receive workflow control parameters, medical sensing images, and measurement data to and from a remote processing system via IEEE 802.11 Wi-Fi standards, Ultra Wide-Band (UWB) standards, wireless FireWire, wireless USB, Bluetooth, or another high-speed wireless networking standard. Such wireless capability allows the clinician 107 to more freely position the bedside controller 202 inside or outside of the sterile field 105 for
25 better workflow management.

With reference now to Figures 3A, 3B, 3C and 4, Figure 3A is a diagrammatic perspective view of a bedside controller 300, Figure 3B is a diagrammatic rear perspective view of the bedside controller, Figure 3C is a diagrammatic perspective view of the bedside controller mounted to a bed rail, and Figure 4 is a functional block diagram of the bedside
30 controller 300 according to aspects of the present disclosure. The bedside controller 300 is similar to the bedside controllers 102 and 202 in medical sensing systems 100 and 200, and is operable to, among other things, initiate a medical sensing or treatment procedure workflow, display real-time images captured during the procedure, and accept measurement input on the

images from a clinician. The bedside controller 300 generally improves system control available to a clinician working at a patient table. For instance, giving a clinician both workflow control and measurement capability within the sterile field reduces errors and improves workflow efficiency.

5 As show in Figure 3A, the bedside controller 300 includes an integrally formed housing 302 that is easy to grasp and move around a catheter lab or other medical setting. In one embodiment, the integrally formed housing 302 may be seamlessly molded from materials such as thermoplastic or thermosetting plastic or moldable metal. In other
10 embodiments, the integrally formed housing 302 may comprise a plurality of housing portions fixedly bonded in a substantially permanent manner to form an integral housing. The housing 302 is resistant to fluids, and, in one embodiment, may have a rating of IPX4 against fluid ingress as defined by the International Electrotechnical Commission (IEC) standard 60529. In other embodiments in which the housing 302 may be used in different
15 environments, the hub may have a different fluid ingress rating. In the illustrated embodiment, the housing 302 is about 10.5 inches in width, about 8.25 inches in height, and has as thickness of about 2.75 inches. In alternative embodiments, the housing may have a different width, height, or thickness that is similarly conducive to portability.

 As shown in Figure 3B, the housing 302 further includes self-contained mounting structure 303 disposed on the housing. In the illustrated embodiment, the mounting structure
20 is disposed near an outer edge of the housing. The mounting structure 303 allows the bedside controller 300 to be releasably mounted in a variety of places in and out of a catheter lab in a self-contained manner. That is, the bedside controller 300 may be directly secured to another object without the use of a separate external mount. In the illustrated embodiment, the
25 mounting structure 303 includes a mounting channel 304 and a retaining clamp 305 that pivots over the mounting channel to secure a mounting platform therewithin. The mounting channel 304 is defined by a longer front wall 350, a top wall 352, and a shorter back wall 354, and the retaining clamp includes a slot 356 that extends through the clamp in a manner generally parallel to the mounting channel. The front wall 350 and the back wall 354 are
30 generally perpendicular to a touch-sensitive display 307 in the housing 302, and the top wall 352 is generally parallel to the display 307. In the illustrated embodiment, the retaining clamp is spring-loaded and releasably exerts pressure on objects situated in the mounting channel. In alternative embodiments, the retaining clamp may be configured differently and exert force via mechanisms other than springs.

As shown in Figure 3C, in operation, the bedside controller 300 may be releasably secured to a mounting platform, for example a bed rail 306, by pivoting the mounting clamp 305 to an open position, positioning the controller such that the rail extends through the length of the channel 304, and releasing the clamp such that it secures the rail within the channel. When the rail 306 is positioned in the mounting channel 304 and the clamp 305 is holding it therein, three surfaces of the rail are respectively engaged by the front wall 350, the top wall 352, and the back wall 354, and a fourth surface of the rail extends through the slot 356 in the clamp 305. In this manner, the mounting structure 303 may maintain the bedside controller 300 in a position generally parallel to a procedure table 350 associated with the bed rail 306, as shown in Figure 3B. Described differently, the mounting structure 303 is a cantilevered mounting structure in that it secures one end of the controller to an object while the majority of the controller extends away from the object in an unsupported manner. Such a cantilevered position allows for a display of the controller to be both readable and at a comfortable input angle for an operator. Further, the self-contained mounting structure 303 allows the bedside controller 300 to be quickly released from the bed rail 306 and reattached to an IV pole, a cart on which a processing system is deployed, or other location in or out of the sterile field to allow for convenient workflow control and image analysis. In alternative embodiments the mounting structure 303 of the bedside controller may vary from the design illustrated in Figures 3A and 3B and include additional and/or different components to allow for self-contained mounting.

Embedded into the front of the housing 302 is the touch-sensitive display 307 that comprises both a touch panel 308 and a flat panel display 309. The touch panel 308 overlays the flat panel display 308 and accepts user input via human touch, stylus touch, or some other analogous input method. In other words, the touch-sensitive display 307 displays images and accepts user input on the same surface. In the current embodiment, the touch panel 308 is a resistive-type panel, but in alternative embodiments it may be a capacitive-type panel, projective-type panel, or some other suitable type of touch enabled input panel. Further, the touch panel 308 is operable to accept multiple inputs simultaneously (multitouch), for instance, to enable rotation of a three-dimensional rendering of a vessel along multiple axes. Additionally, the touch panel 308 is capable of receiving input when a sterile drape 301 is covering the bedside controller 300 and also when a user is gloved. The touch panel 308 is controlled by a touch controller 310 disposed within the housing 302. Further, when a clinician makes contact with the touch panel 308, the touch panel is operable to provide

haptic feedback via a haptics controller 312 and haptics drivers 314. This haptic technology is operable to simulate a plurality of sensations on the touch panel 308 by varying the intensity and frequency of vibrations generated when a user contacts the touch panel. In some embodiments, the housing 302 may include a sheath configured to store a stylus therein.

5 Thus, a clinician may remove the stylus from the sheath in the housing to make measurements on the bedside controller and store it when the measurements have been completed.

Beneath the touch panel 308 is the flat panel display 309 that presents a graphical user interface (GUI) 316 to a user. In the illustrated embodiment, the flat panel display 309 is a
10 LCD display but in alternative embodiments, it may be a different type of display such an LED display or an AMOLED display. In the illustrated embodiment, the flat panel display 309 is illuminated by a LED backlight power inverter 318. As mentioned above, the GUI 316 not only allows a clinician to control a medical sensing workflow but also make measurements on images captured from a patient in the sterile field. A method of interacting
15 with the GUI 316 to make vessel measurements will be discussed in greater detail in association with Figures 8-11.

The bedside controller 300 includes a single board processing platform 320 within the housing 302 that is operable to render the GUI 316 and process user input. In the illustrated embodiment, the processing platform has a pico form factor and includes integrated
20 processing components such as a processor 321, system memory 322, graphics processing unit (GPU), communications module 323, and I/O bus controller. In some embodiments, the processor 321 may be a low power processor such as an Intel Atom[®] processor or a ARM-based processor, and the communications module 323 may be a 10/100/1Gb Ethernet module. And, the I/O bus controller may be a Universal Serial Bus (USB) controller. The
25 bedside controller 300 further includes a storage module 324 that is a non-transitory computer readable storage medium operable to store an operating system (i.e. software to render and control the GUI), image manipulation software, medical sensing data and images received from a processing system, and other medical sensing-related software. The processor 321 is configured to execute software and instructions stored on the storage module
30 324. In the illustrated embodiment, the storage module 324 is a solid state drive (SSD) hard drive communicatively coupled to the processing platform 320 via a SATA connection, but, in alternative embodiments, it may be any other type of non-volatile or temporary storage module. The bedside controller 300 further includes a wireless communications module 326

communicatively coupled to the processing platform 320. In some embodiments, the wireless communications module is a IEEE 802.11 Wi-Fi module, but in other may be a Ultra Wide-Band (UWB) wireless module, a wireless FireWire module, a wireless USB module, a Bluetooth module, or another high-speed wireless networking module.

5 In the illustrated embodiment, the bedside controller 300 is powered via both a wired 12VDC power-over-Ethernet (PoE) connection 328 and a battery 330 disposed within the housing 302. In one embodiment, the battery 330 may be sealed within the integrally formed housing 302 and may be recharged through electrical contacts disposed on the exterior of the housing and electrically coupled to the battery. As shown in the embodiment of Figure 3B,
10 the front wall 350 may include one or more electrical contacts 358 through which the battery 330 may be charged when the controller is mounted to objects with compatible charging structure. In other embodiments, the housing 302 may include a battery compartment with a removable cover to permit battery replacement. Such a battery compartment cover may be resistant to fluid ingress (e.g., with an IPX4 rating). The bedside controller 300 may be
15 coupled to a processing system in the catheter lab via the PoE connection 328, over which it receives medical sensing images that have been captured from the patient and rendered on the processing system. In operation, when the bedside controller is coupled to the PoE connection 328, it receives power and communications over the same physical wire. When the bedside controller 300 is disconnected from the PoE connection 328, it runs on battery
20 power and receives data wirelessly via the wireless communications module 326. When used wirelessly in a catheter lab, the bedside controller may directly communicate with a processing system (i.e. in an ad-hoc wireless mode), or, alternatively, it may communicate with a wireless network that serves a plurality of wireless devices. In alternative
25 embodiments, the bedside controller 300 may receive power and data through different wired connections, or receive data communications through a wired data connection and power from the battery 330, or receive data communications through the wireless module 326 and power from a wired electrical connection. In some embodiments, the bedside controller 300 may be used in a semi-wireless configuration, in which the battery 330 provides backup power to the controller when the controller is temporarily disconnected from a wired power
30 source. For example, if at the beginning of a procedure, the bedside controller 300 is connected to a PoE connection (or other type of wired connection) and during the procedure the controller must be disconnected from the PoE connection to allow for a cabling adjustment, the battery 330 may keep the controller alive until a PoE connection can be re-

established. In this manner, a full power-off and reboot of the controller 300 is avoided during a procedure. As shown in Figure 4, a DC-DC power converter 332 converts input voltage to a voltage usable by the processing platform 320.

It is understood that although the bedside controller 300 in the illustrated
5 embodiments of Figures 3 and 4 includes specific components described herein, the bedside controller may include any number of additional components, for example a charge regulator interposed between the electrical contacts and the battery, and may be configured in any number of alternative arrangements in alternative embodiments.

With reference now to Figures 5 and 6, illustrated are examples of locations in which
10 the bedside controller 300 may be mounted. Figure 5 is a diagrammatic perspective view of a multi-modality mobile processing system 500. The processing system 500 is disposed on a cart 502 that enables the processing system to be easily moved between different locations such as different catheter labs. As shown in Figure 5, the bedside controller 300 is mounted to the cart 502 so that it may be transported to catheter labs with the processing system. The
15 bedside controller 300 is releasably secured to the cart via the self-contained mounting structure 303 that is built into the housing 302. Further, in some embodiments, the cart 502 may include a dock for the bedside controller 300 such that when the controller is docked on the cart its battery is recharged through the electrical contacts 358 disposed on the housing 302. As shown in Figure 6, the bedside controller 300 may also releasably attach to an IV
20 pole 600 via the self-contained mounting structure 303. When so attached, the bedside controller 300 may be rolled next to a patient in the sterile field and thus within reach of a clinician who may operate the controller with a single hand.

