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(54) **ULTRASOUND SYSTEM FOR INTERNAL IMAGING INCLUDING CONTROL MECHANISM IN A HANDLE**

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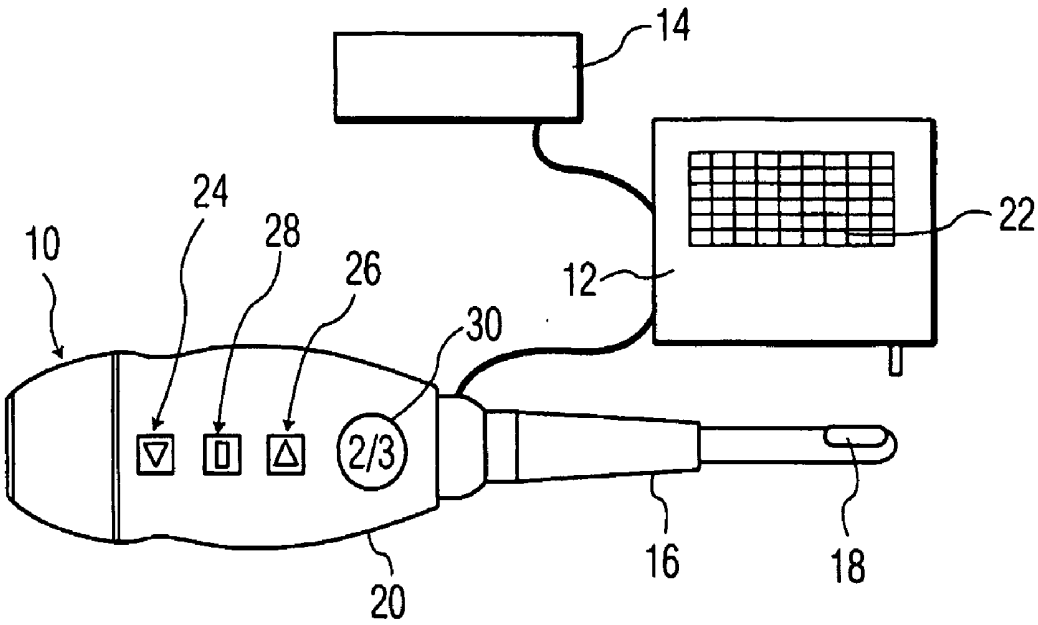
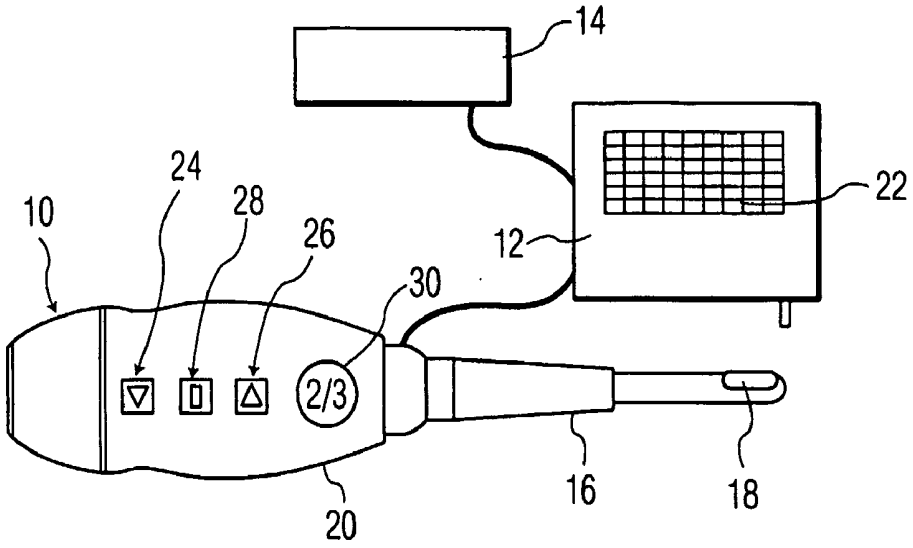
(57) **ABSTRACT**

Ultrasound systems for imaging internal structure of a patient including a probe (**10**) having a handle (**20,32**) and a transducer (**18**) arranged in connection with the handle (**20,32**) for obtaining images, either in the handle as in a transthoracic probe (**10**) or in a probe shaft (**16**) coupled to the handle as in a TEE probe (**10**). Controls on the handle enable a switch in the operation mode of the probe (**10**) and/or optimization of images obtained by the transducer (**18**). A display device (**14**) coupled to the probe (**10**) displays control menus and optional obtained images. A control unit (**12**) controls the probe (**10**) and display device (**14**) based on control activation. A change in control menu displayed by the display device (**14**), a switch in the mode of operation of the probe (**10**) and/or adjustment of images obtained by probe (**10**) is effected based on activation of handle control(s) (**24,26,28**). A foot pedal (**38**) can be provided including same controls (**24,26,28**) as the handle (**20,32**).

