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(54) SYSTEM AND METHOD FOR DISPLAYING ULTRASOUND IMAGES

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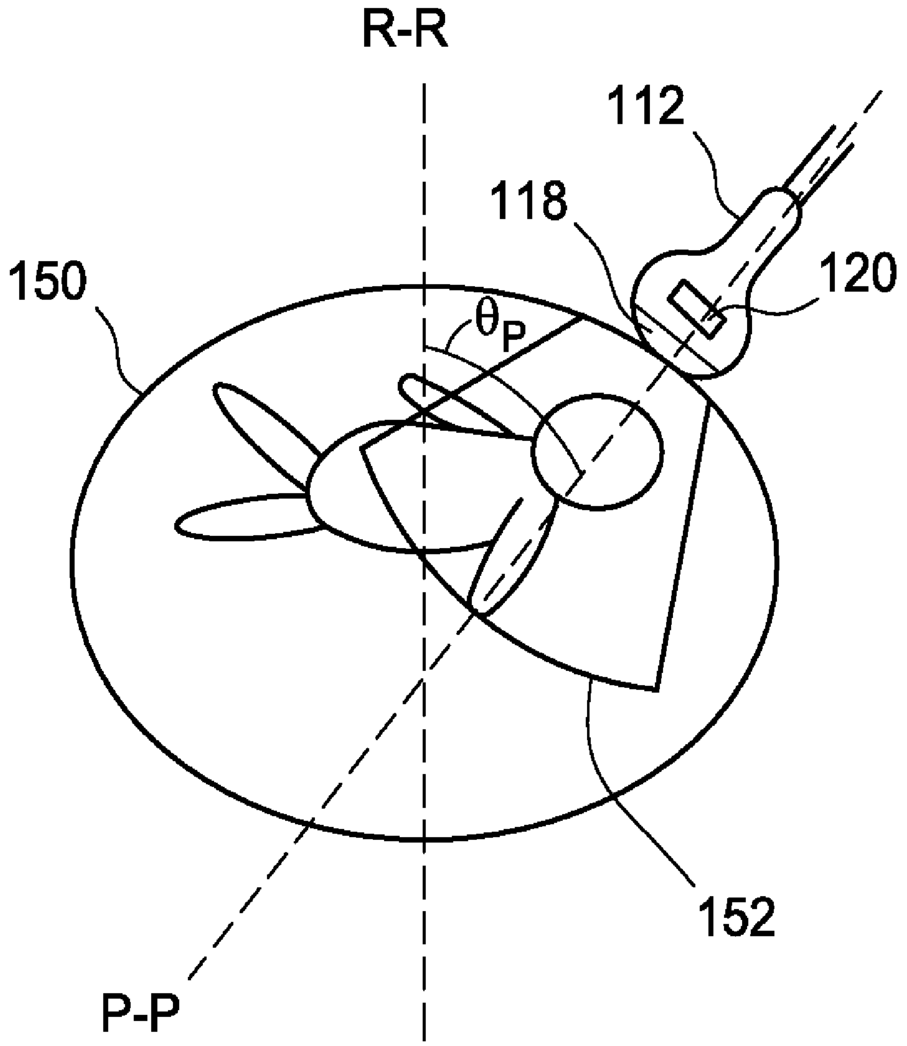
(57) **ABSTRACT**

An ultrasound imaging system comprises a probe configured to transmit ultrasound signals toward a target region of interest (ROI) and receive returned echo data from the target ROI. The system further comprises a sensor for generating a signal relating to a probe orientation, a display for displaying an image of the target ROI and a processor connected the probe for receiving the echo data and generating the image of the target ROI. The processor is further configured to receive the probe orientation signal and display the image of the target ROI based on the probe orientation signal.