Figure 7 is a high-level flowchart illustrating a method 700 of conducting a medical sensing workflow with the bedside controller 300 of Figures 3-4 according to various aspects
25 of the present disclosure. The method 700 will be described in the context of an IVUS procedure but may equally apply to any number of medical sensing or treatment procedures, such as an OCT procedure, a FLIVUS procedure, an ICE procedure, etc. The method 700 begins at block 702 where a medical sensing workflow is initiated with the bedside controller 300. Using an IVUS procedure as an example, a clinician in the sterile field and adjacent a
30 patient may select the "IVUS" option out of a plurality of modes (e.g., OCT, Chromaflow, FLIVUS, etc) on the bedside controller's GUI to begin the IVUS workflow. Next, in block 704, after an IVUS imaging catheter has been inserted into the patient, the clinician may select a 'Live Images' option on the bedside controller's GUI to receive live images from the

catheter. Using the real-time images, the clinician may guide the catheter within the patient to a desired position. In typical embodiments, a processing system may collect raw IVUS data from the catheter and process the data to render IVUS images. The bedside controller retrieves the IVUS images from the processing system and displays them to a user in real-time. Then, in block 706, after the IVUS catheter has been appropriately positioned in the patient using the live images, the clinician selects a 'Record' option on the bedside controller GUI and begins the catheter pull back. The processing system responds to the record command and begins rendering and storing IVUS images. The method 700 proceeds to block 708 where, after the IVUS catheter pull back has been completed, the clinician terminates the recording of IVUS images via the bedside controller's GUI. Then, in block 710, the clinician at the bedside recalls the captured IVUS images on the bedside controller and finds the IVUS images associated with the area of interest. Specifically, the bedside controller may present a condensed view of all captured images and the clinician may navigate through them using gestures on the bedside controller's touch panel to find the target area. Finally, in block 720, the clinician performs measurements on the IVUS images directly on the bedside controller. The user of the bedside controller creates measurements by interacting with an image through a series of presses, moves and releases using a finger or stylus on the controller's touch-sensitive display. These actions are interpreted by the bedside controller's internal processor and converted to measurements on the display. For precise measurements, the clinician may annotate the images using a stylus or another tool compatible with the bedside controller's touch panel. After the appropriate measurements have been completed, the clinician may save the images to the processing system by selecting the appropriate options in the bedside controller GUI. A method of performing measurements on the bedside controller will be described below.

Figure 8 is high-level flowchart of a method 800 that describes a measurement workflow on the bedside controller 300 of Figures 3A-4. In one embodiment, the method 800 may be carried out during block 720 of the method 700 in Figure 7 as part of a medical sensing workflow on intravascular images. Further, in the illustrated embodiment, the method 800 of making measurements on the bedside controller 300 is implemented in measurement software stored in the storage module 324 in the bedside controller. In general, when measuring images, such as intravascular images, a clinician has the option of making different types of measurements such as diameter measurements and area measurements. Typically, when making area measurements, a clinician may either denote the edges of an

object by drawings a series of discrete points that are connected in subsequent processing or by drawing a continuous line around the object to the measured. In this regard, the method 800 of performing measurements on images is “smart” in that it does not require a user to select a particular measurement mode prior to interacting with an image on the bedside
5 controller. For instance, when a user performs a series of measurement inputs on the bedside controller, the GUI software interprets the nature (e.g. shape) of a user’s measurement inputs, automatically enters either diameter mode, area-point mode or area-draw mode, and outputs the desired measurement on the controller’s display.

In more detail, the method 800 begins at block 802 where an image to be measured is
10 displayed on the bedside controller and a user inputs a measurement start point on the image with an input device. For example, the user may use a finger or stylus to indicate a point on a vessel border from which a measurement will commence. Note that prior to selecting the measurement start point, the measurement software did not require the user to select a measurement mode. Next, in block 804, the user, without removing the input device from the
15 image after indicating the start point, drags the input device across the image a distance to trace a line. Then, in block 806, the user withdraws the input device from the image at a measurement end point. The method 800 proceeds to decision block 808 where the measurement software determines whether the distance between the start point and the end point is less than a threshold value. In one embodiment, the threshold value is equivalent to
20 10 pixels, but, in alternative embodiments, the threshold value may be smaller or larger or measured in different units. Further, in some embodiments, the threshold value is adjustable either manually by a user or automatically based on detected error rates. If the distance is less than the threshold value, the method proceeds to block 810 where the measurement software enters area-point mode and draws a point on the image corresponding to the end
25 point (i.e. where the user lifted the input device from the touch-enabled display). This sequence is illustrated in Figure 9. Specifically, when a user presses (900) an input device on an image and immediately lifts (902) the input device, the input will be interpreted as a point entry and a point 904 will be drawn on the image.

The method 800 then proceeds to decision block 812 where it is decided whether
30 additional points are needed to make a measurement on the image. If additional points are needed, the method proceeds to block 814 where a user touches and releases the displayed image at a different location. Note that in this branch of method 800, the measurement software is in area-point mode so that all entries will be interpreted as points and, when an

input is detected, a point will be drawn on the image in block 810 regardless of the distance between a start point and end point of the input. If no additional points are needed to make a measurement in decision block 812, the method 800 proceeds to block 816, where a user selects a 'Done' button in the bedside controller GUI to exit area-point mode. In block 818,
5 the measurement software creates an area measurement using the entered points. For example, in an embodiment directed toward vessel measurement, the measurement software connects the entered points to create a bounding circle at the vessel's outer edge. In one embodiment, the measurement software uses the entered points as seed points to assist edge detection algorithms.

10 With reference back to decision block 808, if the distance between the start point and the end point is greater than or equal to the threshold, the method 800 proceeds to decision block 820 where the measurement software determines whether the drawn line is "relatively straight". That is, it determines whether the user desires to measure a diameter with a line or an area with a enclosed shape. As shown in Figure 10, to make such a determination, the
15 measurement software compares intervening points on the traced line between a start point 1000 and an end point 1002 against a boundary threshold 1004. If all intervening points are within the boundary threshold 1004, the measurement software determines that the user desires to make a diameter measurement and transforms the traced line into a straight line 1006 extending from the start point to the end point. The diameter measurement is thus
20 based on the length of the straight line 1006. In alternative embodiments, however, the measurement software may employ different methods for determining whether the user desires to make a diameter measurement or an area measurement, such as detecting whether intervening points between start and end points increase in distance from the start point before decreasing in distance from the start point or detecting whether the traced line
25 extending through the start point, at least one intervening point, and the end point is arcuate past a threshold degree. At decision block 820, if the user's traced line is relatively straight, the method proceeds to block 822 where the measurement software enters diameter mode and outputs a measurement of the straight line 1006 created between the start and end points. If, however, the traced line is not relatively straight, the method 800 proceeds to 818 where the
30 measurement software enters area-draw mode. As shown in Figure 11, the traced line 1100 between start point 1102 and end point 1104 extends outside of a boundary threshold (not shown) and is thus not relatively straight, prompting the measurement software to enter area-draw mode. Once this determination is made, the software connects the start and ends points

to create a unbroken bounding line 1006 from which an area may be calculated. After an area measurement has been made in block 818 (either in area-point mode or area-draw mode), the method proceeds to decision block 824 where it is determined if another measurement needs to be done. If so, the method proceeds back to block 802 where a user selects another start
5 point on the image without first selecting a measurement mode. If all measurements have been completed, the method 800 ends.

It is understood that the methods 700 and 800 illustrated in the flow charts of Figures 7 and 8 may, in alternative embodiments, be performed in a different order and may include different and/or additional blocks in some embodiments. For example, workflows for
10 some medical sensing procedure may allow for additional measurement modes, such as volumetric measurements. According to the described aspects of the present disclosure, a user may initiate any such additional measurement modes without first selecting a measurement mode, thus simplifying the workflow. Further, the steps in methods 700 and 800 described above may be completed over the course of more than one patient visit to a
15 catheter lab.

Although illustrative embodiments have been shown and described, a wide range of modification, change, and substitution is contemplated in the foregoing disclosure and in some instances, some features of the present disclosure may be employed without a corresponding use of the other features. For example, in some embodiments, the touch-
20 enabled integrated bedside controllers 102 and 300 may be used to control and measure non-cardiovascular diagnostic data such as data from cranial or peripheral arteries, as well as data from non-vascular body portions. Further, the controllers 102 and 300 may be used to control an MRI workflow and measure MRI image data, or may be utilized in computer assisted surgery (CAS) applications. Further, the modules described above in association with the
25 bedside controller 300 may be implemented in hardware, software, or a combination of both. And the bedside controller may be designed to enable user control in many different network settings such as ad-hoc networks, local area networks, client-server networks, wide area networks, internets, and the controller may have a number of form factors such as a tablet, a smartphone, a laptop, or any other similar device. It is understood that such variations may
30 be made in the foregoing without departing from the scope of the present disclosure. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the present disclosure.

WHAT IS CLAIMED IS:

1. A method of performing measurements on medical images with a bedside controller, the method comprising:
- 5 receiving, through a touch-sensitive display on the bedside controller, a user measurement input on an image displayed on the display, the user measurement input including a start point defined by a point of initial contact with the touch-sensitive display and an end point defined by a point of last contact with the touch-sensitive display;
- selecting a measurement mode based on a shape of the user measurement input; and
- 10 calculating a measurement value associated with the user measurement input based on the measurement mode.
2. The method of Claim 1, wherein selecting the measurement mode includes selecting one of a diameter measurement mode and an area measurement mode based on the
- 15 shape of the user measurement input.
3. The method of Claim 2, wherein selecting the measurement mode includes:
- determining whether any intervening points along the user measurement input between the start point and the end point fall outside of a boundary threshold;
- 20 selecting the diameter measurement mode if none of the intervening points fall outside of the boundary threshold; and
- selecting the area measurement mode if at least one intervening point falls outside of the boundary threshold.
- 25 4. The method of Claim 3,
- wherein selecting the diameter measurement mode includes drawing a straight line between the start point and the end point; and
- wherein calculating the measurement value includes calculating the length of the
- 30 straight line.

5. The method of Claim 3,
wherein selecting the area measurement mode includes connecting the start point and
the end point to create a bounded object; and
wherein calculating the measurement value includes calculating the area of the
5 bounded object.

6. The method of Claim 1, wherein selecting the measurement mode includes:
calculating a distance between the start point and the end point of the user
measurement input on the image;
10 comparing the distance to a threshold; and
selecting a measurement mode based on the comparison.

7. The method of Claim 6, wherein selecting a measurement mode based on the
comparison includes selecting an area-point mode if the distance is less than the threshold.
15

8. The method of Claim 7, wherein selecting the area-point mode includes:
interpreting subsequent user measurement inputs as points; and
connecting the points to create a bounded object;
wherein calculating the measurement value includes calculating the area of the
20 bounded object.

9. The method of Claim 1, wherein selecting a measurement mode includes choosing
a measurement mode between one of a diameter mode, an area-point mode, and an area-draw
mode.
25

10. The method of Claim 1, wherein receiving the user measurement input includes
detecting contact on the touch-sensitive display from one of a stylus and a body part.