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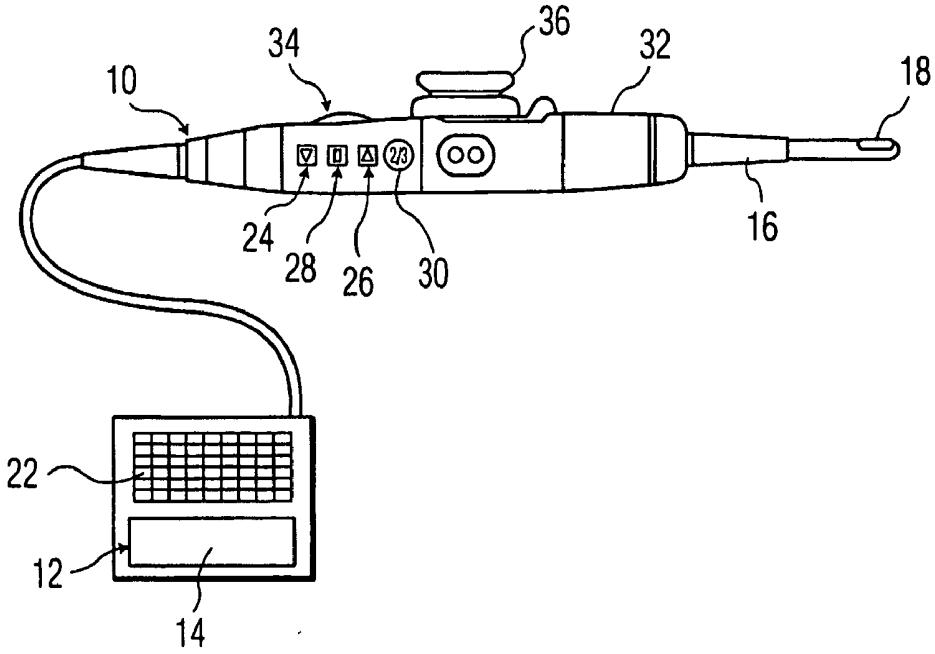
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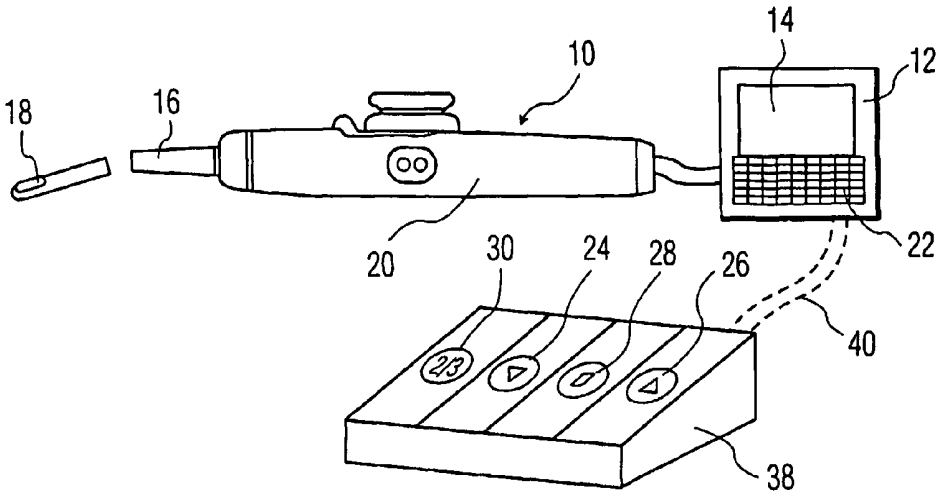
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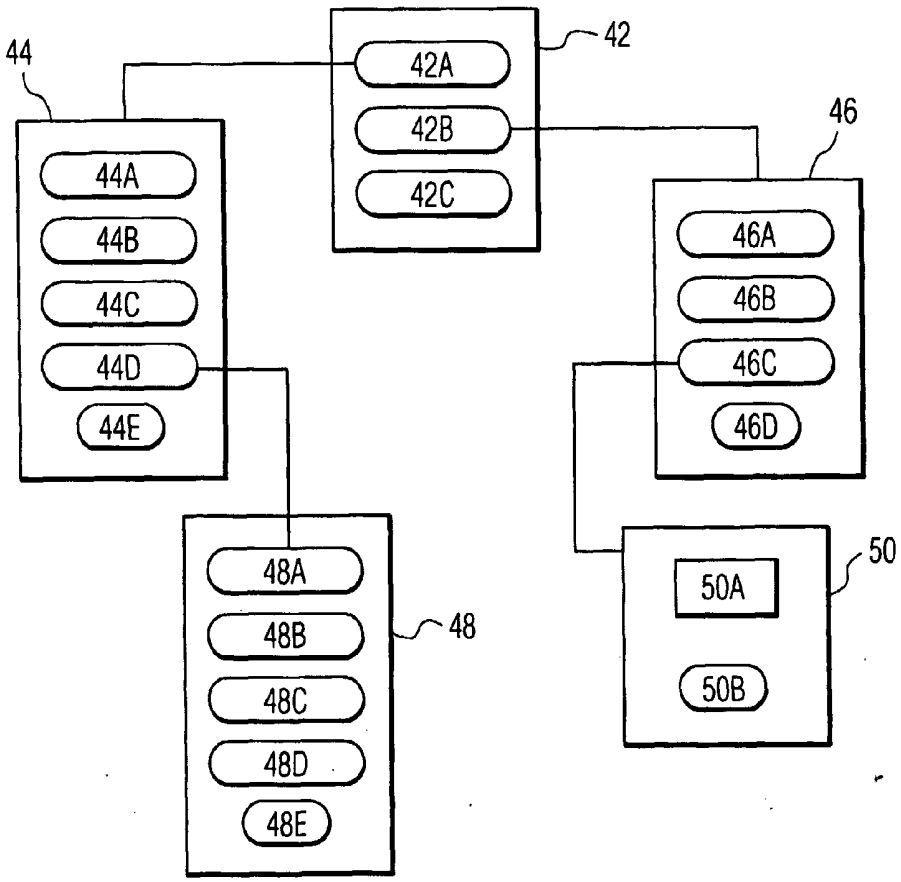
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ULTRASOUND SYSTEM FOR INTERNAL IMAGING INCLUDING CONTROL MECHANISM IN A HANDLE

