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(54) **SYSTEMS AND METHODS FOR TOUCH-BASED INPUT ON ULTRASOUND DEVICES**

(71) Applicant: **FUJIFILM Sonosite, Inc.**, Bothell, WA (US)

(72) Inventors: **Axel Koch**, Renton, WA (US); **Jason Fouts**, Bothell, WA (US)

(73) Assignee: **FUJIFILM SONOSITE, INC.**, Bothell, WA (US)

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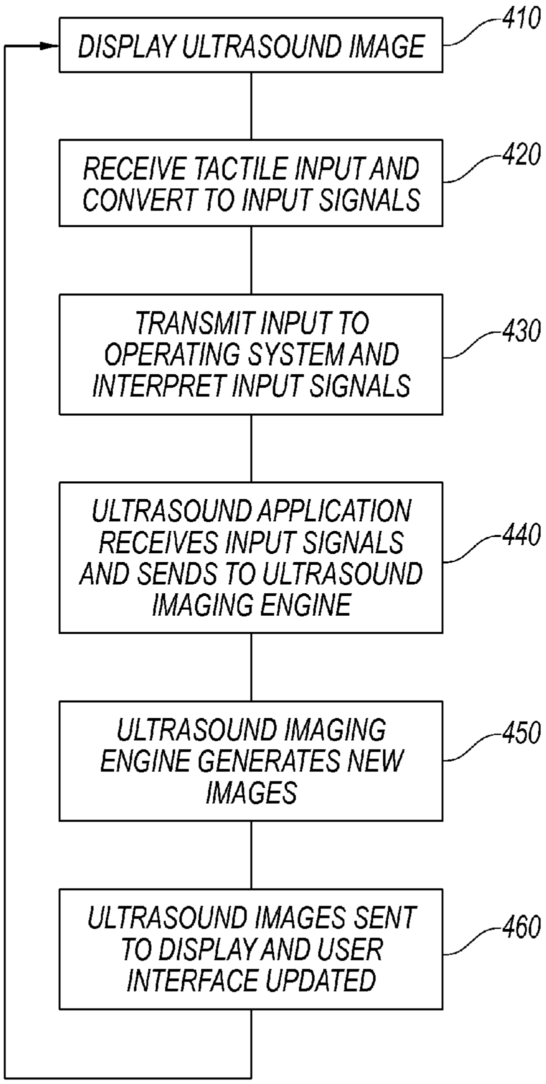
USPC **345/173**

(57) **ABSTRACT**

Systems and methods for receiving touch-based input from an operator of an imaging device are disclosed herein. In one embodiment, an ultrasound imaging device is configured to receive tactile input from an operator. The imaging device presents an ultrasound image to the operator and the operator can perform one or more touch inputs on the image. Based on the received input, the imaging device can update the display of the image.