11. The method of Claim 1, wherein receiving the user measurement input includes
30 detecting contact on the touch-sensitive display through one of a sterile drape and a glove.

12. A bedside controller, comprising:
a housing, the housing including self-contained mounting structure;

a touch-sensitive display disposed within a surface of the housing and configured to display images and receive user input on the surface;

a processor disposed within the housing;

a communication module disposed within the housing, communicatively coupled to
5 the processor, and configured to transmit and receive medical data from a processing system;
and

a non-transitory computer readable storage module disposed within the housing,
communicatively coupled to the processor, and including a plurality of instructions stored
therein and executable by the processor, the plurality of instructions including:

10 instructions for receiving, through the touch-sensitive display, a user
measurement input on an image displayed on the display;

instructions for selecting a measurement mode based on a shape of the user
measurement input; and

15 instructions for calculating a measurement value associated with the user
measurement input based on the measurement mode.

13. The bedside controller of Claim 12, wherein the touch-sensitive display is
configured to accept user input through a sterile drape.

20 14. The bedside controller of Claim 12, wherein the touch-sensitive display is
configured to accept user input from gloved touch.

15. The bedside controller of Claim 12, wherein the touch-sensitive display is
configured to provide haptic feedback to a user.

25 16. The bedside controller of Claim 12, wherein the housing is fluid resistant.

17. The bedside controller of Claim 12, wherein the communication module is a
wireless communication module.

30 18. The bedside controller of Claim 12, including a rechargeable battery disposed
within the housing, the battery being configured to provide power to the non-transitory

computer readable storage module, the communication module, the processor, and the touch-sensitive display.

19. The bedside controller of Claim 18, wherein the bedside controller is configured
5 to dock to a processing system and draw power therefrom to recharge the battery.

20. The bedside controller of Claim 12, wherein the instructions for selecting the
measurement mode include instructions for selecting one of a diameter measurement mode
and an area measurement mode based on the shape of the user measurement input.
10

21. The bedside controller of Claim 20, wherein the instructions for selecting the
measurement mode include:

instructions for determining whether any intervening points along the user
measurement input between the start point and the end point fall outside of a boundary
15 threshold;

instructions for selecting the diameter measurement mode if none of the intervening
points fall outside of the boundary threshold; and

instructions for selecting the area measurement mode if at least one intervening point
falls outside of the boundary threshold.
20

22. The method of Claim 21,
wherein the instructions for selecting the diameter measurement mode include
instructions for drawing a straight line between the start point and the end point; and
wherein the instructions for calculating the measurement value include instructions
25 for calculating the length of the straight line.

23. The method of Claim 21,
wherein the instructions for selecting the area measurement mode include instructions
for connecting the start point and the end point to create a bounded object; and
30 wherein the instructions for calculating the measurement value include instructions
for calculating the area of the bounded object.

24. The bedside controller of Claim 12, wherein the instructions for receiving a user measurement input include instructions for receiving a start point defined by a point of initial contact with the touch-sensitive display and an end point defined by a point of last contact with the touch-sensitive display.

5

25. The bedside controller of Claim 24, wherein the instructions for selecting the measurement mode include:

instructions for calculating a distance between the start point and the end point of the user measurement input on the image;

10

instructions for comparing the distance to a threshold; and

instructions for selecting a measurement mode based on the comparison.

26. A medical measuring system, comprising:

a medical sensor device configured to gather medical data from a patient;

15

a processing system communicatively coupled to the medical sensor device and operable to receive the medical data from the medical sensor device, the processing system being further operable to transform the medical data into medical images representative of the patient; and

20

a bedside controller communicatively coupled to the processing system and operable to receive the medical images from the processing system and display the medical images on a touch-sensitive display, the bedside controller being further configured to receive, through the touch-sensitive display, a user measurement input on a medical image displayed on the display,

25

select a measurement mode based on a shape of the user measurement input, and calculate a measurement value associated with the user measurement input based on the measurement mode.

30

27. The medical measuring system of Claim 26, wherein the bedside controller is configured to select one of a diameter measurement mode and an area measurement mode based on the shape of the user measurement input.

28. The medical measuring system of Claim 26, wherein the bedside controller is configured to receive a user measurement input start point defined by a point of initial contact

with the touch-sensitive display and a user measurement input end point defined by a point of last contact with the touch-sensitive display.

29. The medical measuring system of Claim 28, wherein the bedside controller is
5 further configured to calculate a distance between the start point and the end point of the user measurement input on the image, compare the distance to a threshold, and select a measurement mode based on the comparison.

30. The medical measuring system of Claim 26, wherein the bedside controller is
10 configured to control the commencement and termination of a recordation of medical data captured by the medical sensor device.

31. A method of conducting a medical workflow with a touch-sensitive bedside controller, the method comprising:
15 initiating a medical workflow using a graphical user interface on the bedside controller;
positioning an imaging tool within a patient's body based on images captured by the imaging tools and displayed on the bedside controller;
controlling the initiation and termination of a recordation of images by the imaging
20 tool using the graphical user interface on the bedside controller;
navigating through the recorded images to identify an image of interest using the graphical user interface on the bedside controller; and
performing measurements on the image of interest using the graphical user interface on the bedside controller.

25
32. The method of Claim 31, wherein the initiating includes selecting the medical workflow out of a plurality of medical workflows presented as selectable options within the graphical user interface.

30
33. The method of Claim 32, wherein the plurality of medical workflows includes two or more of an intravascular ultrasound (IVUS) imaging workflow, an intravascular photoacoustic (IVPA) imaging workflow, an optical coherence tomography (OCT) workflow,

a forward looking IVUS (FL-IVUS) workflow, a fractional flow reserve (FFR) workflow, a coronary flow reserve (CFR) workflow, and an angiography workflow.

34. The method of Claim 31, wherein the performing measurements includes
5 touching and releasing portions of the image of interest as it is displayed on the bedside controller to make one of an area measurement and a diameter measurement.

35. The method of Claim 34, wherein the touching and releasing includes making one of the area measurement and the diameter measurement without first selecting a measurement
10 mode corresponding one of the area measurement and the diameter measurement.

36. The method of Claim 31, wherein the initiating, positioning, controlling, navigating, and performing are performed on the bedside controller in a sterile field.

37. The method of Claim 31, wherein navigating through the recorded images
15 includes navigating through a condensed view of all of the recorded images.

38. The method of Claim 31, wherein navigating through the recorded images includes performing navigation-type gestures on the touch-sensitive display.
20

39. The method of Claim 31, wherein performing measurements includes annotating the image of interest with the measurements.

40. The method of Claim 39, further including saving to a processing system the
25 image of interest with the measurement annotations thereon.

41. The method of Claim 31, wherein the imaging tool is a sensor disposed on a catheter within a vessel of the patient.

42. The method of Claim 41, wherein the controlling includes coordinating the
30 recordation with a pullback of the catheter.

43. The method of Claim 31, wherein controlling the initiation and termination includes selecting a record option in the graphical user interface to initiate the recordation.

44. The method of Claim 31, further including receiving haptic feedback in response to performing measurements on the image of interest using the graphical user interface.

45. The method of Claim 31, wherein the images captured by the imaging tool are associated with one of intravascular ultrasound (IVUS), intravascular photoacoustic (IVPA), optical coherence tomography (OCT), forward looking IVUS (FL-IVUS), fractional flow reserve (FFR), coronary flow reserve (CFR), and angiography.

46. A bedside controller, comprising:

a housing;

a touch-sensitive display disposed within a surface of the housing and configured to display images and receive user input on the surface;

a processor disposed within the housing;

a communication module disposed within the housing, communicatively coupled to the processor, and configured to transmit and receive medical data; and

a non-transitory computer readable storage module disposed within the housing, communicatively coupled to the processor, and including a plurality of instructions stored therein and executable by the processor, the plurality of instructions including:

instructions for rendering a graphical user interface (GUI) on the touch-sensitive display;

instructions for displaying images of a patient as they are being captured by an imaging tool disposed within the patient's body;

instructions for initiating and terminating a recordation of the images based on user input to the GUI;

instructions for displaying the recorded images within the GUI so that a user may identify an image of interest; and

instructions for making a measurement on the image of interest based on a user measurement input to the GUI.

47. The bedside controller of Claim 46, wherein the images of the patient are associated with one of intravascular ultrasound (IVUS), intravascular photoacoustic (IVPA), optical coherence tomography (OCT), forward looking IVUS (FL-IVUS), fractional flow reserve (FFR), coronary flow reserve (CFR), and angiography.

5

48. The bedside controller of Claim 46, wherein the plurality of instructions includes instructions for presenting a plurality of workflow modes selectable by a user through the GUI.

10

49. The bedside controller of Claim 48, wherein the plurality of instructions includes instructions for receiving a user selection of a workflow mode out of the plurality of workflow modes through the GUI.

15

50. The bedside controller of Claim 48, wherein the plurality of workflow modes includes two or more of an intravascular ultrasound (IVUS) imaging mode, an intravascular photoacoustic (IVPA) imaging mode, an optical coherence tomography (OCT) mode, a forward looking IVUS (FL-IVUS) mode, a fractional flow reserve (FFR) mode, a coronary flow reserve (CFR) mode, and an angiography mode.

20

51. The bedside controller of Claim 46, wherein the instructions for displaying the recorded images within the GUI includes instructions for displaying a condensed view of all of the recorded images.

25

52. The bedside controller of Claim 46, wherein the instructions for displaying the recorded images within the GUI includes instructions for receiving gesture inputs through the touch-sensitive display for navigation through the recorded images.

30

53. The bedside controller of Claim 46, wherein the plurality of instructions includes instructions for annotating the image of interest with the measurements.

54. The bedside controller of Claim 23, wherein the plurality of instructions includes instructions for saving to a processing system the image of interest with the measurement annotations thereon.

55. The bedside controller of Claim 46, wherein the imaging tool is a sensor disposed on a catheter within a vessel of the patient.

5 56. The bedside controller of Claim 55, wherein the instructions for initiating and terminating include instructions for coordinating the recordation with a pullback of the catheter.

10 57. The bedside controller of Claim 46, wherein the instructions for making a measurement include instructions for selecting one of an area measurement mode and a diameter measurement mode based on the user measurement input.

15 58. The bedside controller of Claim 46, wherein the instructions for rendering a GUI on the touch-sensitive display include instructions for providing haptic feedback in response to touch-based input to the GUI.

20 59. The bedside controller of Claim 46, wherein the instructions for displaying the recorded images include instructions for displaying a three-dimensional rendering of a portion of the patient's body.

25 60. The bedside controller of Claim 59, wherein the instructions for displaying a three-dimensional rendering include: instructions for receiving multiple concurrent touch inputs via the touch-sensitive display; and instructions for rotating the three-dimensional rendering about an axis based on the multiple concurrent touch inputs.