[0001] The present invention relates generally to medical ultrasound systems for internal imaging and more specifically to medical ultrasound systems including a control mechanism in a handle which is manipulated during the examination.

[0002] Various medical probes including transducers are used to obtain images of internal organs and structures. For example, a transesophageal echocardiographic (TEE) probe includes a transducer designed to be inserted into the mouth of a patient and positioned in the patient's esophagus so that the heart and other internal cardiac structures to be imaged are in the direction of view of the transducer. Similarly, a transthoracic transducer is designed to be positioned on the patient's thorax so that the heart and other internal structures to be imaged in the thoracic cavity are in the direction of view of the transducer.

[0003] TEE probes include a transducer arranged in a probe shaft adapted to be inserted into the patient's body, a "mid-handle" connected to the probe shaft and which remains outside of the patient's body, and a processing unit connected to the mid-handle via a cable so that the mid-handle is interposed between the cable and the probe shaft. The processing unit is controlled by controls on a control panel and provides images to an associated display device such as a monitor. Controls are often positioned on the mid-handle to enable adjustment of the articulation and rotational position of the tip of the transducer, i.e., to point the tip in the direction of the object to be imaged.

[0004] Transthoracic probes include a transducer arranged in a handle which is positioned transthoracically on the patient's body and a processing unit connected to the handle via a cable. The processing unit is controlled by controls on a control panel and provides images to an associated display device.