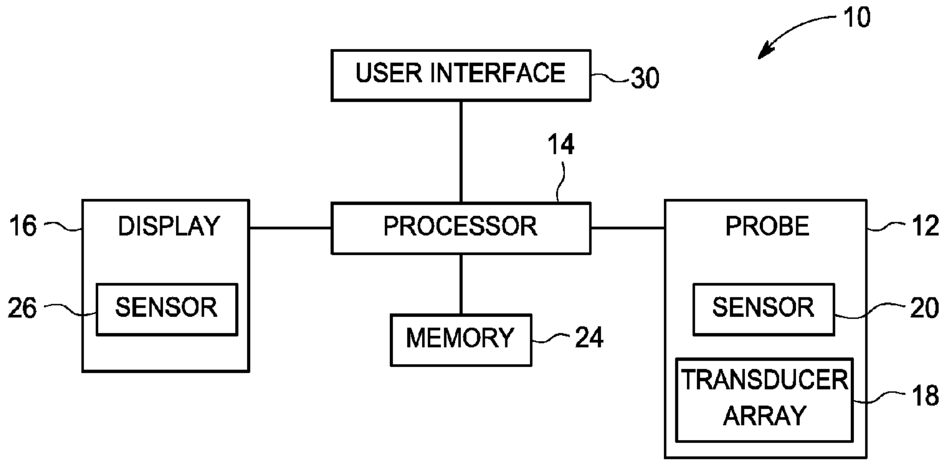

10
USER INTERFACE
30
14
16
DISPLAY
PROCESSOR
PROBE
12
26
SENSOR
SENSOR
20
MEMORY
24
TRANSDUCER ARRAY
18

FIG. 1

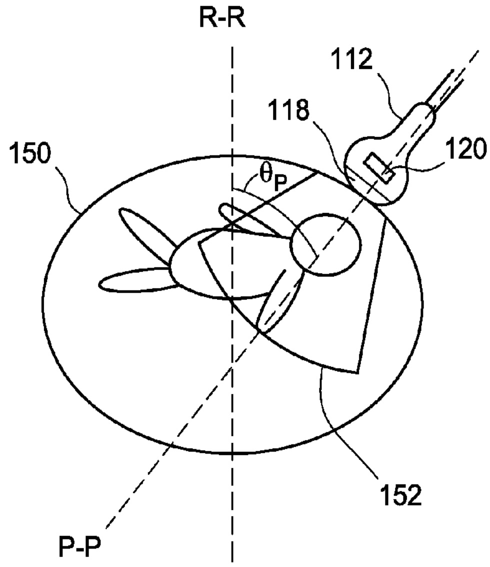

R-R
112
118
150
120
θP
152
P-P

FIG. 2

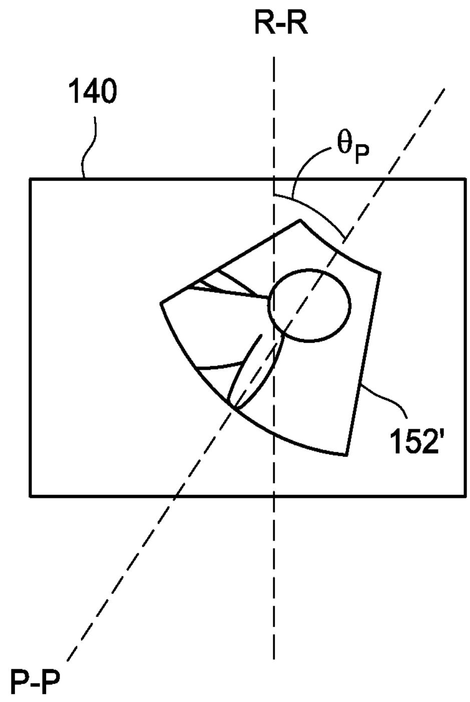


FIG. 3

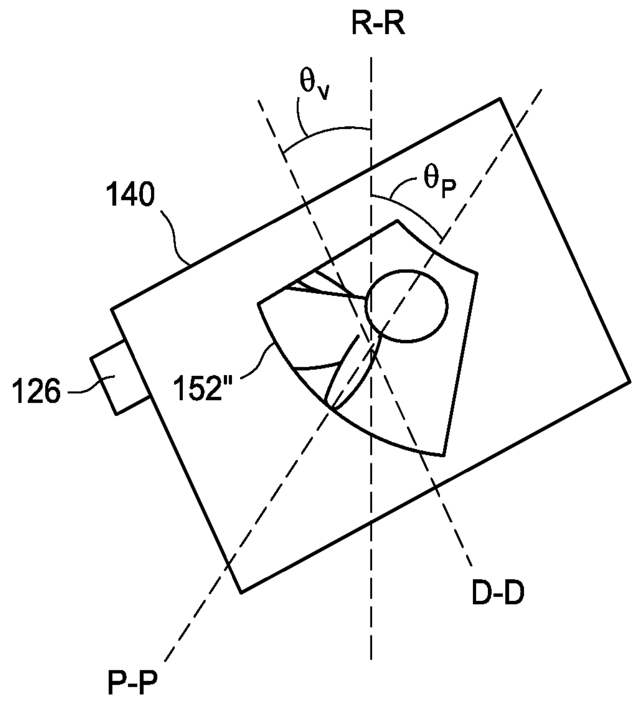


FIG. 4

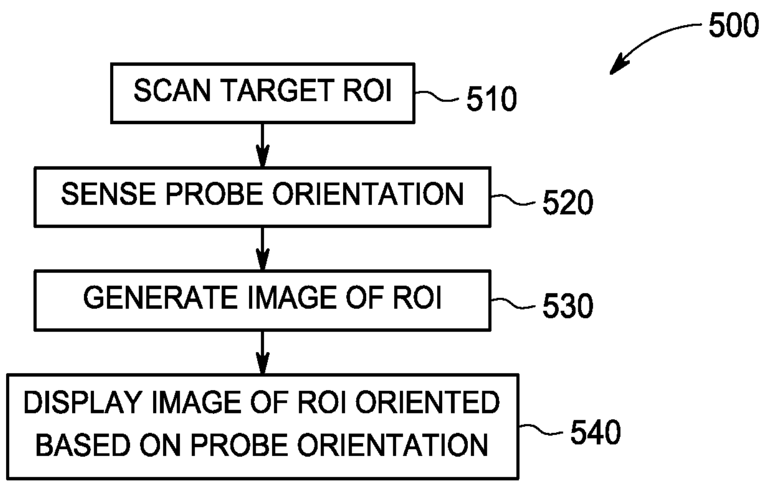

500
SCAN TARGET ROI
510
SENSE PROBE ORIENTATION
520
GENERATE IMAGE OF ROI
530
DISPLAY IMAGE OF ROI ORIENTED BASED ON PROBE ORIENTATION
540

FIG. 5

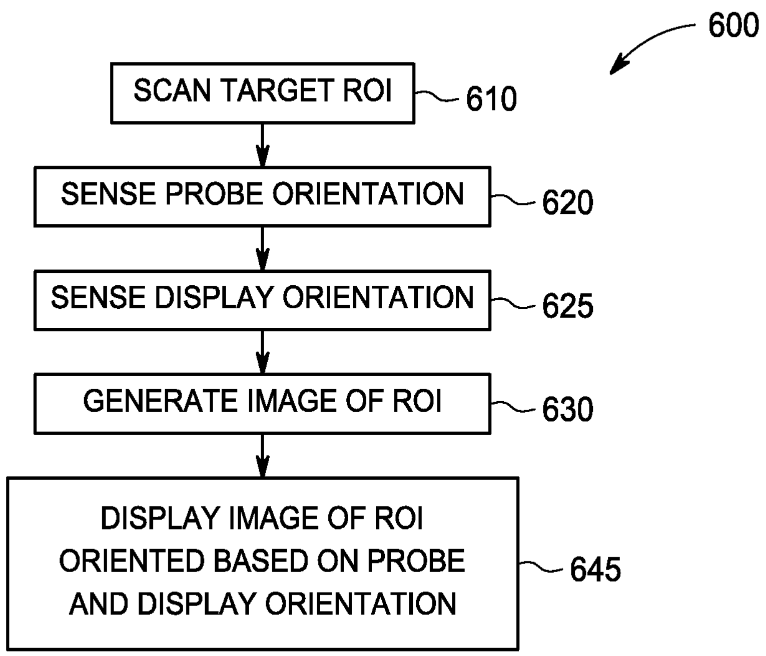

600
SCAN TARGET ROI
610
SENSE PROBE ORIENTATION
620
SENSE DISPLAY ORIENTATION
625
GENERATE IMAGE OF ROI
630
DISPLAY IMAGE OF ROI ORIENTED BASED ON PROBE AND DISPLAY ORIENTATION
645

FIG. 6

SYSTEM AND METHOD FOR DISPLAYING ULTRASOUND IMAGES

BACKGROUND OF THE INVENTION

[0001] The subject matter disclosed herein relates generally to an ultrasound imaging system and a method for orientating the ultrasound image displayed.

[0002] In the field of medical ultrasound imaging, a probe, comprising a transducer array, is typically used to transmit ultrasound energy into a target, such as a patient, and to detect reflected ultrasound energy from the target. Based on the energy and timing of the reflected ultrasound waves, it is possible to determine detailed information about a region of interest (ROI) inside the target. The information may be used to generate images and/or quantitative data such as blood flow direction or rate of flow.