30 61. A bedside controller, comprising:
an integrally formed housing;
self-contained mounting structure disposed on the housing, the mounting structure including:

a mounting channel defined in the housing; and

a retaining clamp disposed above the mounting channel and configured to releasably secure a mounting platform within the mounting channel such that the bedside controller is mounted to the mounting platform;

a touch-sensitive display disposed within a surface of the housing and configured to display images and receive user input on the surface;

a processor disposed within the housing;

a communication module disposed within the housing, communicatively coupled to
5 the processor, and configured to transmit and receive medical data; and

a battery disposed within the integrally formed housing and electrically coupled to the touch-sensitive display, the processor, and the communication module.

62. The bedside controller of Claim 61, wherein the self-contained mounting
10 structure is disposed near an outer edge of the housing such that when the mounting structure is releasably secured to a mounting platform the bedside controller is mounted in a cantilevered manner.

63. The bedside controller of Claim 61, wherein the self-contained mounting
15 structure is operable to releasably secure the bedside controller to a bed rail in a sterile field.

64. The bedside controller of Claim 63, wherein the self-contained mounting
structure is configured to releasably secure the bedside controller to the bed rail in such a
manner that the display of the bedside controller is generally parallel with a top surface of a
20 table associated with the bed rail.

65. The bedside controller of Claim 61,
wherein the mounting channel is defined by a front wall, a top wall, and a back wall,
the front and back walls being generally perpendicular to the display and the top wall being
25 generally parallel to the display; and

wherein the retaining clamp includes a slot extending generally parallel to the mounting channel.

66. The bedside controller of Claim 65, wherein the front, top, and back walls and the
30 slot cooperate with respective surfaces of an elongate object to releasably secure the bedside controller thereto.

67. The bedside controller of Claim 61, wherein the integrally formed housing is seamlessly molded.

68. The bedside controller of Claim 61, wherein the images include images
5 associated with one of intravascular ultrasound (IVUS) imaging, intravascular photoacoustic (IVPA) imaging, optical coherence tomography (OCT), forward looking IVUS (FL-IVUS), fractional flow reserve (FFR), coronary flow reserve (CFR), and angiography.

69. The bedside controller of Claim 61, further including electrical contacts disposed
10 on an exterior surface of the housing and electrically coupled to the battery, the electrical contacts configured to receive an electrical charge and pass the electrical charge to the battery.

70. The bedside controller of Claim 69, wherein the electrical contacts are disposed
15 within the mounting channel and configured to receive an electrical charge when the bedside controller is mounted.

71. The bedside controller of Claim 61, wherein the touch-sensitive display is configured to accept user input through a sterile drape.
20

72. The bedside controller of Claim 61, wherein the touch-sensitive display is configured to accept user input from gloved touch.

73. The bedside controller of Claim 61, wherein the touch-sensitive display is
25 configured to provide haptic feedback to a user.

74. The bedside controller of Claim 61, wherein the housing is fluid resistant.

75. The bedside controller of Claim 61, wherein the communication module is a
30 wireless communication module.

76. A method of releasably mounting a bedside controller to a mounting platform associated with a patient undergoing an intravascular workflow, comprising:

pivoting a retaining clamp to an open position, the retaining clamp being disposed on the bedside controller such that it extends over a mounting channel defined in a housing of the bedside controller;

positioning the bedside controller such that the mounting platform extends through the mounting channel;

releasing the retaining clamp such that it engages the mounting platform to releasably secure the mounting platform within the mounting channel, thereby mounting the bedside controller to the mounting platform;

viewing intravascular medical information associated with the patient displayed on a touch-sensitive display of the bedside controller; and

inputting user inputs on the touch-sensitive display to manipulate the medical information displayed on the touch-sensitive display.

77. The method of Claim 76,

wherein the mounting channel is defined by a front wall, a top wall, and a back wall, the front and back walls being generally perpendicular to the touch-sensitive display and the top wall being generally parallel to the touch-sensitive display; and

wherein positioning the bedside controller includes positioning the bedside controller such that the front, top, and back walls and the slot engage the respective surfaces of the mounting platform.

78. The method of Claim 76,

wherein the retaining clamp includes a slot extending generally parallel to the mounting channel; and

wherein releasing the retaining clamp includes securing a portion of the mounting platform within the slot when the retaining clamp is in a closed position.

79. The method of Claim 76, wherein the mounting channel is disposed near an outer edge of the housing such that subsequent to releasing the retaining clamp, the bedside controller is releasably secured to the mounting platform in a cantilevered manner.

80. The method of Claim 76,
wherein the retaining clamp is spring-loaded; and
wherein the releasing the retaining clamp includes exerting pressure on the mounting
platform within the mounting channel.

5

81. The method of Claim 76, wherein the mounting platform is a bed rail in a sterile
field.

82. The method of Claim 81, wherein releasing the retaining clamp includes
10 releasably securing the bedside controller to the bed rail in such a manner that the touch-
sensitive display of the bedside controller is generally parallel with a top surface of a table
associated with the bed rail.

83. The method of Claim 76, wherein the mounting platform is disposed on an IV
15 pole.

84. The method of Claim 76, wherein the mounting platform is disposed on a mobile
cart.

20 85. The method of Claim 76, further including electrically charging a battery of the
bedside controller via electrical contacts disposed within the mounting channel when the
bedside controller is mounted to the mounting platform.

25 86. The method of Claim 76, wherein inputting user inputs includes inputting user
inputs through a sterile drape.

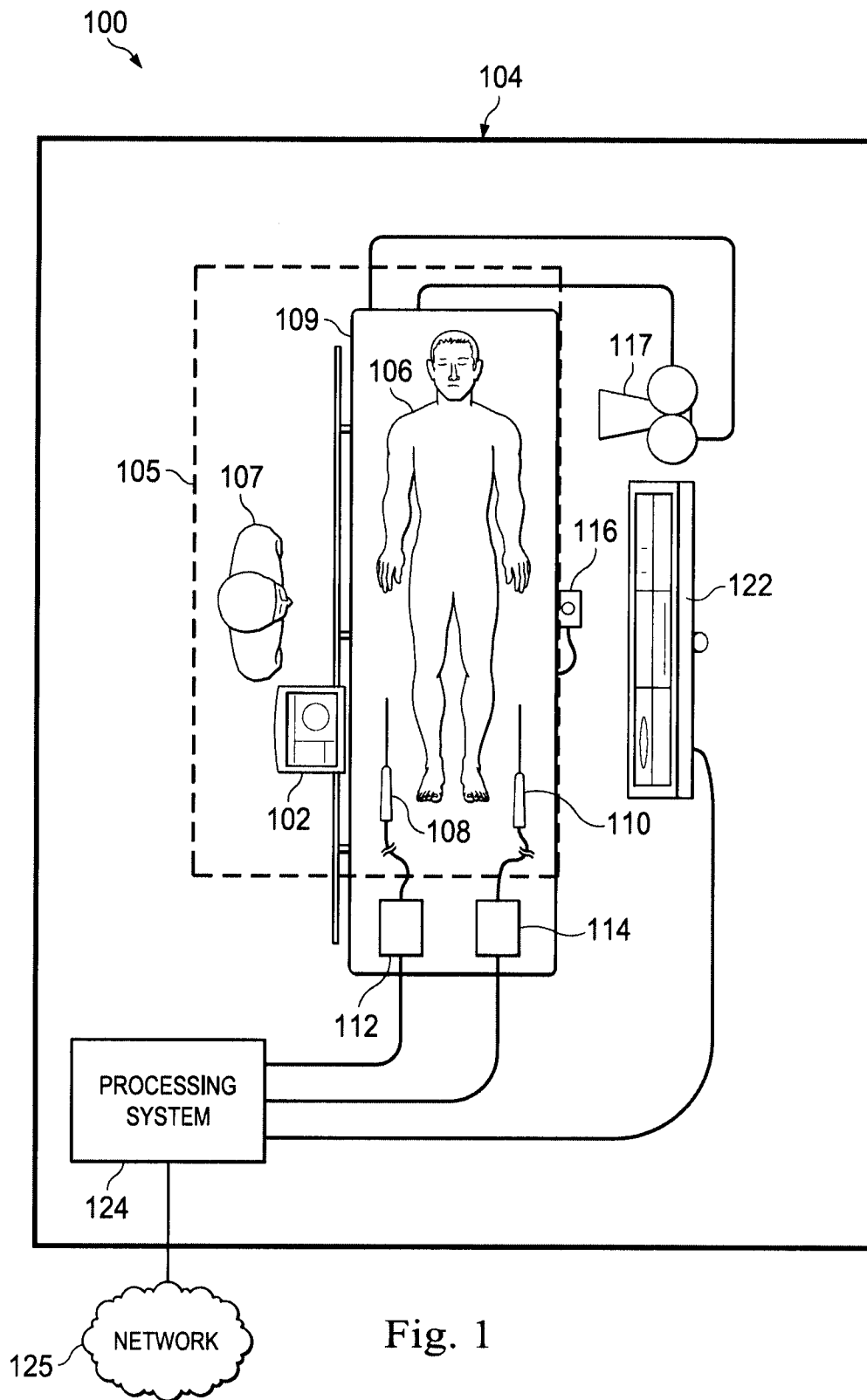
87. The method of Claim 76, wherein inputting user inputs includes inputting user
inputs via gloved touch.

30 88. The method of Claim 76, wherein viewing medical information includes viewing
an image captured by an imaging tool disposed within the patient and displayed by the touch-
sensitive display.

89. The method of Claim 88, further including performing measurements on the image through the user inputs.

90. The method of Claim 76, wherein viewing medical information includes viewing
5 one of intravascular ultrasound (IVUS) imaging information, intravascular photoacoustic (IVPA) imaging information, optical coherence tomography (OCT) information, forward looking IVUS (FL-IVUS) information, fractional flow reserve (FFR) information, and coronary flow reserve (CFR) information.