[0005] It is a drawback of prior art TEE probes that only positional adjustment of the transducer tip can be effected by the controls on the handle (hereinafter both the handle of the transthoracic probe and the mid-handle of the TEE probe will be referred to as a handle). A drawback of transthoracic probes is that operational control of the probe is not effected by controls situated on the handle. Although such transducers have different operational modes, such as a two-dimensional imaging mode, a real-time (live) three-dimensional imaging mode, a color mode and a harmonics biplane mode, these operational modes are not adjustable by the controls on the handle of the prior art probes. Thus, if in the course of an examination, the examiner wants to switch between a two-dimensional mode and a three-dimensional mode, the operator would have to access a separate control unit, i.e., the control panel, and could not effect such a change using the controls on the handle. Accessing the control panel is distracting and requires the operator to repeatedly shift and reposition his body and may also require the operator to remove his hands from the handle of the probe. This may cause movement of the transducer which would require re-positioning of the transducer and thus may lengthen the examination.

[0006] Another drawback of the prior art probes is that controls for optimizing the image are not adjusted by the controls on the handle, when present. The transducers have various image optimizing controls such as frequency, depth, focus and zoom that are present on the control panel, and these image-optimizing features are not adjustable by the controls on the handle of the prior art probes. As such, if in the course of an examination, the user wants to zoom into the image to increase the magnification of a part of the image, the user would have to access the control panel.

[0007] It is an object of the invention to provide a new ultrasound probe for imaging internal structures including a control system incorporated into a handle of the ultrasound probe to thereby enable easier access to system controls and image-optimizing controls.

[0008] It is yet another object of the present invention to provide a new control system for medical probes which have a handle that is manipulated during a medical examination.

[0009] It is another object of the invention to provide a control system for ultrasonic medical probes which provides convenient toggling between two-dimensional and three-dimensional imaging modes.

[0010] It is another object of the invention to incorporate system controls of an ultrasonic medical probe, such as a transthoracic probe and a transesophageal probe, into a handle of the probe.

[0011] In order to achieve these objects and others, an ultrasound system for imaging internal structure of a patient in accordance with the invention includes a probe including a handle and an ultrasonic transducer arranged in connection with the handle for obtaining images. The handle includes one or more controls designed to enable a switch in the mode of operation of the probe or optimization of images obtained by the transducer. A display device is coupled to the probe and displays control menus and optionally the images obtained by the probe. A control unit controls the probe and display device based on activation of the controls such that a change in the control menu displayed by the display device, a switch in the mode of operation of the probe and/or adjustment of the images obtained by the probe is effected based on the activation of the control(s).

[0012] By enabling adjustment in the mode of operation of the probe and images obtained by the probe via controls on the handle, a more efficient examination can be conducted since the user does not have to reach in order to access the system control unit or remove her hands from the handle as would be required if the system controls are placed on the a control panel as in conventional ultrasound systems.

[0013] As noted above, the transducer is arranged in connection with the handle, for example, either actually in a housing of the handle and arranged therein or in a probe shaft coupled to the handle. In the former case, the probe can be designed as a transthoracic probe. In the latter case, the probe may be a transesophageal echocardiographic probe so that the probe shaft is adapted to be inserted into a patient and the handle is a "mid-handle" thereof interposed between the probe shaft and the cable connecting the mid-handle to the control unit. A positioning device such as a trackball may also be arranged on the mid-handle for adjusting the position of an indicator in images displayed on the display device. As such, not only can the mode of operation of the probe and images obtained by the probe be controlled by the controls on the mid-handle, but also the position of the indicator in

the images can be controlled and this enables measurement of the internal structures to be more efficiently performed.

[0014] In one embodiment, the controls include a toggle-back button which when pressed, causes a preceding option on a displayed control menu to be highlighted or an incremental decrease in a variable to be displayed, a select button which when pressed, effects a switch in the mode of operation of the probe or adjustment of a property of the images obtained by the transducer associated with an option or variable highlighted on the displayed control menu and a toggle-forward button which when pressed, causes a subsequent option on the displayed control menu to be highlighted or an incremental increase in a variable to be displayed.

[0015] One of the controls may be a switching control arranged to switch the mode of operation of the probe between a two-dimensional mode of operation and a three-dimensional mode of operation when activated. By providing a control to effect this change, it would not be required to access the control menus and buttons to effect this change and thus the change can be made very quickly and easily.

[0016] Another embodiment of an ultrasound system for imaging internal structure of a patient includes a probe including a handle and an ultrasonic transducer arranged in connection with the handle for obtaining images. The system also includes a display device that displays control menus and a foot pedal which includes one or more controls similar to the controls on the handle in the embodiments described above. A control unit is also provided similar to that in the embodiment above.