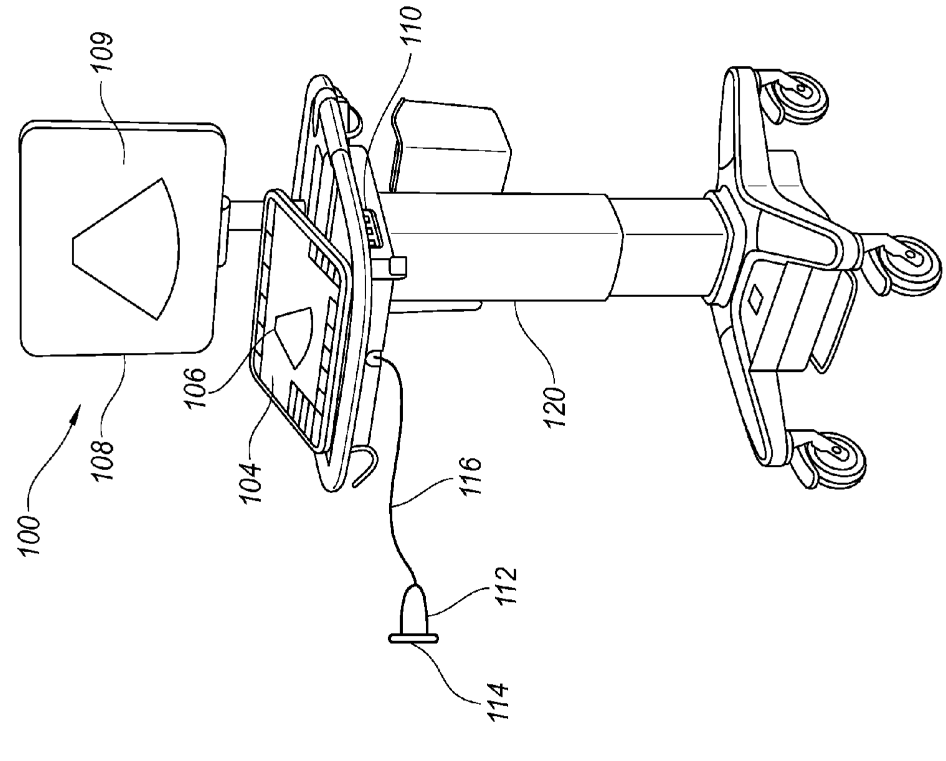


Fig. 1A

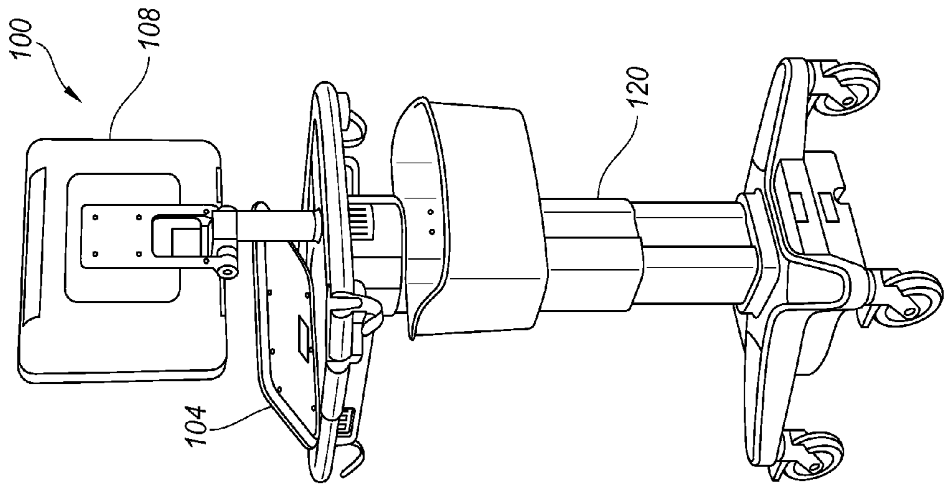


Fig. 1B

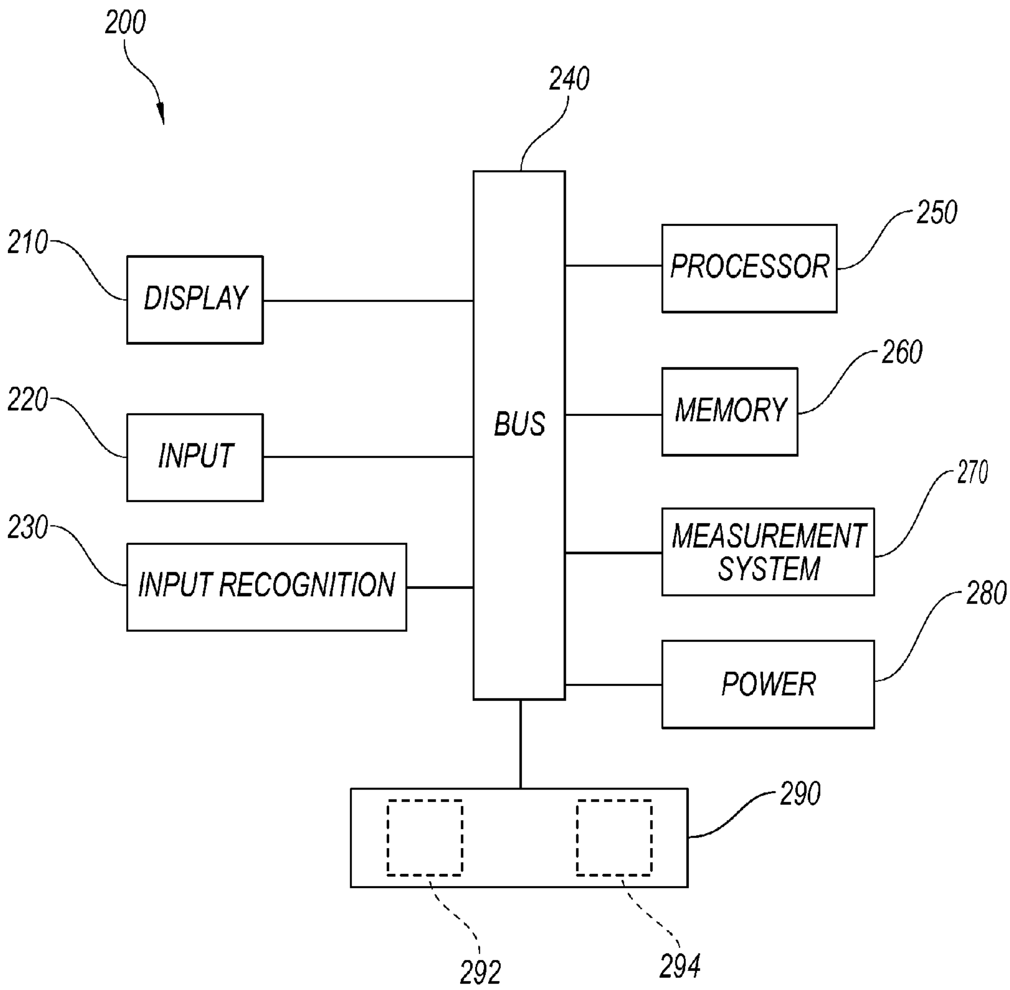

200
240
210
DISPLAY
220
INPUT
230
INPUT RECOGNITION
BUS
PROCESSOR
250
MEMORY
260
MEASUREMENT SYSTEM
270
POWER
280
290
292
294