10



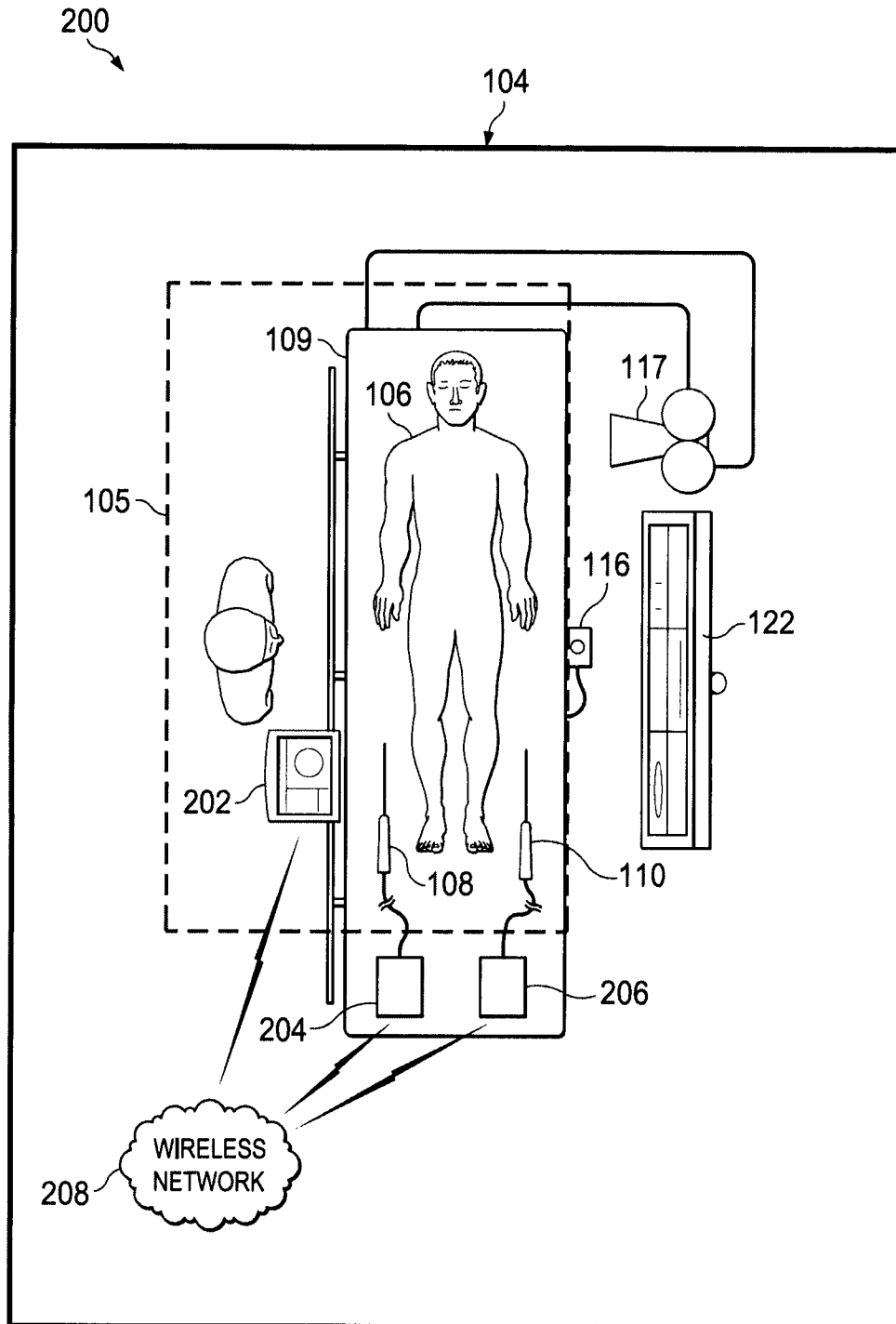


Fig. 2

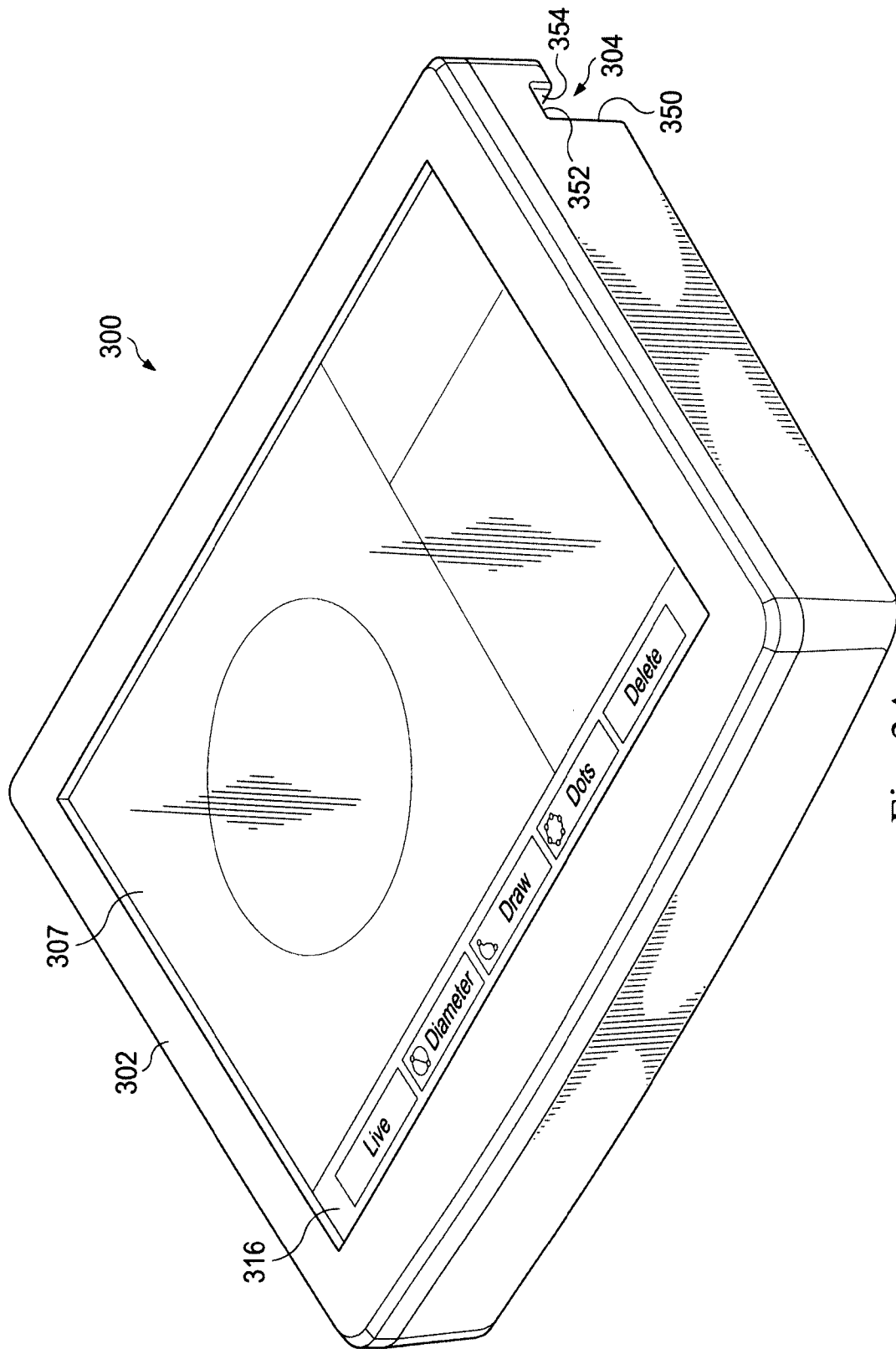


Fig. 3A

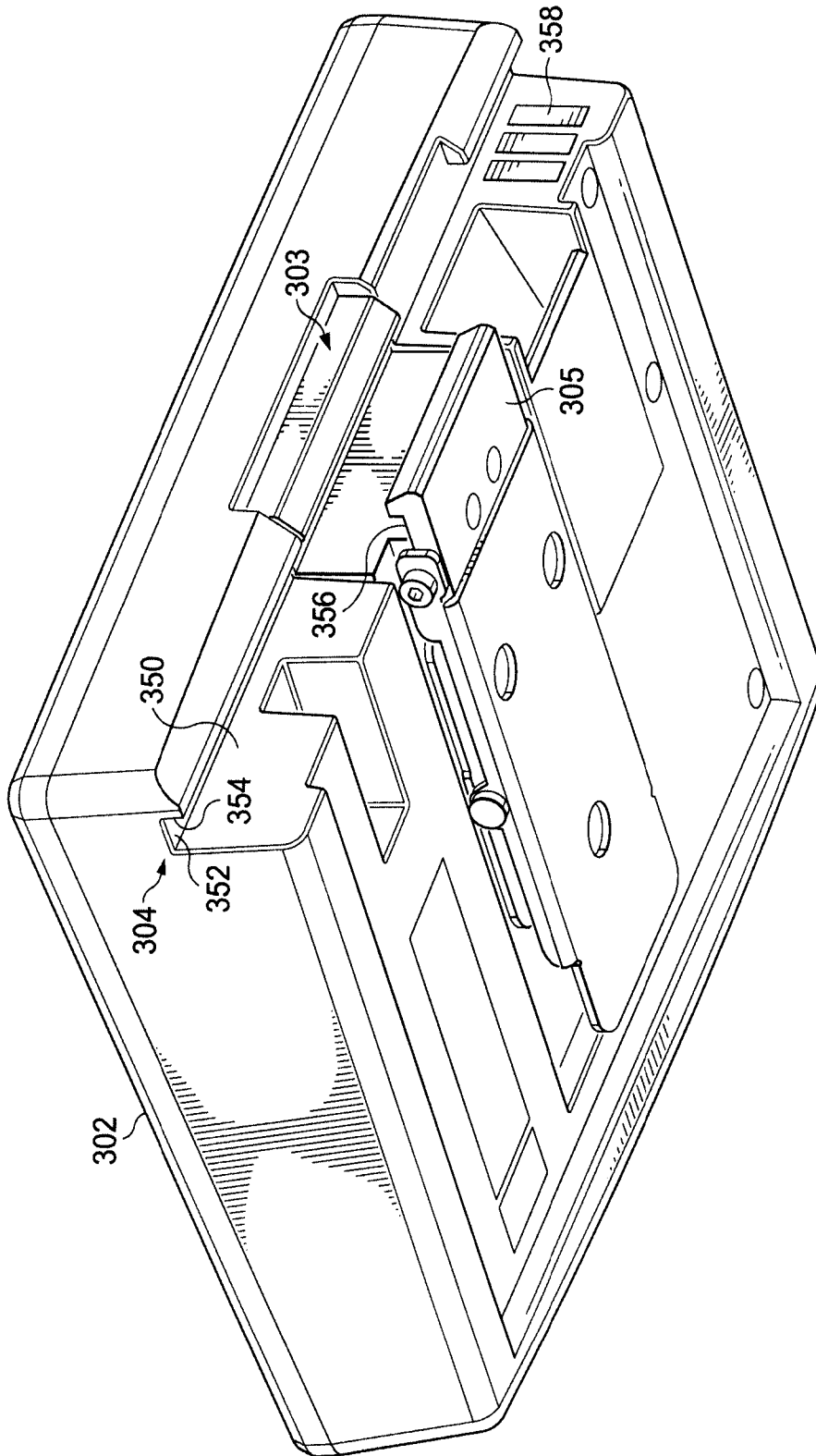


Fig. 3B

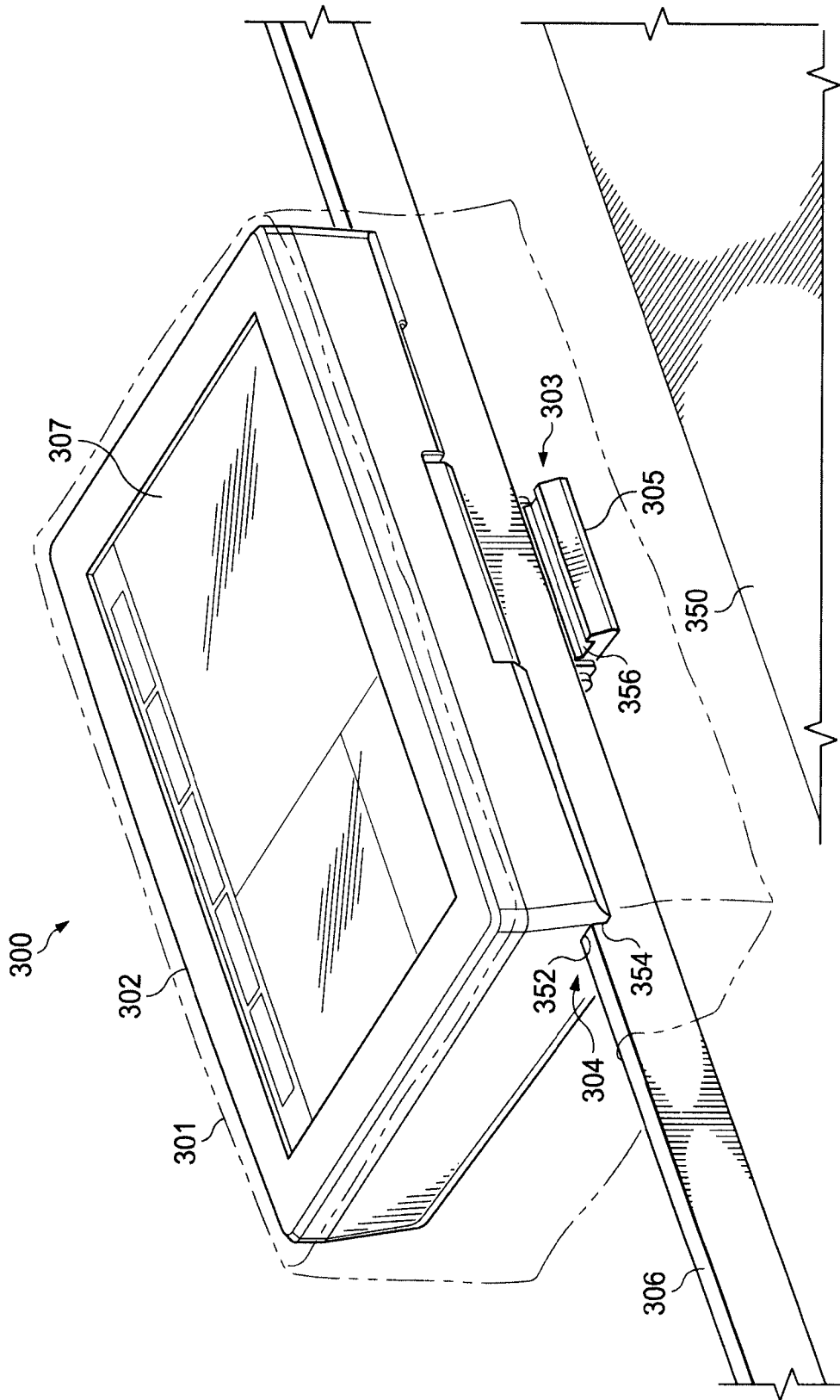


Fig. 3C

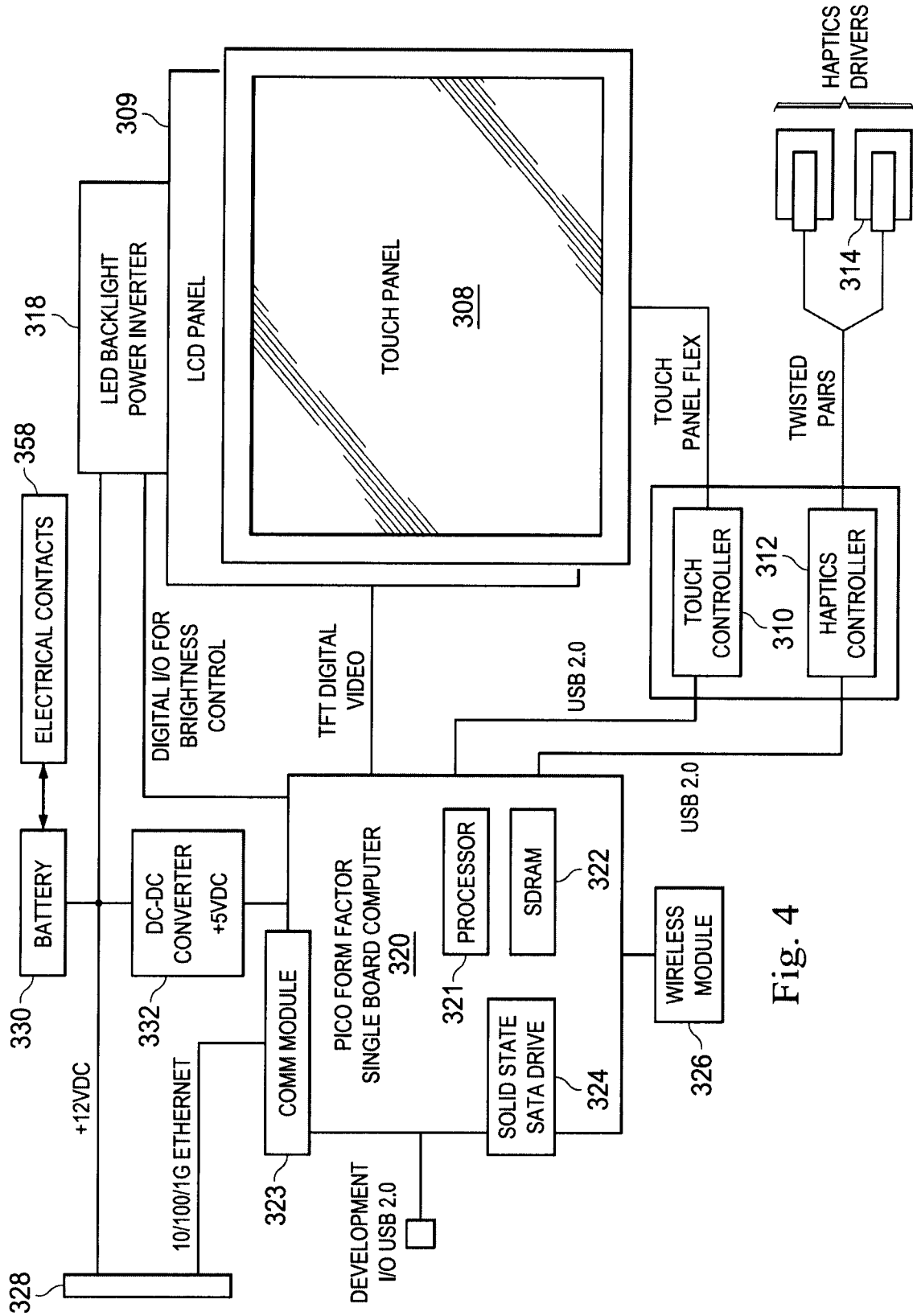


Fig. 4

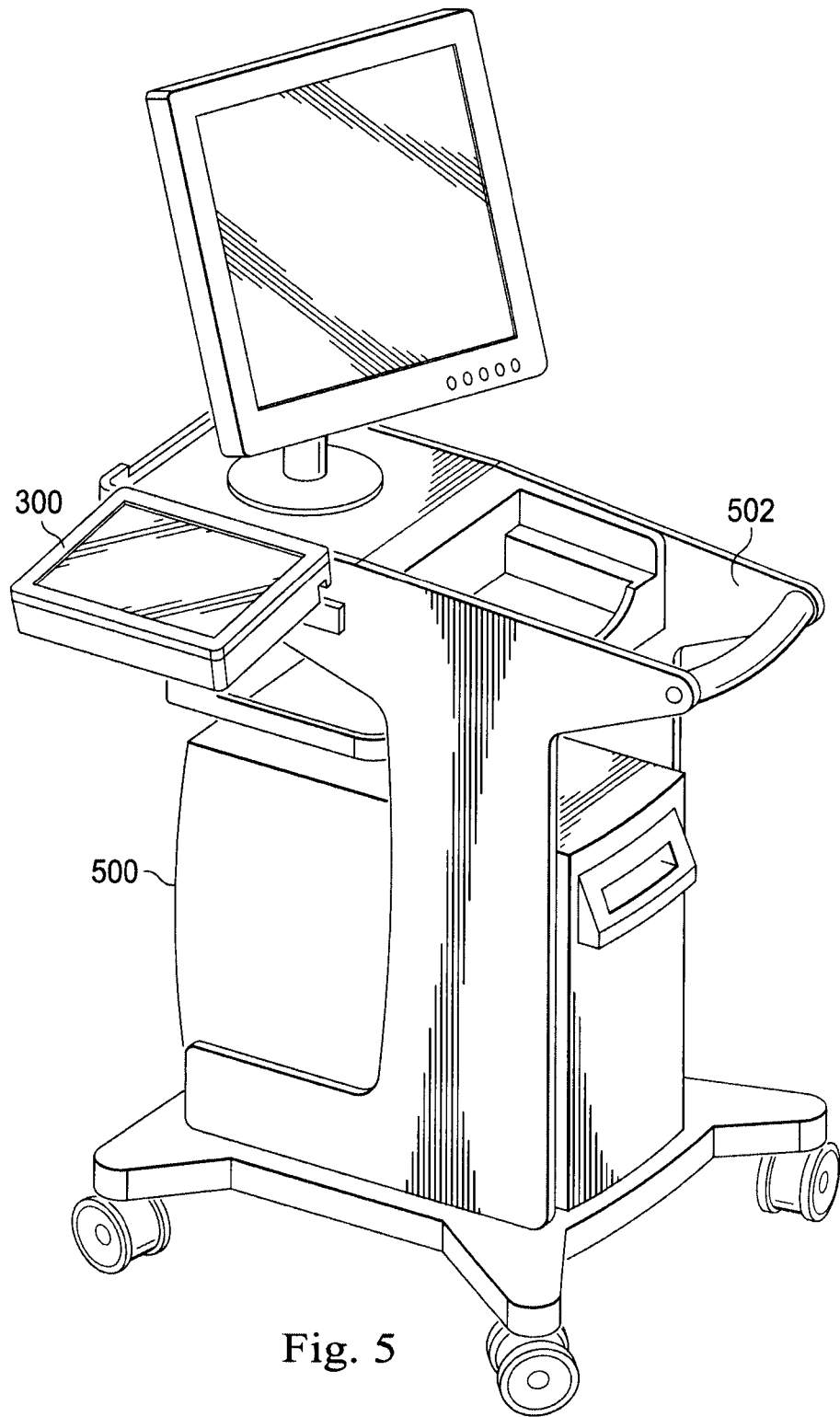


Fig. 5

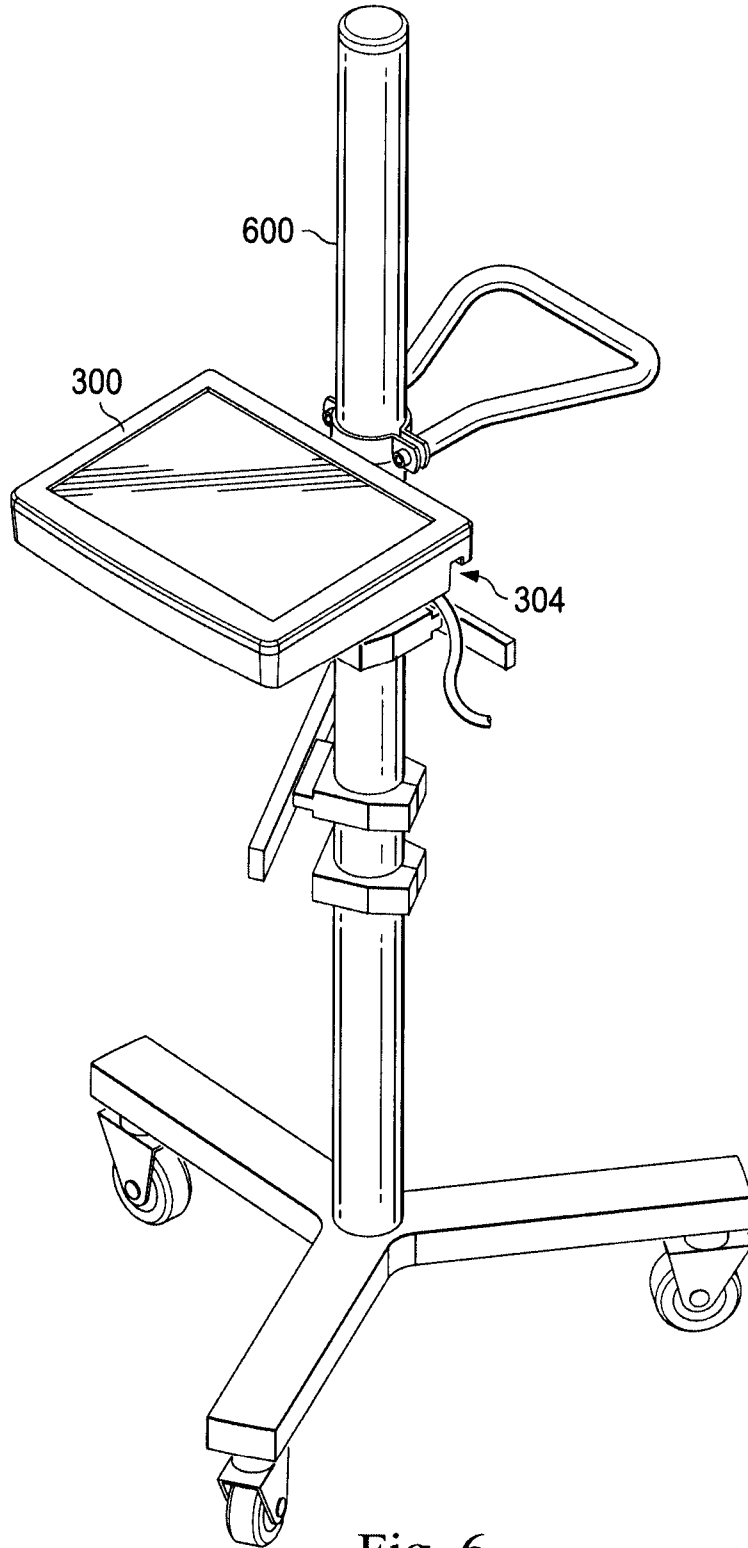


Fig. 6

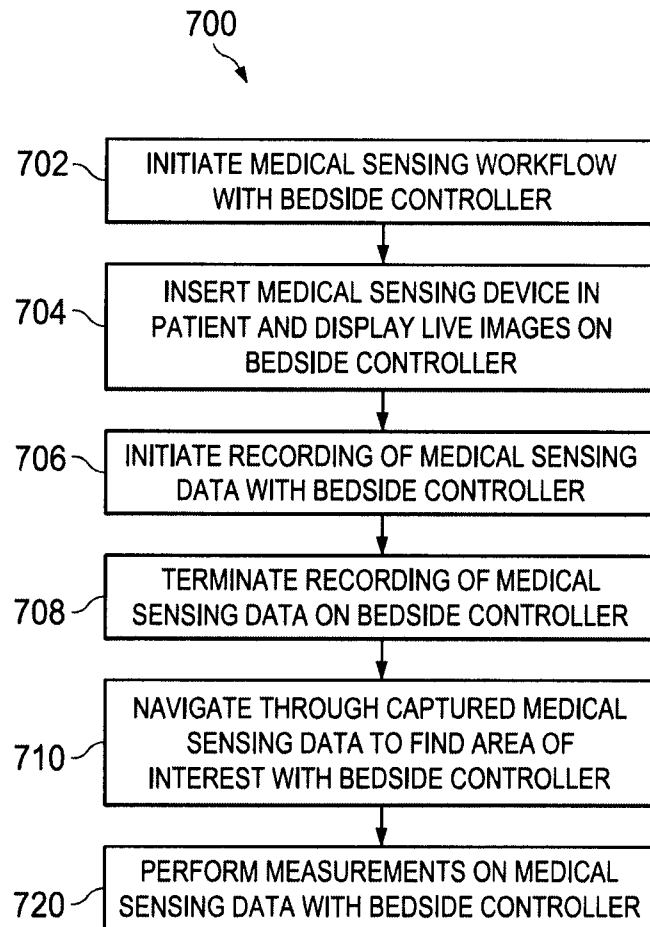


Fig. 7

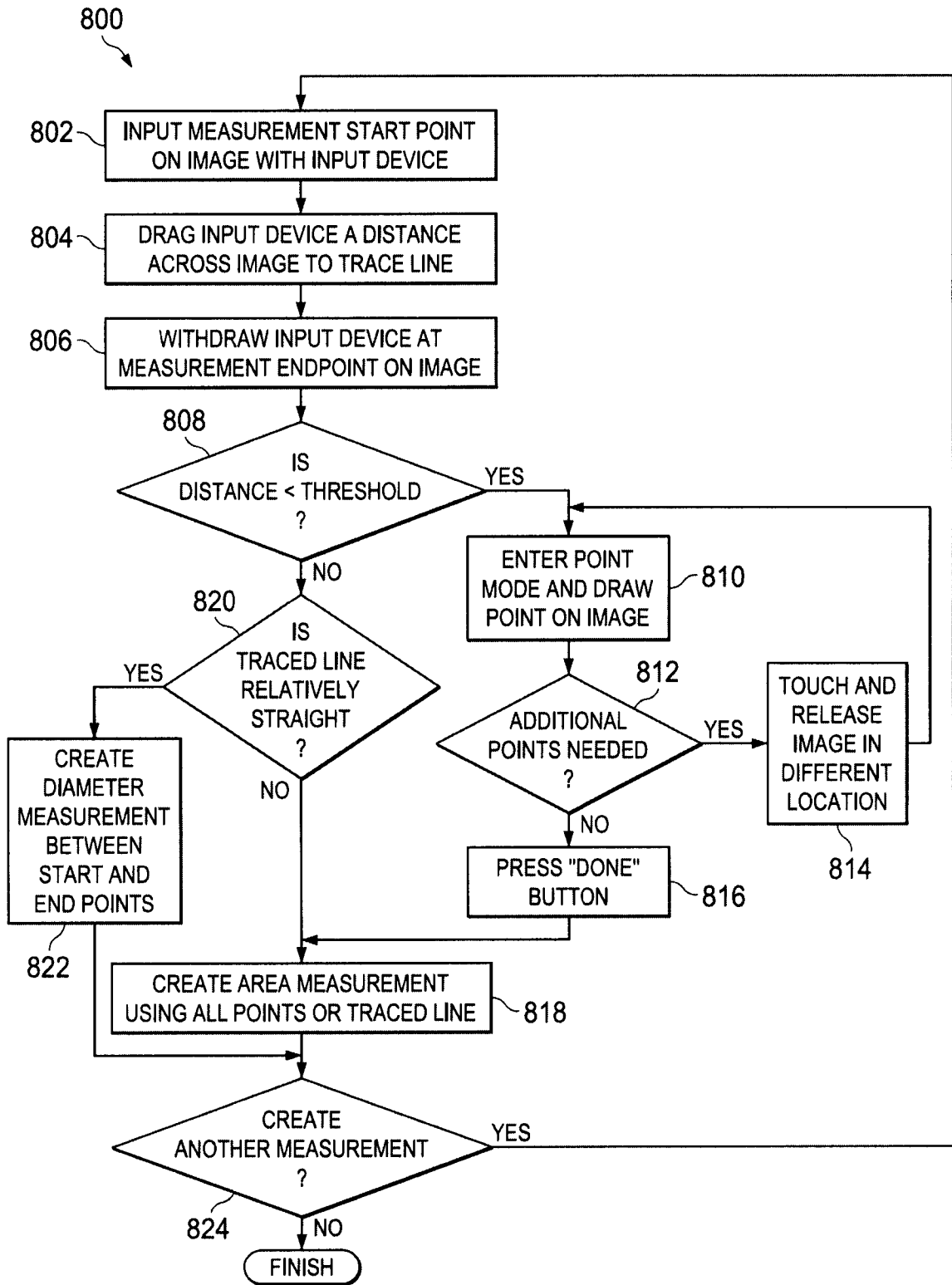


Fig. 8

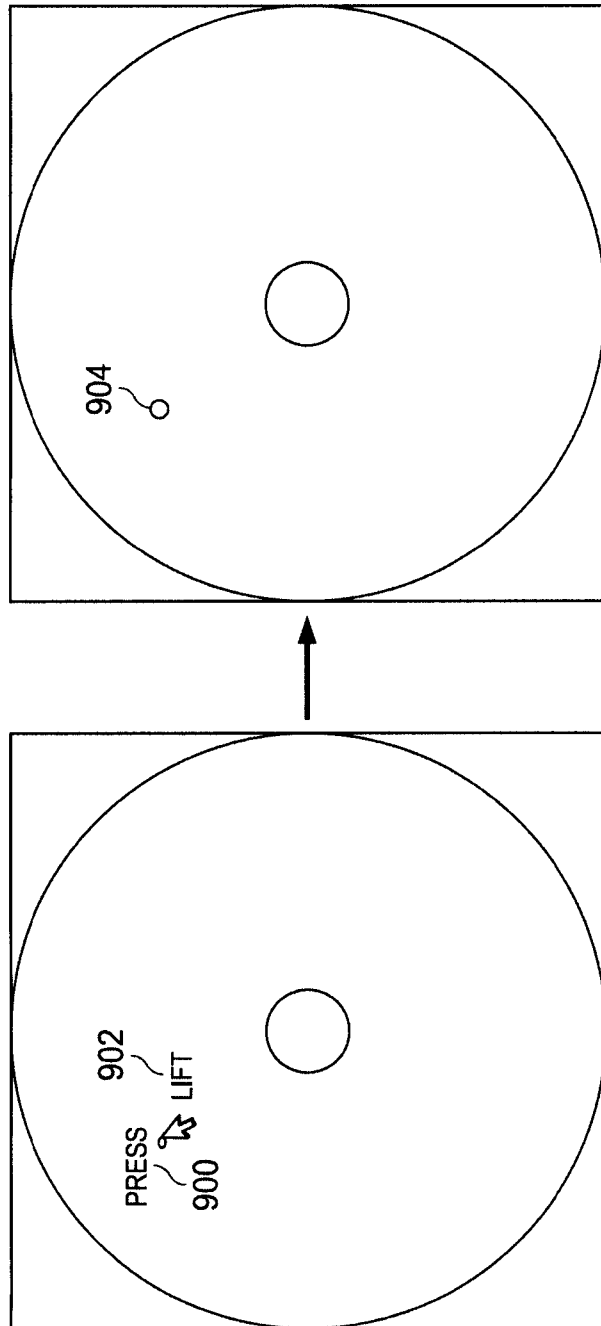


Fig. 9

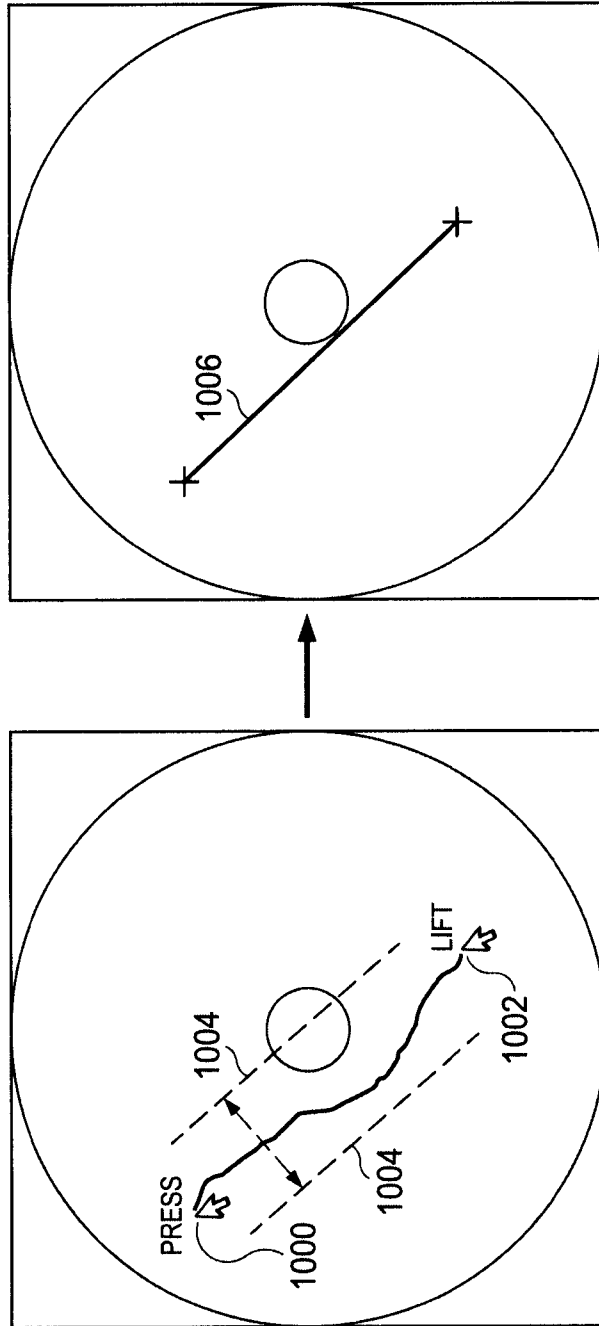


Fig. 10

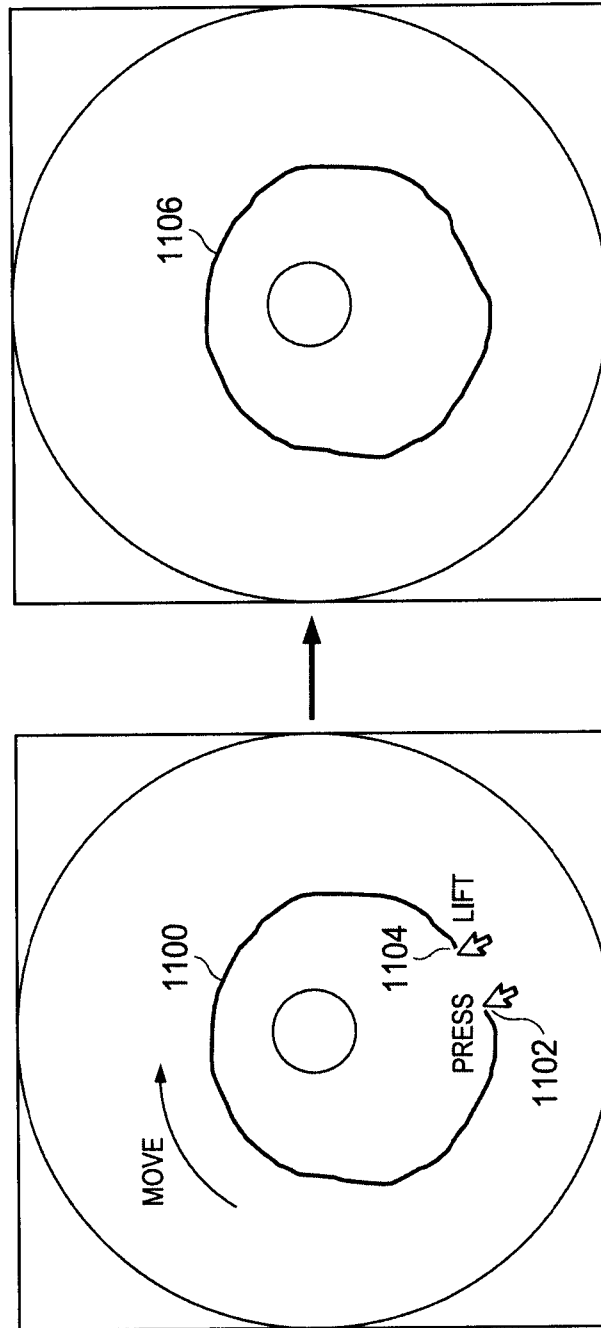


Fig. 11

A. CLASSIFICATION OF SUBJECT MATTER*A61B 8/12(2006.01)i, G06F 3/048(2006.01)i, G06F 3/041(2006.01)i*

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A61B 8/12; A61B 1/00; A61B 1/005; G06K 9/00; G09G 5/00; A61M 5/168; G06F 3/041

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: touch-sensitive, GUI, bedside controller, medical workflow, intravascular

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|--|--|