[0017] By providing the system controls on a foot pedal, the user is able to change the operation of the probe and the images displayed on the display device without removing her hands from the handle and also without removing her hands from the positional controls for the probe shaft. This reduces the possibility of unnecessary movement of the transducer during an examination.

[0018] When another set of system controls is also provided on the handle in the manner discussed above, the additional advantages discussed above are also obtained.

[0019] The invention, together with further objects and advantages hereof, may best be understood by reference to the following description taken in conjunction with the accompanying drawings, wherein like reference numerals identify like elements and wherein:

[0020] FIG. **1** is a front plan view of a handle of a transthoracic probe in accordance with the invention;

[0021] FIG. **2** is a front plan view of a mid-handle of a TEE probe in accordance with the invention;

[0022] FIG. **3** is a front perspective view of a foot pedal in accordance with the invention; and

[0023] FIG. **4** shows an example of a control menu hierarchy for use in the invention.

[0024] Referring to the accompanying drawings wherein like reference numerals refer to the same or similar elements, FIG. I shows a system for ultrasonic imaging including a transthoracic probe **10**, a control unit **12** and a display device **14** such as a monitor. The probe **10** includes a handle **20** coupled to the control unit **12** through a cable-and an ultrasonic transducer **18** arranged in connection with the handle **20**, i.e., arranged in the handle **20**, for obtaining images of the internal structure of the patient. The control unit **12** and display device **14** may be integral with one another, i.e., formed as a common unit.

[0025] A control panel **22** including function-specific controls is arranged in connection with the control unit **12**. The function-specific controls include controls for switching the mode of operation of the probe **10** and for optimizing the images obtained by the transducer **18** and displayed on the display device **14** as well as other known controls for use in connection with the probe **10**. The control unit **12** includes appropriate electronics to perform the functions selected by the function-specific controls, i.e., to direct the transducer **18** to adjust its transmission and reception properties and direct the display device to adjust its display of images derived from the received waves.

[0026] The handle **20** includes three depressible control buttons **24**, **26**, **28** arranged thereon which enable a switch in the mode of operation of the probe **10** or adjustment of the images obtained by the transducer **18** and displayed on the display device **14** (as discussed more fully below). **5** Control button **24** is a toggle-back button and when pressed, causes a preceding option on a control menu to be highlighted or an incremental decrease in a variable to be displayed on the control menu. Thus, button **24** preferably has a downwardly oriented arrow formed thereon. Control button **26** is a toggle-forward button and when pressed, causes a subsequent option on the control menu to be highlighted or an incremental **10** increase in a variable to be displayed on the control menu. Thus, button **26** preferably has an upwardly oriented arrow formed thereon.

[0027] The screen may be the display device **14**, a portion of the viewing window of the display device **14** or separate from the display device **14**. Hereinafter, the display device **14** will be considered to show both the control menus and the images obtained by the **15** processing of the waves received by the transducer **18**.

[0028] Control button **28** is a select button and when pressed, causes the highlighted option of the control menu to be activated or the selected variable to be implemented. Activation of the select button **28** may result in a change in the operation of the probe **10** (when the highlighted option is an operation mode different from the one in which the system is **20** operating), adjustment of the images being obtained by the transducer **18** (when the highlighted option is for example an image varying feature such as zoom) or display of another control menu (when the highlighted option has narrower possible options).

[0029] Handle **20** also includes a depressible control **30** which, when depressed, enables an immediate switch in the operation of the probe **10** from a two-dimensional mode of operation to a three-dimensional mode of operation, or vice versa. This provides a convenient way to toggle between two-dimensional and live three-dimensional imaging modes.

[0030] The display device **14** and controls **24**, **26**, **28**, **30** are coupled to the processing unit **12** which controls the probe **10** and the display device **14** based on activation of the controls **24**, **26**, **28**, **30**. Controls **24** and **26** are effective to change the highlighted option on a control menu when a control menu is displayed on the display device **14** or to

adjust a property of the images obtained by the probe **10** when a menu having a property adjustment characteristic is provided (discussed below with reference to FIG. **4**).

[**0031**] Control **28** is effective to cause the display device **14** to initiate the highlighted option. If the highlighted option calls for display of another control menu, then when pressed, control **28** will cause that control menu to be displayed. If the highlighted option calls for a change in the property of the images obtained by the probe **10**, then when control **28** is pressed, the change will be made. If the highlighted option calls for a change in the mode of operation of the probe **10**, then when control **28** is pressed, the change will be made.