Fig. 2

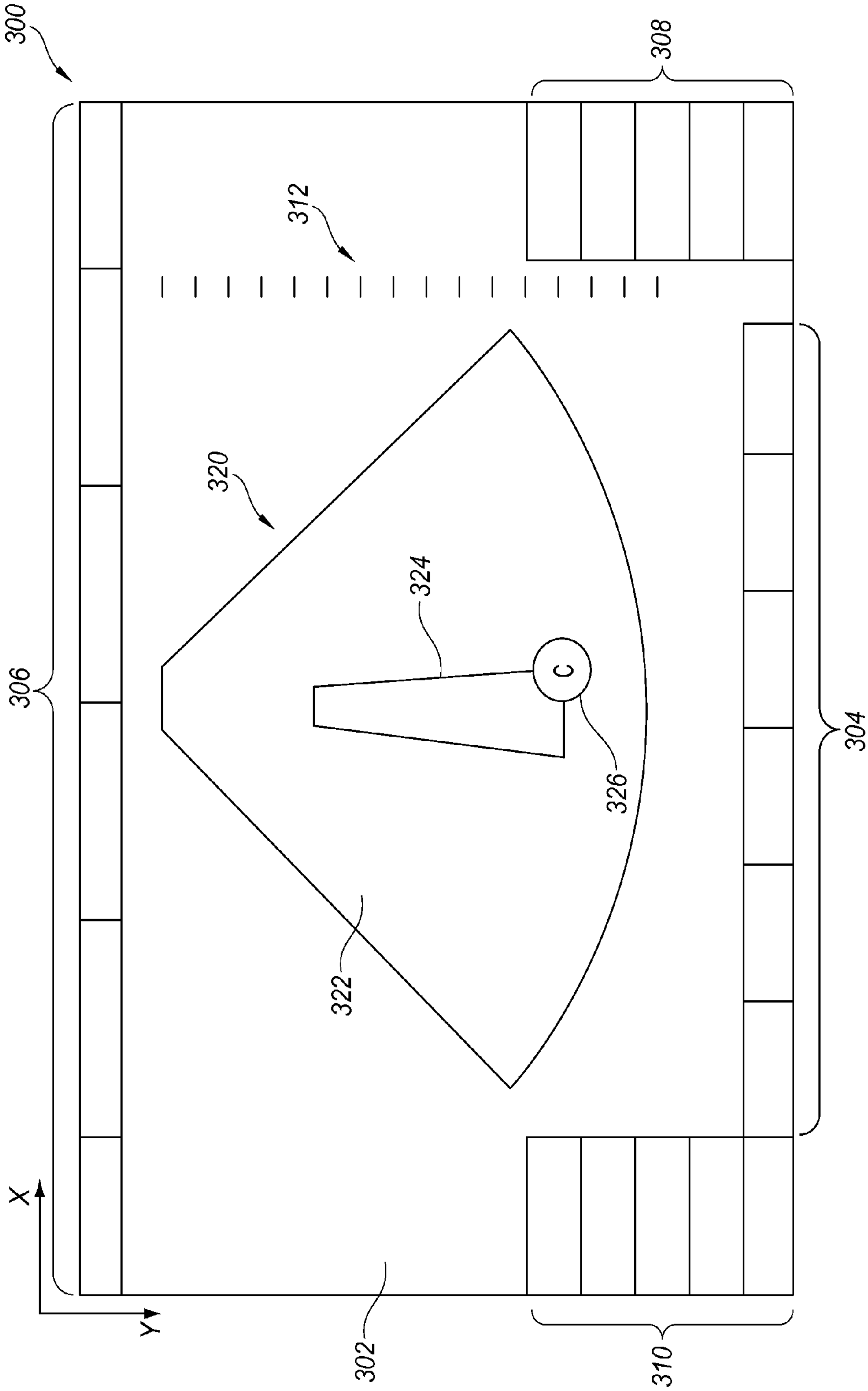


Fig. 3A

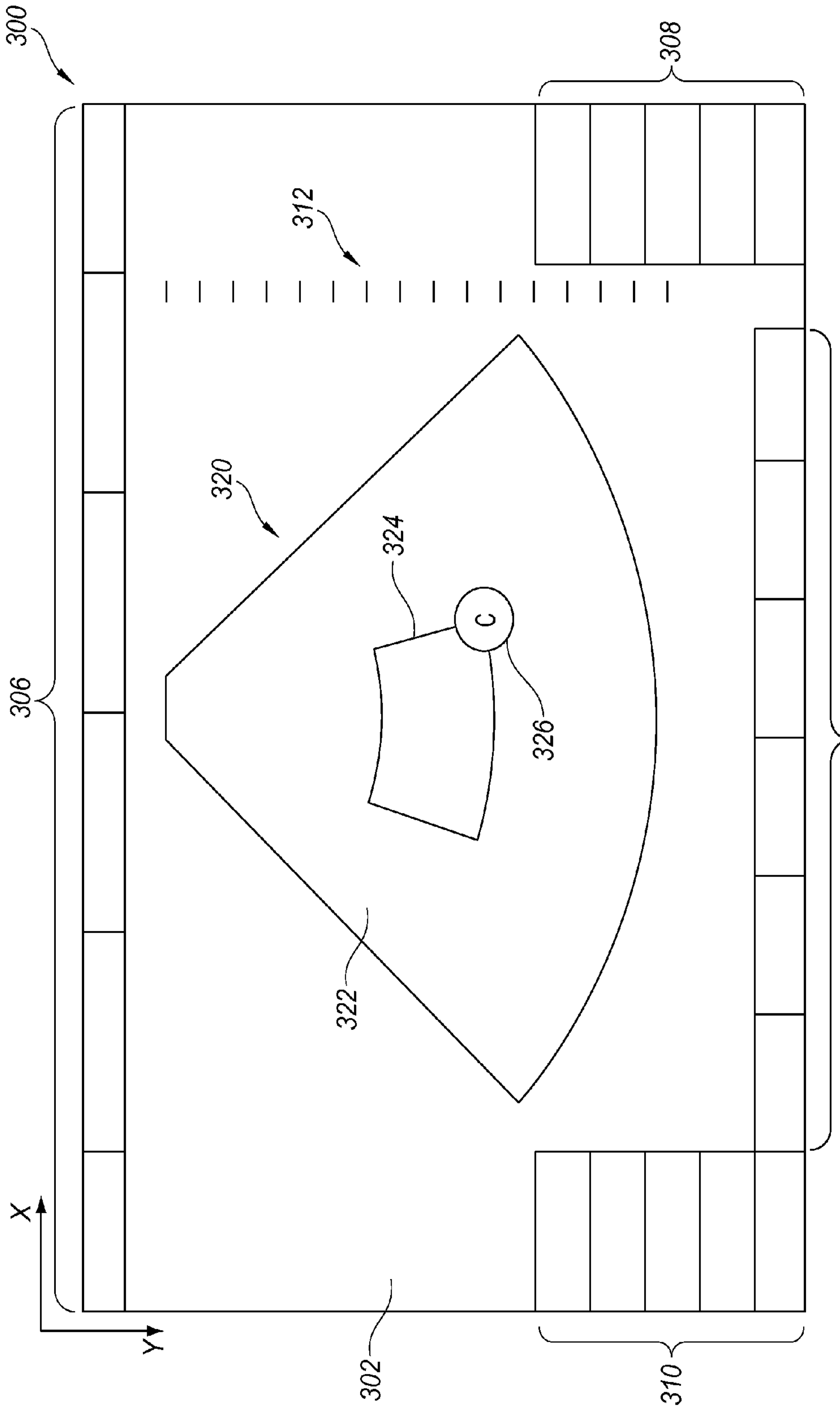


Fig. 3B

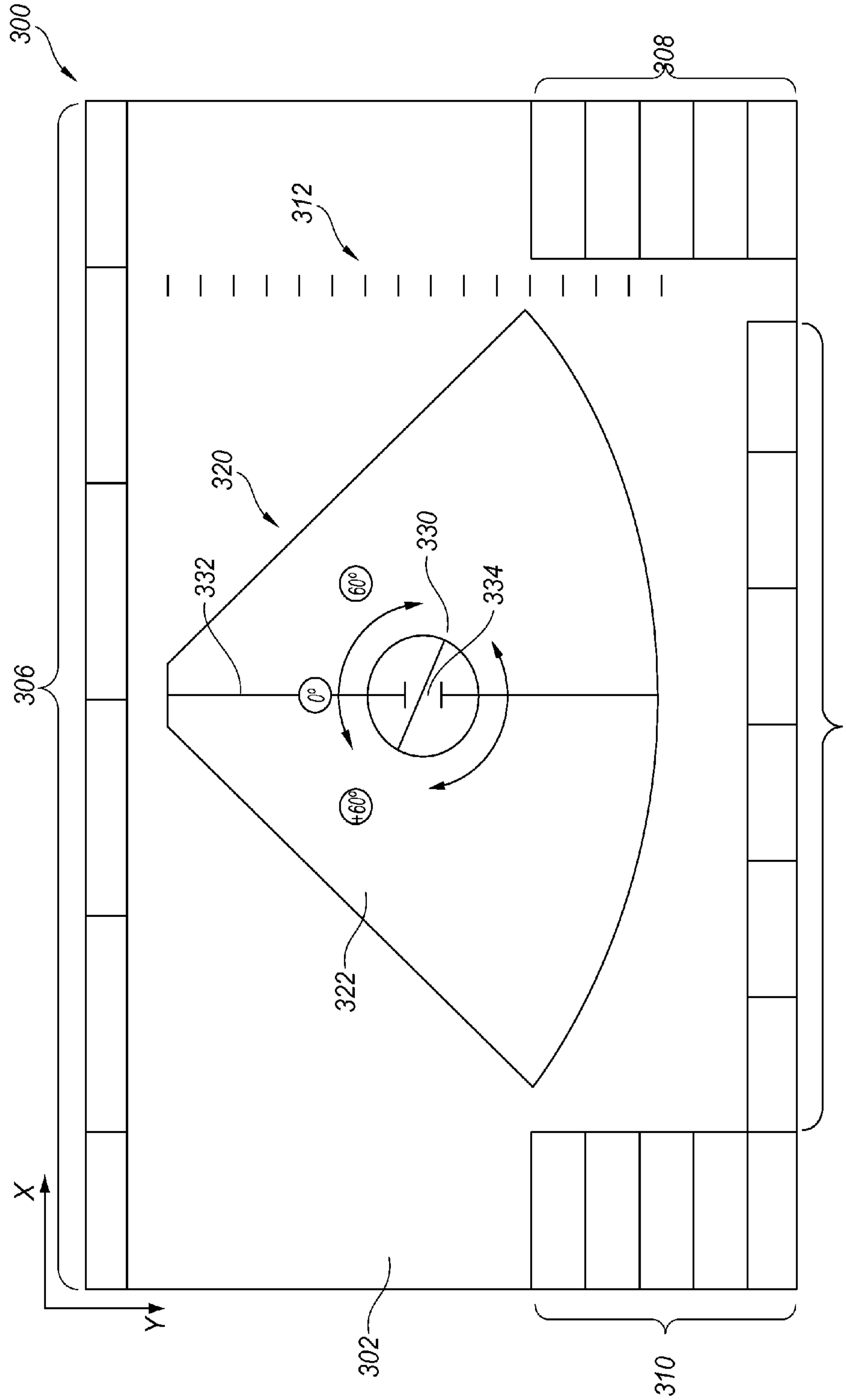


Fig. 3C

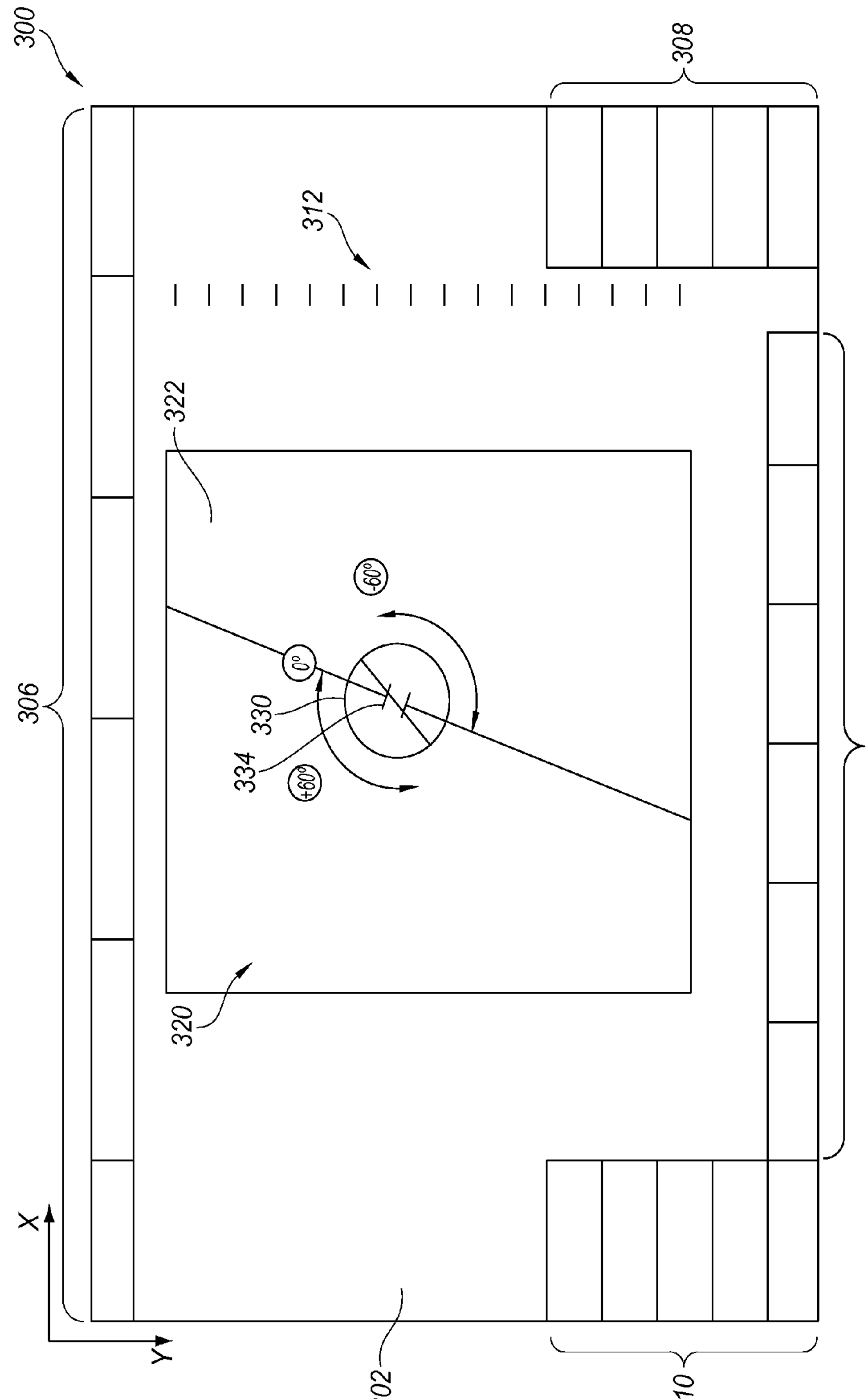


Fig. 3D

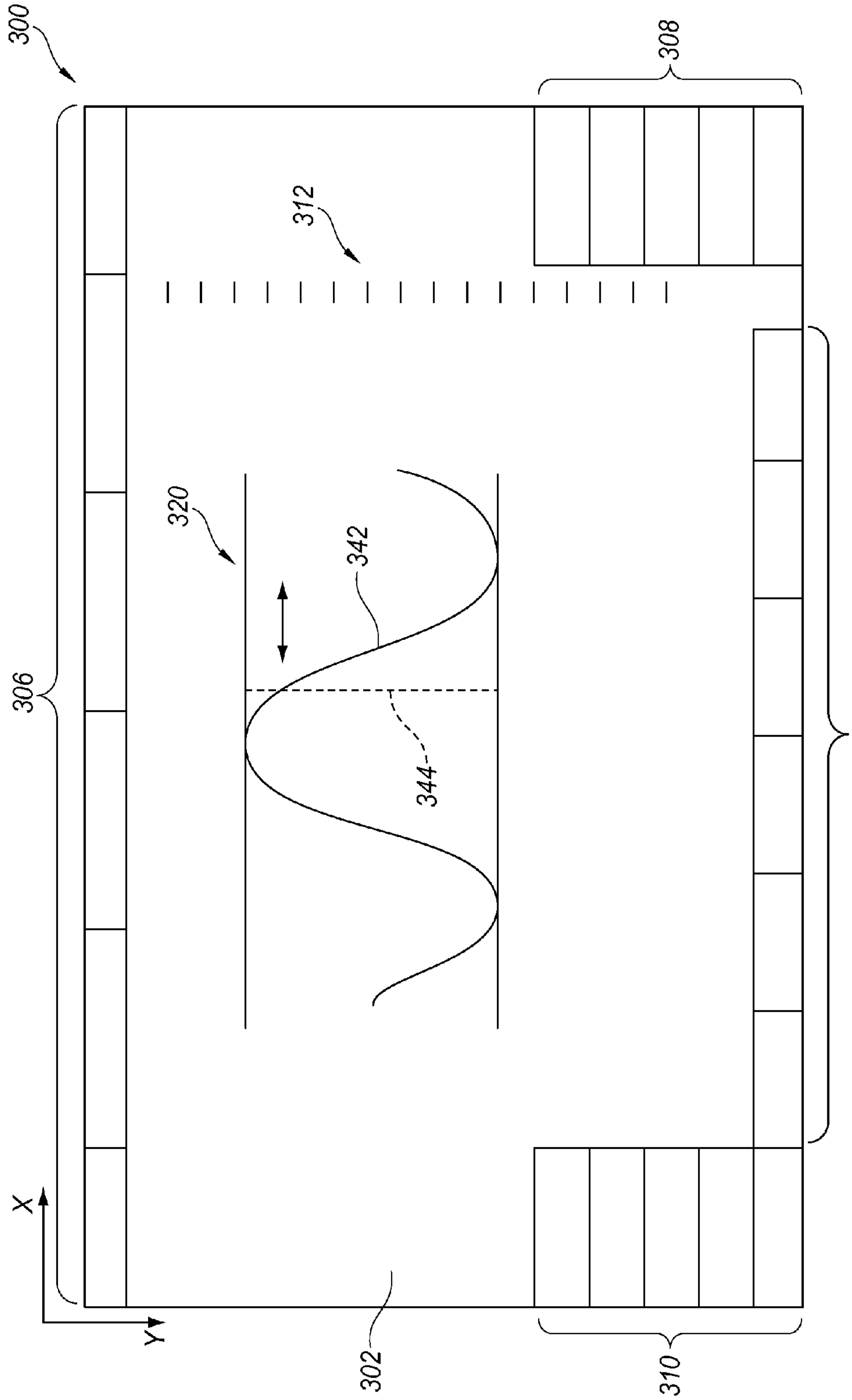


Fig. 3E

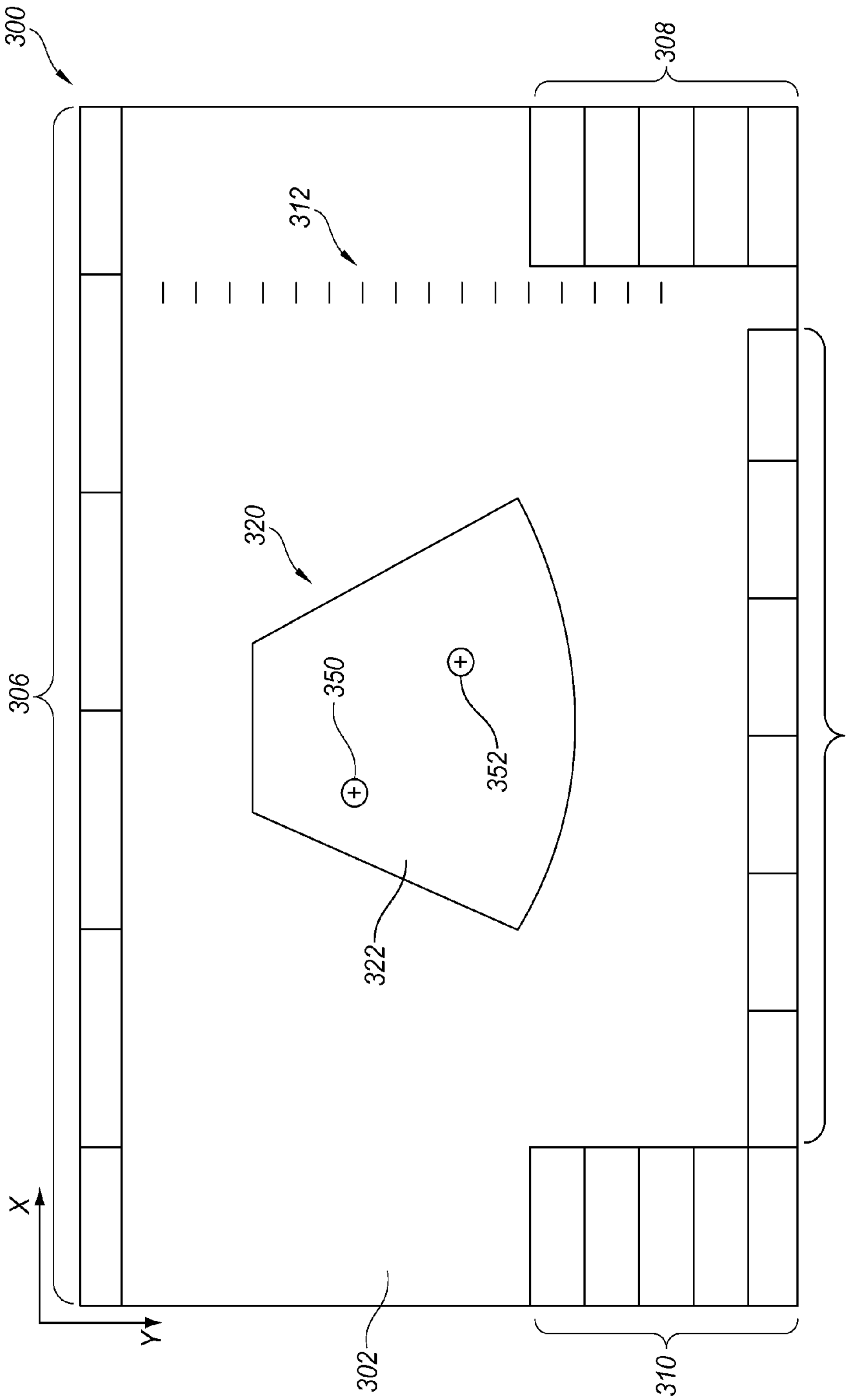


Fig. 3F

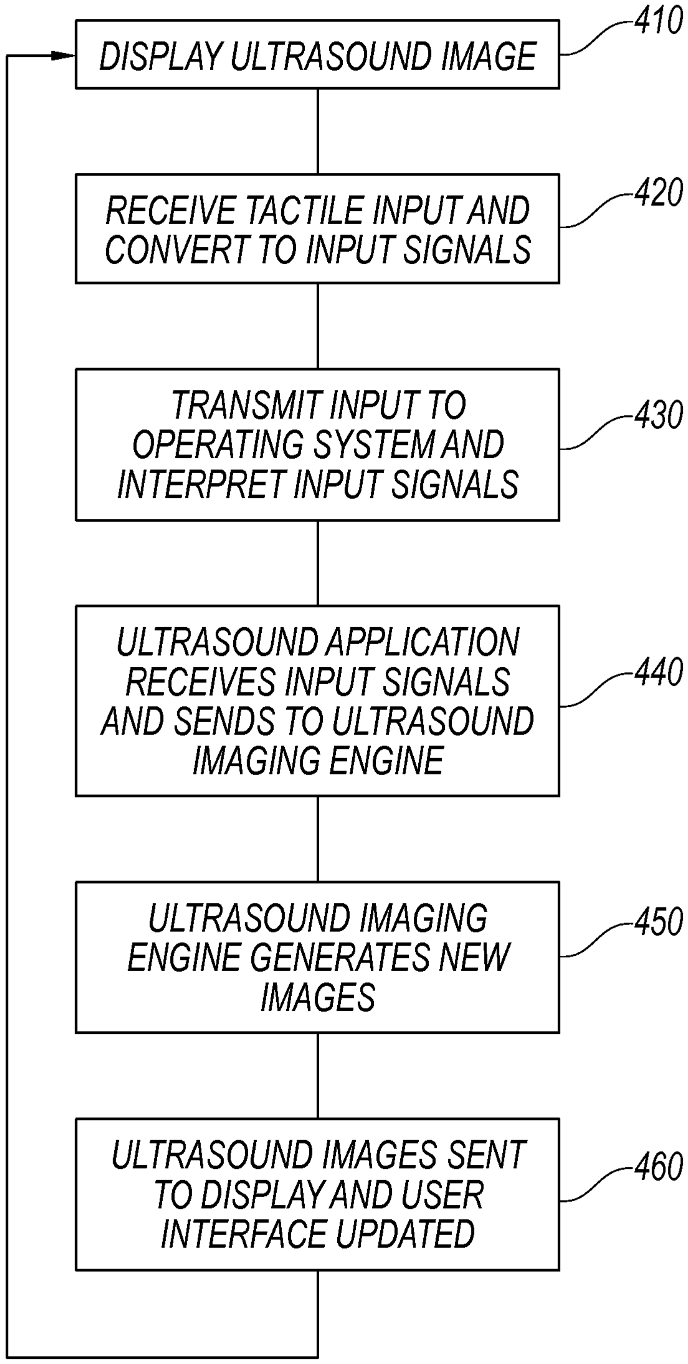

DISPLAY ULTRASOUND IMAGE
410
RECEIVE TACTILE INPUT AND CONVERT TO INPUT SIGNALS
420
TRANSMIT INPUT TO OPERATING SYSTEM AND INTERPRET INPUT SIGNALS
430
ULTRASOUND APPLICATION RECEIVES INPUT SIGNALS AND SENDS TO ULTRASOUND IMAGING ENGINE
440
ULTRASOUND IMAGING ENGINE GENERATES NEW IMAGES
450
ULTRASOUND IMAGES SENT TO DISPLAY AND USER INTERFACE UPDATED
460

Fig. 4

SYSTEMS AND METHODS FOR TOUCH-BASED INPUT ON ULTRASOUND DEVICES

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority under 35 U.S.C. 119(e) to U.S. Provisional Application Ser. No. 61/711,185, filed Oct. 8, 2012, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The disclosed technology relates generally to touch-based user input and in particular to systems and methods for receiving touch-based user input on ultrasound imaging devices.

BACKGROUND

[0003] In ultrasound imaging devices, images of a subject are created by transmitting one or more acoustic pulses into the body from a transducer. Reflected echo signals that are created in response to the pulses are detected by the same or a different transducer. The echo signals cause the transducer elements to produce electronic signals that are analyzed by the ultrasound system in order to create a map of some characteristic of the echo signals such as their amplitude, power, phase or frequency shift etc. The map therefore can be displayed to a user as images.

[0004] Many ultrasound imaging devices include a screen for displaying ultrasound images and a separate input device (e.g., a hardware control panel and/or keyboard) for inputting commands and adjusting the display of the images on the screen. Use of a control panel to adjust ultrasound images can be awkward and cumbersome, as an operator may have to manipulate several variables simultaneously to adjust the image to his or her liking. Furthermore, inputting commands using a control panel may require that the operator break visual contact with the image display to focus on the control panel. In addition, a control panel on an ultrasound imaging device may include several commands and/or functions, requiring an operator to undergo extensive training before becoming proficient in using the device. A need exists for an intuitive ultrasound image display system that reduces the need for an operator to break visual contact with the display while decreasing time spent adjusting images on the display.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIGS. **1**A and **1**B are isometric front and rear views, respectively, of an ultrasound imaging system configured in accordance with an embodiment of the disclosed technology.