| X A | US 2006-0274928 A1 (JEFFREY COLLINS et al.) 07 December 2006 See paragraphs [0038]-[0046], [0076], [0082]-[0091], [0104]-[0108], and figures 1-2, 8. | 31-33, 36-37, 39-41, 43, 45-51, 53-55, 59 1-30, 34-35, 38, 42, 44, 52, 56-58, 60-90 |
| A | US 2007-0146339 A1 (SAMSUNG ELECTRONICS CO., LTD.) 28 June 2007 See abstract, paragraphs [0075]-[0082], claim 1, and figure 7. | 1-30 |
| A | US 2011-0009813 A1 (RANKERS ULRICH) 13 January 2011 See abstract, paragraphs [0080]-[0087], [0101], and figures 5-6. | 1-30 |
| A | WO 2010-123858 A2 (ENVISIONIER MEDICAL TECHNOLOGIES, INC. et al.) 28 October 2010 See abstract, paragraphs [0049]-[0052], [0088], [0107], and figures 9, 15. | 31-90 |

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

20 FEBRUARY 2013 (20.02.2013)

Date of mailing of the international search report

20 FEBRUARY 2013 (20.02.2013)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
189 Cheongsu-ro, Seo-gu, Daejeon Metropolitan
City, 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

Park Seung Bae

Telephone No. 82-42-481-5393



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2012/065293

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|--|------------------|-------------------------|------------------|