[**0032**] Possible control options include various modes of operation of the transducer, such as, but not limited to, color, two-dimensional, real-time (live) three-dimensional, harmonics and biplane, as well as various image-optimizing features, such as, but not limited to, frequency, depth, focus and zoom. Once one of the control options is selected, additional, secondary control options are also available. For example, pressing the control option for two-dimensional operation mode can be designed to result in the appearance of a secondary control menu which will present sub-options within the two-dimensional mode. The particular sub-option can be selected by the buttons **24**, **26** and **28**. Additional sub-menus can also be presented based on the selection of the control option. There will thus be a tree or hierarchy of control menus programmed into the control unit **12** for display on the display device **14** in correspondence with the pressing of the control buttons **24**, **26** and **28**. This aspect is discussed in greater detail below with reference to FIG. **4**.

[**0033**] FIG. **2** shows part of a TEE probe **10** including a handle **32** and three depressible control buttons **24**,**26**,**28** arranged thereon and having the same functions as described above. The handle **32** also includes the switching control **30** and a positioning device **34** such as a trackball. The trackball **34** is used to adjust the position of an indicator or cursor on the images obtained by the transducer **18** and displayed on a display device **14**. As known in the art, adjustment of the indicator is useful to obtain measurements of the internal structure being imaged.

[**0034**] A probe shaft **16** is connected to the handle **32** and houses the transducer **18** as known in the art. Thus, the transducer **18** is arranged in connection with the handle **32** via the probe shaft **16**. Handle **32** also includes usual controls **36** for controlling the probe shaft **16** and tip of the transducer **18**.

[**0035**] The placement of the positioning device **34** on the handle **32** enables the position of the indicator in the images to be adjusted without requiring the user to remove her hands from the handle **32** as would be necessary when the positioning device is placed on or proximate the control panel **22** as in conventional ultrasound systems.

[**0036**] FIG. **3** shows a foot pedal device **38** having three depressible control buttons **24**, **26**, **28** and a switching control **30** arranged thereon and which have the same functions as described above. The foot pedal **38** is connected to the processing unit **12** of the probe **10**. The coupling between the foot pedal **38** and the processing unit **12** may be a cable **40** (shown in dotted lines) or a wireless connection.

[**0037**] An advantage of the use of the foot pedal **38** is that the foot pedal **38** can be placed on the floor in a convenient and ergonomic location so that the ultrasound user does not need to move her hands from the handle **20** in order to access the system controls. Rather, she needs only to selectively press the control buttons **24**, **26**, **28**, **30** to change the system controls, i.e., the mode of operation of the probe **10** and the processing variables of the images obtained by the transducer **18**. Thus, the foot pedal **38** is particularly useful in environments where space for the ultrasound system is limited, such as in operating rooms.

[**0038**] The foot pedal **38** can be used in combination with the ultrasound imaging systems shown in FIGS. I and **2** in which the same controls on the foot pedal **38** are also present on the handle **20**,**32**.

[**0039**] FIG. **4** shows a hierarchy of a control menu in accordance with the invention. A first control menu is shown at **42** and includes three selection options **42**A, **42**B (highlighted), **42**C. Each option will cause a different change in the operation of the ultrasound system.

[**0040**] If toggle-back button **24** is pressed, then option **42**A will be highlighted. If toggle-forward button **26** is pressed, then option **42**C will be highlighted. The toggling buttons **24**,**26** can be designed such that toggling back from option **42**A will cause option **42**C to be highlighted and toggling forward from option **42**C will cause option **42**A to be highlighted. The toggle buttons **24**,**26** may be designed to provide continuous toggling from one control option to another when pressed more than a threshold amount of time.

[**0041**] If the option **42**A is highlighted when the select button **28** is pressed, another control menu **44** will appear on the display device **14**. Control menu **44** has four selection options **44**A, **44**B, **44**C, **44**D which will cause a different change in the operation of the ultrasound system and a back option **44**E which, when highlighted and select button **28** is pressed, will cause the preceding control menu to appear (control menu **42**).

[**0042**] If the option **44**D is highlighted when the select button **28** is pressed, another control menu **48** will appear on the display device **14**. Control menu **48** has four selection options **48**A, **48**B, **48**C, **48**D which will cause a different change in the operation of the ultrasound system and a back option **48**E which, when highlighted and select button **28** is pressed, will cause the preceding control menu to appear (control menu **44**).