[0006] FIG. **2** is a block diagram showing the components of an ultrasound imaging system in accordance with an embodiment of the disclosed technology.

[0007] FIGS. **3**A-**3**F illustrate suitable user interface methods for manipulation of an ultrasound image in accordance with an embodiment of the disclosed technology.

[0008] FIG. **4** is a flow diagram illustrating a process for receiving user input in accordance with an embodiment of the disclosed technology.

DETAILED DESCRIPTION

[0009] The present technology is generally directed to ultrasound imaging devices configured to receive touch-based input. It will be appreciated that several of the details set forth below are provided to describe the following embodiments in a manner sufficient to enable a person skilled in the relevant art to make and use the disclosed embodiments. Several of the details described below, however, may not be necessary to practice certain embodiments of the technology. Additionally, the technology can include other embodiments that are within the scope of the claims but are not described in detail with reference to FIGS. **1**-**4**.

[0010] FIGS. **1**A and **1**B are front and rear isometric views, respectively, of an ultrasound imaging device **100** configured in accordance with an embodiment of the disclosed technology. In the illustrated embodiment, the device **100** includes a first display **104** (e.g., a touchscreen display) and a second display **108**, each coupled (e.g., via a cable, wirelessly, etc.) to a processing unit **110**. The first display **104** is configured to present a first display output **106** (e.g., a user interface and/or ultrasound images) to an operator of the ultrasound imaging device **100**. Similarly, the second display **108** is configured to present a second display output **109** (e.g., a user interface and/or ultrasound images). A support structure **120** holds the device **100** and allows the operator to move the device **100** and adjust the height of the first and second displays **104** and **108**.

[0011] The processing unit **110** can be configured to receive ultrasound data from a probe **112** having an ultrasound transducer array **114**. The array **114** can include, for example, a plurality of ultrasound transducers (e.g., piezoelectric transducers) configured to transmit ultrasound energy into a subject and receive ultrasound energy from the subject. The received ultrasound energy may then be transmitted as one or more ultrasound data signals via a link **116** to the ultrasound processing unit **110**. The processing unit **110** may be further configured to process the ultrasound signals and form an ultrasound image, which can be included in the first and second display outputs **106** and **109** shown on the displays **104** and **108**, respectively.