| US 2006-0274928 A1 | 07.12.2006 | AU 2006-254689 A1 | 07.12.2006 |
| | | AU 2006-317424 A1 | 31.05.2007 |
| | | CA 2610345 A1 | 07.12.2006 |
| | | CA 2629727 A1 | 31.05.2007 |
| | | CN 101203170 A0 | 18.06.2008 |
| | | CN 101360453 A | 04.02.2009 |
| | | EP 1893077 A1 | 05.03.2008 |
| | | EP 1951117 A1 | 06.08.2008 |
| | | JP 2008-541889 A | 27.11.2008 |
| | | JP 2009-516551 A | 23.04.2009 |
| | | KR 10-2008-0021723 A | 07.03.2008 |
| | | KR 10-2008-0070767 A | 30.07.2008 |
| | | US 7783094 B2 | 24.08.2010 |
| | | WO 2006-128302 A1 | 07.12.2006 |
| | | WO 2007-059615 A1 | 31.05.2007 |
| | | US 2007-0146339 A1 | 28.06.2007 |
| KR 10-2007-0069668 A | 03.07.2007 | | |
| US 2011-0009813 A1 | 13.01.2011 | CA 2761606 A1 | 13.01.2011 |
| | | EP 2452282 A1 | 16.05.2012 |
| | | US 2011-0006876 A1 | 13.01.2011 |
| | | US 2011-0006880 A1 | 13.01.2011 |
| | | US 2011-0009724 A1 | 13.01.2011 |
| | | US 2011-0009725 A1 | 13.01.2011 |
| | | US 2011-0010257 A1 | 13.01.2011 |
| | | US 8344847 B2 | 01.01.2013 |
| WO 2011-005633 A2 | 13.01.2011 | | |
| WO 2010-123858 A2 | 28.10.2010 | CN 102458217 A | 16.05.2012 |
| | | EP 2421425 A2 | 29.02.2012 |
| | | KR 10-2012-0008059 A | 25.01.2012 |