[0003] Generally, the processed ultrasound images are displayed at 0 degrees, meaning that the axis bisecting the displayed ROI is a vertical gravitational axis or a y-axis. For an inexperienced user, it may be difficult to comprehend the spatial relationship between a target ROI being scanned and the orientation of the displayed ROI image. Additionally, since the field of view provided by the transducer geometry only provides a subset of the slice the anatomy of interest, it can be a challenge for an inexperienced user to find and visualize what they are looking for. To further complicate challenges faced by an inexperienced user, the display orientation of a portable or handheld ultrasound system may be variable and inconsistent. As a result of these challenges, increases in scan times and overall exam length may produce workflow inefficiencies.

[0004] Therefore, a system and method for displaying ultrasound images having the orientation of the displayed anatomy change based on the orientation of the probe and/or the device is desired.

[0005] The above-mentioned shortcomings, disadvantages and problems are addressed herein which will be understood by reading and understanding the following specification.

BRIEF DESCRIPTION OF THE INVENTION

[0006] In an embodiment, an ultrasound imaging system comprises a probe configured to transmit ultrasound signals toward a target region of interest (ROI) and receive returned echo data from the target ROI. The system further comprises a sensor for generating a signal relating to a probe orientation, a display for displaying an image of the target ROI and a processor connected to the probe for receiving the echo data and generating the image of the target ROI. The processor is further configured to receive the probe orientation signal and display the image of the target ROI based on the probe orientation signal.

[0007] In another embodiment, a method of displaying an ultrasound image comprises scanning with a probe a target region of interest (ROI) and receiving echo data from the ROI, and sensing with a sensor a probe orientation. The method further comprises generating with a processor an image of the ROI, and displaying with a display the image of the ROI based on the probe orientation.

[0008] Various other features, objects, and advantages of the invention will be made apparent to those skilled in the art from the accompanying drawings and detailed description thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a schematic diagram on an ultrasound imaging system in accordance with an embodiment;

[0010] FIG. **2** is schematic representation of the ultrasound probe in accordance with the embodiment of FIG. **1**, scanning a target;

[0011] FIG. **3** is a schematic representation of a displayed ROI image in accordance with an embodiment;

[0012] FIG. **4** is a schematic representation of a displayed ROI image in accordance with an embodiment; and

[0013] FIG. **5** is a flowchart of a method in accordance with the embodiment of FIG. **3**; and

[0014] FIG. **6** is a flowchart of a method in accordance with the embodiment of FIG. **4**.

DETAILED DESCRIPTION OF THE INVENTION

[0015] In the following detailed description, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration specific embodiments that may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the embodiments, and it is to be understood that other embodiments may be utilized and that logical, mechanical, electrical and other changes may be made without departing from the scope of the embodiments. The following detailed description is, therefore, not to be taken as limiting the scope of the invention.

[0016] Referring to FIG. **1**, an ultrasound system **10** includes a probe **12**, a processor **14**, and a display **16**. Both the probe **12** and the display **16** are operatively connected to processor **14**. This connection may be wired or wireless. The ultrasound system **10** may be a console-based or laptop system or a portable system, such as a handheld system. In one embodiment, the processor **14** may be integral to the probe **12**. In another embodiment, the processor **14** and the display **16** may be integrated into a single housing.

[0017] The probe **12** is configured to transmit ultrasound signals toward a target region of interest (ROI) and receive returned echo data from the target ROI. The probe comprises a transducer array **18**. The transducer array **18** has a plurality of transducer elements configured to emit pulsed ultrasonic signals into a target region of interest (ROI). It should be appreciated that while the transducer array may have a variety of geometries including 2D array, curved linear array, and convex array, the transducer array **18** will comprise at least one row of transducer elements.

[0018] Pulsed ultrasonic signals are back-scattered from structures in the body, like blood cells or muscular tissue, to produce echoes that return to the transducer array **18**. The echoes are converted into electrical signals, or ultrasound data, by the transducer elements in the transducer array **18** and the electrical signals are received by the processor **14**.

[0019] The probe **12** also may include a probe orientation sensor **20**. Orientation sensor **20** is configured to measure a tilt angle of probe **12** with respect to a vertical gravitational axis, for example, axis R-R shown in FIG. **2**. The orientation sensor **20** may comprise an accelerometer. An accelerometer is a device that measures static or dynamic acceleration forces. By measuring, for example, the amount of static acceleration due to gravity, an orientation or tilt of a device with respect to the earth can be determined. The orientation sensor **20** may further comprise any other device or technology known to determine the orientation of an object with respect to a vertical gravitational axis. For example, the orientation sensor **20** may comprise optical tracking, electromagnetic field (EMF) tracking or image tracking devices, or any combination thereof.