[0012] In the example shown, either of the displays **104** and **108** may be configured as a touchscreen, and the processing unit **110** can be configured to adjust the display outputs **106** and **109**, respectively based on touch-based input received from an operator. The displays **104** and **108** can include any suitable touch-sensitive display system such as, for example, resistive touchscreens, surface acoustic wave touchscreens, capacitive touchscreens, surface capacitance touchscreens, projected capacitance touchscreens, mutual capacitance touchscreens, self-capacitance touchscreens, infrared touchscreens, optical imaging touchscreens, dispersive signal touchscreens, acoustic pulse recognition touchscreens, etc. In addition, the displays **104** and **108** can be configured to receive input from a user via one or more fingers (e.g., a fingertip, a fingernail, etc.), a stylus, and/or any other suitable pointing implement.

[0013] In operation, for example, the operator may hold the probe **112** with a first hand while adjusting the ultrasound image presented in the display output **106** with a second hand, using, for example, one or more touch-based inputs or gestures. These inputs may include, for example, direct manipulation (e.g., dragging one or more fingers on the display **104** to move an element on the display output **106**), single and double tapping the display **104** with one or more fingers, flicking the display **104** with one or more fingers, pressing and holding one or more fingers on the display **104**, pinching and expanding two or more fingers on the display **104**, rotating two or more fingers on the display **104**, etc. As explained in further detail below, the processing unit **110** can be configured to receive the inputs from the display **104** and update the display output **106** to correspond the operator input.

[0014] As noted above, the display output **106** may include a user interface (UI) to control measurements and/or output of the device **100**. In some embodiments, for example, the display output **109** may be similar or identical to the display output **106**. In other embodiments, however, the display output **109** may be tailored for persons within close proximity to the device **100** (e.g., a patient and/or a physician). For example, the display output **109** may include larger sized renderings of ultrasound images formed by the processing unit **110** compared to those display in the display output **106**. In other embodiments, either of the display outputs **106** and **109** can be configured for direct manipulation. For example, the display outputs **106** and **109** can be configured such that there is generally a one-to-one size relationship between a region in the subject being imaged and the image presented to the operator. This can offer the advantage of allowing the operator an intuitive experience when interacting with the image.