[**0043**] As an example of the manner in which a property of the images displayed on the display device **14** is changed, consider that a change in depth is desired. Option **42**B may be designated "image changing properties" and when highlighted and control button **28** is pressed, will cause control menu **46** to appear. Control menu **46** has three selection options **46**A, **46**B, **46**C and a back option **46**D which, when highlighted and select button **28** is pressed, will cause the preceding control menu to appear (control menu **42**).

[**0044**] Option **46**A may read "zoom", option **46**B may read "focus" and option **46**C may read "depth". If when the control menu **46** appears, option **46**A is highlighted, then the toggle-forward button **26** is pressed twice to toggle the control menu **46** to make option **46**C highlighted. Then, select button **28** is pressed and control menu **50** appears. Control menu **50** is a specific control menu which enables a property to be adjusted, depth in this case. It would have an area of the screen in which the current depth is shown (area

50A) and a back option **50**B. By pressing the toggle-forward button **26** or the toggle-back button **24**, the depth can be adjusted to the desired depth. When the desired depth is shown in area **50**A, the select button **28** would be pressed to cause the depth to be changed to the desired depth. The back option **50**B would then be highlighted by pressing the toggle-forward button **26**.

[**0045**] In this manner, other properties of the images and the modes of operation of the probe **10** can be set as desired and changed, using only the toggle buttons **24**,**26** and the select button **28**. For a quick change between two-dimensional and three-dimensional imaging, the button **30** can be pressed thereby avoiding the need to scroll through the control menus. Once button **30** is pressed, any submenu options will immediately be displayed in the same manner as if the three-dimensional option was selected through the main toggle menu.

[**0046**] The placement of the buttons **24**, **26** and **28** on the handle **20** and **32** thus allows user access to all system options without the need to reach over and select functions directly on the control panel **22**.

[**0047**] Although buttons **24**, **26**, **28**, **30** are described as being depressible buttons, other types of manually activatable controls can also be used in accordance with the invention, such as switches, LCD screens, and the like. Also, mention is made of the selectable option on the control menu being highlighted. It must be appreciated that other mechanisms for indicating which option will be selected when the select button **28** is pressed can also be used in the invention and highlighting is merely one example of such an indicating mechanism. Moreover, while a foot pedal is mentioned, a similar device for hand operation could be provided.

[**0048**] Although illustrative embodiments of the present invention have been described herein with reference to the accompanying drawings, it is to be understood that the invention is not limited to these precise embodiments, and that various other changes and modifications may be effected therein by one of ordinary skill in the art without departing from the scope or spirit of the invention.

1. An ultrasound system for imaging internal structure of a patient, comprising

a probe including a handle and an ultrasonic transducer arranged in connection with said handle for obtaining images, said handle including at least one control arranged to enable a switch in the mode of operation of said probe or optimization of images obtained by said transducer;

a display device for displaying a control menu having a plurality of options and enabling highlighting of one of said options; and

a control unit coupled to said probe and said display device for controlling said probe and display device based on activation of said at least one control such that said display device is controlled to display one of a plurality of predetermined control menus based on the activation of said at least one control and said probe is arranged to effect a switch in the mode of operation of said probe or adjustment of the images obtained by said transducer based on the activation of said at least one control.

2. The system of claim 1, wherein said probe is designed as a transesophageal echocardiographic probe and further includes a probe shaft adapted to be inserted into the patient, said transducer being arranged in said probe shaft whereby said handle is a mid-handle for said probe.

3. The system of claim 2, further comprising a positioning device arranged on said handle for adjusting the position of an indicator in images displayed on said display device.

4. The system of claim 3, wherein said positioning device is a trackball.

5. The system of claim 1, wherein said probe is designed as a transthoracic probe and said transducer is arranged in said handle.

6. The system of claim 1, wherein said at least one control comprises a toggle-back button which when pressed, causes a preceding option on the displayed control menu to be highlighted, a select button which when pressed, effects a switch in the mode of operation of said probe or adjustment of a property of the images obtained by said transducer associated with an option highlighted on the displayed control menu and a toggle-forward button which when pressed, causes a subsequent option on the displayed control menu to be highlighted.

7. The system of claim 6, wherein each of said predetermined control menus has a "back" option which enables the display of a preceding control menu when highlighted and said select button is pressed.