| | | WO 2010-123858 A3 | 28.10.2010 |
| | | WO 2010-123858 A3 | 20.01.2011 |

| | | | |
|----------------|---|---------|------------|
| 专利名称(译) | 医疗测量系统和方法 | | |
| 公开(公告)号 | EP2779907A1 | 公开(公告)日 | 2014-09-24 |
| 申请号 | EP2012849119 | 申请日 | 2012-11-15 |
| [标]申请(专利权)人(译) | 火山公司 | | |
| 申请(专利权)人(译) | 火山CORPORATION | | |
| 当前申请(专利权)人(译) | 火山CORPORATION | | |
| [标]发明人 | MERRITT FERGUS J COHEN ASHER DE JONG DUANE LITZZA GERALD L CHELINE AARON J | | |
| 发明人 | MERRITT, FERGUS J. COHEN, ASHER DE JONG, DUANE LITZZA, GERALD L. CHELINE, AARON J. | | |
| IPC分类号 | A61B8/12 G06F3/048 G06F3/041 A61B5/00 G06F19/00 | | |
| CPC分类号 | A61B5/0084 A61B5/0013 A61B5/0059 A61B5/0066 A61B5/0077 A61B5/0095 A61B5/1076 A61B5/7435 A61B5/7445 A61B6/504 A61B6/56 A61B8/12 A61B8/4416 A61B8/467 A61B8/56 A61B8/565 A61B2560/0437 A61B2560/0487 A61M5/007 G06F3/01 G06F3/041 G06F3/04883 G16H40/63 | | |
| 代理机构(译) | 博尔特WADE TENNANT | | |
| 优先权 | 61/560677 2011-11-16 US | | |
| 其他公开文献 | EP2779907A4 | | |
| 外部链接 | Espacenet | | |

摘要(译)

一种利用床边控制器执行对医学图像的测量的方法包括通过床边控制器上的触敏显示器接收在显示器上显示的图像上的用户测量输入，所述用户测量输入包括由点与触摸敏感显示器的初始接触以及由与触摸敏感显示器的最后接触点限定的端点。该方法还包括基于用户测量输入的形状选择测量模式，以及基于测量模式计算与用户测量输入相关联的测量值。