[0015] In illustrated embodiment of FIG. **1**, the ultrasound imaging device **100** includes the two displays **104** and **108**. In some embodiments, however, the device **100** may include additional displays or include only the display **104**. In other embodiments, the displays **104** and **108** may be physically separated from the processing unit **110** and configured to wirelessly communicate with the processing unit **110** to, for example, transmit inputs received from an operator and/or receive the display outputs **106** and **109**, respectively. Furthermore, in some embodiments, both of the displays **104** and **108** may be touch-sensitive, while in other embodiments, only the first display **104**, for example, may be touch-sensitive.

[0016] In some other embodiments, the device **100** may comprise the display **104** and the processing unit **110** as a single integrated component. For example, the ultrasound imaging device **100** may comprise a handheld portable ultrasound system having the display **104**, the processing unit **110**, and the probe **112**, without the support structure **120**.

[0017] The technology disclosed herein allows an operator to collect ultrasound images of a subject while manipulating the images on a first display without looking away, for example, from the second display while operating the imaging device. The disclosed technology allows the operator to manipulate the image using an interface having intuitive touch-based inputs, reducing the time spent learning a set of commands associated with a hardware control panel. Furthermore, in some embodiments of the disclosed technology, the user interface is provided on a touchscreen display with a flat, cleanable surface, allowing the operator to more effectively disinfect the input area than many conventional prior art input devices.

Suitable System

[0018] FIG. **2** and the following discussion provide a brief, general description of a suitable environment in which the technology may be implemented. Although not required, aspects of the technology are described in the general context of computer-executable instructions, such as routines executed by a general-purpose computer (e.g., an ultrasound imaging device processing unit). Aspects of the technology can be embodied in a special purpose computer or data processor that is specifically programmed, configured, or constructed to perform one or more of the computer-executable instructions explained in detail herein. Aspects of the technology can also be practiced in distributed computing environments where tasks or modules are performed by remote processing devices, which are linked through a communication network. In a distributed computing environment, program modules may be located in both local and remote memory storage devices.

[0019] Aspects of the technology may be stored or distributed on computer-readable media, including magnetically or optically readable computer disks, as microcode on semiconductor memory, nanotechnology memory, organic or optical memory, or other portable data storage media. Indeed, computer-implemented instructions, data structures, screen displays, and other data under aspects of the technology may be distributed over the Internet or over other networks (including wireless networks), on a propagated signal on a propagation medium (e.g., an electromagnetic wave(s), a sound wave, etc.) over a period of time, or may be provided on any analog or digital network (packet switched, circuit switched, or other scheme).

[0020] Referring to FIG. **2**, a block diagram illustrating example components of an ultrasound imaging system **200** is shown. In the embodiment shown in FIG. **2**, the system **200** includes a display **210**, an input **220**, an input recognition engine **230**, a bus **240**, one or more processors **250**, memory **260**, a measurement system **270**, and power **280**.

[0021] The display **210** can be configured to display, for example, a user interface to receive commands from an operator and/or present measured ultrasound images. The display **210** may include any suitable visual and/or audio display system such as, for example, a liquid crystal display (LCD) panel, a plasma-based display, a video projection display, etc. While only one display **210** is shown in FIG. **2**, those of ordinary skill in the art would appreciate that multiple displays having similar or different outputs may be implemented in the system **200**, as explained above with reference to FIGS. 1A and 1B.

[0022] In some embodiments, the input **220** may be implemented as a touch-sensitive surface on the display **210**. In other embodiments, the input **220** may include additional inputs such as, for example, inputs from a control panel, a keyboard, a trackball, a system accelerometer and/or pressure sensors in the touch screen, audio inputs (e.g., voice input), visual inputs, etc. In further embodiments, the input **220** may be configured to receive non-tactile gestures performed by an operator without contacting a surface. In these embodiments, for example, the system **200** may include one or more sensors (e.g., one or more cameras, one or more infrared transmitters and/or receivers, one or more laser emitters and/or receivers, etc.) configured to detect, for example, one or more operator hand movements. The system **200** can be configured to analyze the operator hand movements and perform a corresponding action associated with the hand movements.

[0023] The system **200** can receive input from an operator at the input **220** (e.g., one or more touchscreen displays), which can be converted to one or more input signals and transmitted to the input recognition engine **230** and/or the processor **250**. The input signals may include, for example, X-Y coordinate information of the tactile contact with the input **220**, the time duration of each input, the amount of pressure applied during each input, or a combination thereof. The input recognition engine **230** can, based on the input signals, identify the input features (e.g., taps, swipes, dragging, etc.) and relay information regarding the identified input features to the one or more processors **250**.

[0024] The processors **250** can perform one or more corresponding actions (e.g., adjusting an image output to the display **210**) based on the identified input features from the input recognition engine **230**. The input recognition engine **230**, for example, can be configured to detect the presence of two of the operator's fingers at the input **220** in an area corresponding to the output of an ultrasound image on the display **210**. For example, the operator may place his or her two fingers on an image and subsequently move them apart in a "pinch and expand" motion, which may be associated with zooming in on or expanding the view of an area of interest in the image display. The input recognition engine **230** can identify the pinch and expand input and the one or more processors **250** can correspondingly update the output to the display **210** (e.g., increase the zoom level of the currently displayed image at the region where the finger movement was detected).

[0025] The system **200** may control components and/or the flow or processing of information or data between components using one or more processors **250** in communication with the memory **260**, such as ROM or RAM (and instructions or data contained therein) and the other components via a bus **260**. The memory **260** may, for example, contain data structures or other files or applications that provide information related to the processing and formation of ultrasound images. The memory may also, for example, contain one or more instructions for providing an operating system and/or a user interface configured to display commands and receive input from the operator.

[0026] The measurement system **270** can be configured to transmit and receive ultrasound energy into a subject (e.g., a patient) and send acquired ultrasound data to the processor **250** for image processing. The measurement system **270** can include, for example, an ultrasound probe (e.g., the probe **112** in FIGS. **1**A and **1**B). For example, the measurement system **270** may include an array of transducers made from piezoelectric materials, CMUTs, PMUTs, etc. The measurement system **270** may also include other measurement components associated with a suitable ultrasound imaging modality such as, for example, a photoacoustic emission system, a hemodynamic monitoring system, respiration monitoring, ECG monitoring, etc.

[0027] Components of the system **200** may receive energy via a power component **280**. Additionally, the system **200** may receive or transmit information or data to other modules, remote computing devices, and so on via a communication component **235**. The communication component **235** may be any wired or wireless components capable of communicating data to and from the system **200**. Examples include a wireless radio frequency transmitter, infrared transmitter, or hard-wired cable, such as a USB cable. The system **200** may include other additional component **290** having modules **292** and **294** not explicitly described herein, such as additional microprocessor components, removable memory components (flash memory components, smart cards, hard drives), and/or other components.

User Interface

[0028] FIG. **3**A illustrates a display **300** that includes a user interface **302** suitable for manipulating an ultrasound image and/or controlling an acquisition of one or more ultrasound images in response to receiving operator inputs (e.g., a mixture of stroke or traces, as well as taps, hovers, and/or other tactile inputs using one or more fingers). In the example shown in FIG. **3**A, the user interface **302** is configured for use on an ultrasound device (e.g., the ultrasound imaging device **100** in FIGS. **1**A and **1**B) and presented to an operator. As those skilled in the art would appreciate, however, the user interface described herein may form part of any system where it is desirable to receive operator tactile input and perform one or more associated actions. Such systems may include, for example, mobile phones, personal display devices (e.g., electronic tablets and/or personal digital assistants), portable audio devices, portable and/or desktop computers, etc.

[0029] The user interface **302** is configured to present output and input components to an operator. A first user control bar **304**, a second user control bar **306**, a third user control bar **308**, and a fourth user control bar **310** present icons to the operator associated with, for example, various operating system commands (e.g., displaying an image, saving an image, etc.) and/or ultrasound measurements. A adjustable scale **312** can be configured to adjust image generation, measurement, and/or image display parameters such as, for example, time, dynamic range, frequency, vertical depth, distance, Doppler velocity, etc.

[0030] Referring to FIGS. **3**A and **3**B, an ultrasound image display region **320** displays one or more ultrasound images **322** formed from, for example, ultrasound data acquired by an ultrasound measurement system (e.g., the measurement system **270** described above in reference to FIG. **2**). A color box or region of interest (ROI) boundary **324** can be adjusted by the operator to select a particular area in the image **322**. For example, the operator can adjust a shape (e.g., a square, rectangular, trapezoid, etc.) or a size of the boundary **324** to include a ROI in the image **322**. The operator can also move the boundary **324** horizontally (e.g., along the x-axis) or vertically (e.g., along the y-axis) within the display region **320** to select the portion of the image he or she is interested in viewing.