8. The system of claim 1, wherein said handle further comprises an activatable switching control arranged to switch the mode of operation of said probe between a two-dimensional mode of operation and a three-dimensional mode of operation when activated.

9. The system of claim 1, wherein one of said control menus includes options for different modes of operation of said probe.

10. The system of claim 9, wherein the different modes of operation of said probe include two-dimensional, real-time (live) three-dimensional, harmonics, biplane and color.

11. The system of claim 1, wherein one of said control menus includes options for optimizing the images obtained by said probe.

12. The system of claim 11, wherein the options for optimizing the images include adjustment of the frequency of waves transmitted/received by said transducer, depth of the images, focus of the images and zoom of the images.

13. The system of claim 1, further comprising a control panel coupled to said processing unit and including a plurality of function-specific controls for switching the mode of operation of said probe and optimizing the images obtained by said transducer.

14. An ultrasound system for imaging internal structure of a patient, comprising

a probe including a handle and an ultrasonic transducer arranged in connection with said handle for obtaining images;

a display device for displaying a control menu having a plurality of options and enabling highlighting of one of said options;

a foot pedal including at least one control arranged to enable a switch in the mode of operation of said probe or optimization of images obtained by said transducer; and

a control unit coupled to said probe, said foot pedal and said display device for controlling said probe and display device based on activation of said at least one control such that said display device is controlled to display one of a plurality of predetermined control menus based on the activation of said at least one control and said probe is arranged to effect a switch in the mode of operation of said probe or adjustment of the images obtained by said transducer based on the activation of said at least one control.

15. The system of claim 14, wherein said foot pedal is coupled to said control unit wirelessly.

16. The system of claim 14, wherein said at least one control comprises a toggle-back button which when pressed, causes a preceding option on the displayed control menu to be highlighted, a select button which when pressed, effects a switch in the mode of operation of said probe or adjustment of a property of the images obtained by said transducer associated with an option highlighted on the displayed control menu and a toggle-forward button which when pressed, causes a subsequent option on the displayed control menu to be highlighted.

17. The system of claim 14, wherein said foot pedal further comprises an activatable switching control arranged to switch the mode of operation of said probe between a two-dimensional mode of operation and a three-dimensional mode of operation when activated.

18. The system of claim 14, wherein one of said control menus includes options for different modes of operation of said probe, the different modes of operation of said probe include two-dimensional, real-time (live) three-dimensional, harmonics, biplane and color.

19. The system of claim 14, wherein one of said control menus includes options for optimizing the images obtained by said probe, the options for optimizing the images include adjustment of the frequency of waves transmitted/received by said transducer, depth of the images, focus of the images and zoom of the images.

20. The system of claim 14, further comprising a control panel coupled to said processing unit and including a plurality of function-specific controls for switching the mode of operation of said probe and optimizing the images obtained by said transducer.

21. The system of claim 14, further including a probe shaft adapted to be inserted into the patient, said transducer being arranged in said probe shaft.

22. The system of claim 14, wherein said transducer is arranged in said handle.

* * * * *

专利名称(译)	用于内部成像的超声系统包括手柄中的控制机构		
公开(公告)号	US20070093713A1	公开(公告)日	2007-04-26
申请号	US10/559213	申请日	2004-06-07
[标]申请(专利权)人(译)	皇家飞利浦电子股份有限公司		
申请(专利权)人(译)	皇家飞利浦电子N.V.		
当前申请(专利权)人(译)	皇家飞利浦电子N.V.		
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外部链接	Espacenet USPTO		

摘要(译)

用于对患者的内部结构进行成像的超声系统，包括具有手柄（20,32）的探针（10）和与手柄（20,32）连接的换能器（18），用于获得图像，如在手柄中那样经胸探针（10）或在探针轴（16）中，如TEE探针（10）中那样连接到手柄。手柄上的控制使得能够在探针（10）的操作模式中进行切换和/或由换能器（18）获得的图像的优化。耦合到探针（10）的显示设备（14）显示控制菜单和可选的获得图像。控制单元（12）基于控制激活来控制探针（10）和显示设备（14）。由显示装置（14）显示的控制菜单的改变，探针（10）的操作模式中的切换和/或通过探针（10）获得的图像的调整基于手柄控制的激活而实现。（24,26,28）。可以提供脚踏板（38），其包括与手柄（20,32）相同的控制器（24,26,28）。