[0031] In the illustrated examples shown in FIG. **3**A and **3**B, the interface **302** can be configured to receive operator tactile input in order to adjust the shape and size of the boundary **324** in an efficient, fast, and intuitive manner without breaking visual contact with the image **322**. For example, an operator can touch the display region **320** shown in FIG. **3**A with two fingers (e.g., a thumb and an index finger). The operator, while keeping the two fingers in contact with the display **300**, can subsequently move the fingers apart on the display **300** until a desired shape and/or size of the boundary **324** is displayed within the image **322**. The operator can further adjust the boundary **324**, for example, by touching and holding a contact point **326** in and/or on the boundary **324** to re-size and/or reposition the boundary **324** to a desired size and shape.

[0032] In some embodiments, for example, the boundary **324** can also be adjusted through the use of other touch-based input and/or gestures. For example, the interface **302** may be configured to recognize a double tap input (e.g. multiple touch based input by one or more fingers in the same general location) and correspondingly display an expanded view (e.g., zoomed view) of the image within the boundary **324**. In other embodiments, for example, the boundary **324** may be configured to allow the operator to resize the boundary **324** in only one dimension. For example, the boundary **324** can be configured to allow adjustment in only the horizontal (x) or only the vertical (y) dimension, as opposed to conventional "pinch and expand" gestures, which may simply scale a user interface element at the same rate in both directions (i.e. the scaling only depends on the distance between the two contact points).

[0033] In further embodiments, the user interface **302** can be configured to receive a gesture from the operator associated with, for example, a freeze command to freeze the current image (e.g., the image **322**) displayed in the display region **320**. For example, the user interface **302** may be configured to associate a gesture with a freeze command. In conventional ultrasound display systems, the operator may have to break visual contact with an ultrasound image (e.g. the image **322**) to find a freeze button on a control panel. The present system, however, allows the operator to use the gesture anywhere in and/or on the user interface **302** without breaking visual contact with the display. For example, the user interface can be configured to receive a two-finger double-tap from the operator and accordingly freeze the image **322**. A two-finger double-tap can offer the advantage of avoiding false positives that may occur with, for example, a single-finger gesture (e.g., an operator's accidentally freezing the image when he or she intended to do something totally different, like pressing a button).

[0034] FIGS. **3**C and **3**D illustrate the user interface **302** with the display region **320** in a Doppler display mode. In the illustrated embodiment of FIG. **3**C, the image **322** is a Doppler image and a Doppler line **332** and a Doppler gate **334** are shown within the display region **320**. The user interface **302** can be configured to receive operator touch-based input to adjust the size of the Doppler gate **334**. For example, the operator can place two or more fingers within the display region **320** and move them toward or away from each other to contract or expand, respectively, the size of the Doppler gate **334**.

[0035] Referring to FIGS. **3**C and **3**D, the user interface **302** can also be configured to receive rotational touch-based input from an operator to, for example, control a steering angle display **330** of the Doppler gate **334**. For example, the operator can place one or more fingers on the display **300** at the steering angle display **330** and rotate the fingers in contact with the display **300** relative to each other. The ultrasound system (e.g. the system **200** described above in reference to FIG. **2**) can be configured to rotate the Doppler gate measurement accordingly to adjust the angle control of the Doppler gate while the user interface **302** updates the Doppler gate **334** in the display region **320**, as shown in FIG. **3**D.

[0036] In the examples shown in FIGS. **3**C and **3**D, the user interface **302** and be configured to allow the operator to adjust the display of the image **322** with one or more of the following gestures.

[0037] Pinching and expanding the Doppler gate **330** (e.g., increasing or decreasing the distance between the two contact points will increase or decrease, respectively, the Doppler gate size). In some embodiments, for example, the x and y components of the movement may not considered, and only the pixel distance between the contact points may be taken into consideration.

[0038] A multi-touch rotational gesture may, for example, be associated with adjusting the angle correction display **330**. For example, the operator may place two fingers (e.g., a finger and a thumb) on the angle correction display **330** or within the display region **320**. While holding the two fingers approximately the same distance apart from each other, the operator may rotate the fingers in a circular pattern clockwise or counterclockwise to correspondingly adjust the angle correction display **330** (e.g., to adjust a Doppler angle). The operator can perform the rotational gesture until the Doppler gate **334** is suitably aligned with an area of interest in the image **322**. While holding the fingers in the same position, the operator may also move the Doppler gate **332** to another location within the image **322**. As those skilled in the art would appreciate, the operator may also use any other combination of fingers to perform the rotational gesture (e.g., an index finger and a middle finger, a first finger on a first hand and a second finger on a second hand, etc.). In some embodiments, the user interface **302** can be configured to receive a circular tactile input with which the operator can trace, for example, a rotational path of the angle correction display **330** with one or more fingers. In further embodiments, the user interface can be configured to receive three or more separate tactile inputs (e.g., three or more fingers) to rotate the angle correction display **330**.

[0039] An accelerated single touch movement (e.g. a flick) within the display region **320** may be interpreted to control a steering angle of the Doppler line control for linear transducers. For example, the operator may apply the accelerated single touch movement to the Doppler line **332** to adjust an angle thereof to suitably align the Doppler gate **334** with the image **322**.

[0040] An operator may also use, for example, a single touch and drag along the Doppler line **332** to correspondingly align the Doppler gate **334** along ultrasound ray boundaries (e.g., horizontally for linear transducers and at an angle for phased or curved transducers).

[0041] FIG. **3**E illustrates the user interface **302** with the display region **320** in a wave form display mode. In the embodiment of FIG. **3**D, the display region **320** includes, for example, an ECG waveform **342** and an ECG delay line **344** that can be manipulated by an operator using touch-based input. As those of ordinary skill in the art would appreciate, the ECG waveform **342** may be monitored by the operator to determine, for example, during which intervals ultrasound images and/or video clips should be acquired. The delay line **344** can be configured to indicate an operator-desired position on the ECG waveform **342** at which an ultrasound video clip acquisition is triggered. The operator can, for example, touch and hold the delay line **344** to adjust the horizontal position (e.g., along the x-axis) of the delay line **344** until a desired position of triggering along the ECG waveform **342** is reached. Additionally, for example, the user interface **302** can be configured to receive touch-based input to allow the operator to change the gain of the ECG waveform **342** and/or to pan or scroll along the ECG waveform **342** (e.g., using a flick, swipe, and/or dragging input) to view additional portions of the ECG waveform **342**. As those of skill in the art would appreciate, the user interface **302** can be configured to display any suitable waveform to the operator such as, for example, a respiration waveform of a subject, Doppler trace data, M-Mode trace data, etc.

[0042] FIG. **3**F illustrates the user interface **302** with the display region **320** in a caliper measurement mode. In the embodiment of FIG. **3**F, the display region **320** includes the ultrasound image **322** and a first measurement point **350** and a second measurement point **352**. As explained below, the measurement points **350** and **352** can be configured to be placed within an image. Measurement information associated with a portion of the ultrasound image **322** between the measurement points **350** and **352** can be calculated and presented to the user. In the illustrated embodiment, the two measurement points **350** and **352** are shown. In some embodiments, however, there may be several pairs of measurement points, each pair configured to be associated with a discrete measurement. In other embodiments, for example, the operator can trace one or more fingers on the display **300** within the display region **320** to indicate a desired measurement region (e.g., for the measurement of a diameter, area, and/or circumference of the measurement region). In further embodiments, measurement points may be placed individually within the ultrasound image **322** rather than as pairs.

[0043] In the example shown in FIG. **3**F, the user interface **302** can be configured to receive, for example, tactile input from the operator to place the measurement points **350** and **352** at desired locations within the ultrasound image **322**. Based on the locations of the measurement points **350** and **352**, the system **200** (as described above with reference to FIG. **2**) can calculate and display measurement information associated with a portion of the ultrasound image between the measurement points **350** and **352**. For two-dimensional measurements, for example, the measurement information may include a distance between the two measurement points **350** and **352**. For M-Mode measurements, for example, the measurement information may include a distance, a heart rate, and/or an elapsed time in the portion of the ultrasound image **322** between the measurement points **350** and **352**. For Doppler measurements, for example, the measurement information may include a velocity, a pressure gradient, an elapsed time, a +/× ratio, a Resistive Index, an acceleration, etc. between the measurement points **350** and **352**.

Suitable Input Methods

[0044] The flow diagrams described herein do not show all functions or exchanges of data, but instead provide an understanding of commands and data exchanged under the system. Those skilled in the relevant art will recognize that some functions or exchange of commands and data may be repeated, varied, omitted, or supplemented, and other (less important) aspects not shown may be readily implemented. Further, although process steps, method steps, blocks, algorithms or the like may be described in a particular order, such processes, methods, blocks and algorithms may be configured to work in alternate orders. In other words, any sequence or order described herein does not necessarily indicate a requirement that the steps or blocks be performed in that order. The steps or blocks of processes and methods described herein may be performed in any order practical, and some steps may be performed simultaneously.

[0045] FIG. **4** shows a process **400** for receiving tactile input from an operator of an ultrasound imaging device. At block **410**, an image (e.g., a two-dimensional, three-dimensional, M-Mode, and/or Doppler ultrasound image) is presented to an operator on a display (e.g., a touchscreen), while the process **400** monitors the display for operator input (e.g., detecting one or more fingers in contact with the display at the location of the image within the user interface). At block **420**, the process **400** receives tactile input from the operator and converts the input into one or more input signals. At block **430**, the process **400** transmits the input signals to the operating system running, for example, on processor **250** and memory **260** (FIG. **2**) and interprets the input signals as one or more recognized gestures. At block **440**, an ultrasound application (stored, for example, in memory **260**) receives the recognized gestures and provides corresponding instructions for an ultrasound engine configured to form ultrasound images. At block **450**, the ultrasound engine generates one or more updated images based on the interpreted input from the operator. At block **460**, the process **400** updates the user interface and the one or more generated ultrasound images are sent to the display.

CONCLUSION

[0046] Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise," "comprising," and the like are to be construed in an inclusive sense, as opposed to an exclusive or exhaustive sense; that is to say, in the sense of "including, but not limited to." As used herein, the terms "connected," "coupled," or any variant thereof means any connection or coupling, either direct or indirect, between two or more elements; the coupling or connection between the elements can be physical, logical, or a combination thereof. Additionally, the words "herein," "above," "below," and words of similar import, when used in this application, refer to this application as a whole and not to any particular portions of this application. Where the context permits, words in the above Detailed Description using the singular or plural number may also include the plural or singular number respectively. The word "or," in reference to a list of two or more items, covers all of the following interpretations of the word: any of the items in the list, all of the items in the list, and any combination of the items in the list.

[0047] The above Detailed Description of examples of the disclosed technology is not intended to be exhaustive or to limit the disclosed technology to the precise form disclosed above. While specific examples for the disclosed technology are described above for illustrative purposes, various equivalent modifications are possible within the scope of the disclosed technology, as those skilled in the relevant art will recognize. For example, while processes or blocks are presented in a given order, alternative implementations may perform routines having steps, or employ systems having blocks, in a different order, and some processes or blocks may be deleted, moved, added, subdivided, combined, and/or modified to provide alternative or subcombinations. Each of these processes or blocks may be implemented in a variety of different ways. Also, while processes or blocks are at times shown as being performed in series, these processes or blocks may instead be performed or implemented in parallel, or may be performed at different times. Further any specific numbers noted herein are only examples: alternative implementations may employ differing values or ranges.

[0048] The teachings of the disclosed technology provided herein can be applied to other systems, not necessarily the system described above. The elements and acts of the various examples described above can be combined to provide further implementations of the disclosed technology. Some alternative implementations of the disclosed technology may include not only additional elements to those implementations noted above, but also may include fewer elements.

[0049] These and other changes can be made to the disclosed technology in light of the above Detailed Description. While the above description describes certain examples of the disclosed technology, and describes the best mode contemplated, no matter how detailed the above appears in text, the disclosed technology can be practiced in many ways. Details of the system may vary considerably in its specific implementation, while still being encompassed by the disclosed technology disclosed herein. As noted above, particular terminology used when describing certain features or aspects of the disclosed technology should not be taken to imply that the terminology is being redefined herein to be restricted to any specific characteristics, features, or aspects of the disclosed technology with which that terminology is associated. In general, the terms used in the following claims should not be construed to limit the disclosed technology to the specific examples disclosed in the specification, unless the above Detailed Description section explicitly defines such terms.

I/We claim:

1. An ultrasound imaging system, comprising:

a display configured to present a user interface to an operator and to receive tactile input within the user interface from the operator; and

a processor, wherein the processor is configured to receive ultrasound measurements, wherein the processor is configured to generate one or more ultrasound images based on the ultrasound measurements, wherein the processor is configured to present the one or more ultrasound images at the display; wherein the processor is configured to generate one or more updated ultrasound images based on the received tactile input, and wherein the processor is configured to present the one or more updated ultrasound images at the display.

2. The system of claim **1**, further comprising an input recognition engine configured to match the received tactile input to one or more associated actions, wherein the processor is configured to perform one or more associated actions to generate the updated ultrasound image.

3. The system of claim **2** wherein the user interface includes one or more connected lines overlaid onto an ultrasound image, wherein the one or more lines represent a boundary that surrounds an area of a region of interest in the ultrasound image, and wherein the processor is configured to recognize a touch input received along the boundary from at least one finger.

4. The system of claim **3** wherein the corresponding action comprises adjusting the size of the area bounded by boundary.

5. The system of claim **3** wherein the corresponding action comprises adjusting a shape of the area bounded by the boundary.

6. The system of claim **3** wherein the corresponding action comprises adjusting the position of the area bounded by the boundary.

7. The system of claim **3** wherein the processor is configured to recognize a touch input from at least one finger maintained in contact with the display, and wherein the corresponding action comprises adjusting the position of the area bounded by the boundary without changing the size and the shape bounded by the boundary.

8. The system of claim **2** wherein the processor is configured to recognize two successive taps received from at least two fingers, and wherein the corresponding action comprises freezing a output of the ultrasound image thereby presenting a static ultrasound image on the display.

9. The system of claim **2** wherein the processor is configured to recognize a touch input from a first finger and a second finger, wherein the first finger is separated from the second finger by a distance within the user interface, wherein the tactile input further comprises touch input received from the first finger rotating relative to the second finger while the distance between the first finger and the second finger within the user interface remains generally constant, wherein the ultrasound image is a Doppler image, and wherein the corresponding action comprises adjustment of an angle correction display in the Doppler image.

10. The system of claim **2** wherein the processor is configured to recognize a touch input from a first finger at a first location within the user interface corresponding to a first measurement point in the ultrasound image, wherein the corresponding action comprises presenting information on the display related to the first measurement point.

11. The system of claim **10** wherein the processor is further configured to recognize touch input from a second finger at a second location within the user interface corresponding to a second measurement point in the ultrasound image, wherein the corresponding action comprises presenting information on the display associated with a portion of the ultrasound image between the first and the second measurement points.

12. The system of claim **1** wherein the display comprises a touchscreen with a flat, cleanable surface.

13. The system of claim **1** wherein the display is a first display, and further comprising a second display larger than the first display.

14. A method of operating an ultrasound imaging system, the method comprising:

presenting a user interface at a touchscreen display, wherein the user interface includes a ultrasound image;

detecting a first tactile input at the display, wherein the first tactile input includes one or more input features;

converting the detecting tactile input to input signals;

matching the converted input signals to one or more associated actions;

generating an updated ultrasound image based on the associated action; and

presenting the updated ultrasound image within the user interface at the display.

15. The method of claim **14** wherein presenting the user interface includes overlaying one or more connected lines onto an ultrasound image, wherein the one or more lines represent a boundary that surrounds an area of a region of interest in the ultrasound image, and wherein detecting the first tactile input at the display comprises detecting a touch input received along the boundary from at least one finger maintained in contact with the display with the display for a predetermined amount of time.

16. The method of claim **15** wherein generating the updated ultrasound image comprises adjusting the position of the area bounded by the boundary without changing the size and the shape bounded by the boundary.

17. The method of claim **14**,

wherein detecting the first tactile input at the display comprises detecting touch input from a first finger and a second finger;

wherein the first finger is separated from the second finger by a distance within the user interface;

wherein detecting the first tactile input at the display further comprises the detecting touch input received from the first finger rotating relative to the second finger while the distance between the first finger and the second finger within the user interface remains generally constant;

wherein the ultrasound image is a Doppler image; and wherein generating an updated ultrasound image comprises adjusting a steering angle display in the Doppler image.

18. At least one computer-readable storage medium storing instructions for a method performed by an ultrasound device having a processor and a memory, the method comprising:

presenting a user interface at a touchscreen display, wherein the user interface includes a ultrasound image;

detecting a first tactile input at the display, wherein the first tactile input includes one or more input features;

converting the detected input features to input signals;

matching the converted input signals to one or more associated actions;

generating an updated ultrasound image based on the one or more associated actions; and

presenting the updated ultrasound image within the user interface at the display.

* * * * *

专利名称(译)	用于超声设备上的基于触摸的输入的系统和方法		
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