[0020] The processor **14** may be able to control the acquisition of ultrasound data by the probe **12**, process the ultrasound data, and generate frames or images for display on the display **16**. The processor **14** may, for example, be a central processing unit, a microprocessor, a digital signal processor, or any other electrical component adapted for following logical instructions. The processor **14** may also comprise a tracking technology, as an alternative to, or in addition to orientation sensor **20** in the probe, such as image tracking technology, in order to determine a tilt angle or orientation of probe **12** with respect to a vertical gravitational axis, based on the generated image and movement of the image over time.

[0021] The processor **14** may be operatively connected to a memory **24**. The memory **24** is a non-transitory computer readable storage medium. The memory **24** is configured to store instructions, programs and ultrasound data such as processed frames of acquired ultrasound data that are not scheduled to be displayed immediately.

[0022] The processor **14** may also be operatively connected to a user interface **30**. The user interface **30** may be a series of hard buttons, a plurality of keys forming a keyboard, a trim knob, a touchscreen, or some combination thereof. It should be appreciated that additional embodiments of the user interface **30** may be envisioned. The user interface **30** may be used to control operation of the ultrasound system **10**, including to control the input of patient data, to change a scanning or display parameter, and the like. For example, the user interface **30** may configured to allow the ultrasound operator to select between display modes. The display modes may be a standard mode, as described with respect to the prior art, and an orientation-adjusted mode as described herein with respect to FIGS. **3**-**6**.

[0023] Display **16** is operatively connected to processor **14** and is configured to display images. Images may be displayed on display **16** in real time. For purposes of this disclosure, the term "real-time" is defined to include a process performed with no intentional lag or delay. An embodiment may update the displayed ultrasound image at a rate of more than **20** times per second. The images may be displayed as part of a live image. For purposes of this disclosure, the term "live image" is defined to include a dynamic image that updates as additional frames of ultrasound data are acquired. For example, ultrasound data may be acquired even as images are being generated based on previously acquired data while a live image is being displayed. As additional ultrasound data are acquired, additional frames or images generated from more recently acquired ultrasound data are sequentially displayed. Additionally and alternatively, images may be displayed on display **16** in less than real time. Ultrasound data may be stored in memory **24** during a scanning session and then processed and displayed at a later time.

[0024] The display **16** may have a display orientation sensor **26**. Similar to orientation sensor **20**, the orientation sensor **26** is configured to measure the tilt angle of display **16** with respect to a vertical gravitational axis, for example, shown in FIG. **4**. The orientation sensor **26** may be an accelerometer. It should be appreciated that the orientation sensor **26** may be any other device or technology known to determine the orientation of an object with respect to a vertical gravitational axis. For example, the orientation sensor **26** may be an EMF tracking device.

[0025] Referring to FIG. **2**, a schematic representation of a target **150** is shown in accordance with an embodiment. Target **150** may be a human or an animal. In the embodiment shown, the target **150** is a pregnant subject. The target **150** is oriented with respect to a reference axis R-R. Reference axis R-R is a vertical gravitational axis. Target **150** comprises a ROI **152**. The ROI **152** may be a subset of the target **150**. For example, in the embodiment shown, the ROI **152** comprises a fetus within the target **150**.

[0026] A probe **112** comprises a transducer array **118** and a probe orientation sensor **120**. The transducer array **118** is configured to send ultrasonic signal towards a target ROI **152** and receive the resulting echo data. The ROI **152** comprises a center line P-P that bisects the ROI **152**. The center line P-P is perpendicular to transducer array **118** and bisects the transducer array **118**. For example, if the transducer array **118** comprises a row of **100** transducer elements, the center line P-P bisects the row of transducer elements with **50** transducer elements on either side of center line P-P.

[0027] Orientation sensor **120** is configured to determine an angle θ_P of probe **112** with respect to axis R-R. Angle θ_P is defined by the angle between axis R-R and center line P-P. If probe **112** were aligned with axis R-R, the angle θ_P would be 0 degrees and the center line P-P would be aligned with axis R-R. In the depicted embodiment shown, angle θ_P is greater than 0 degrees but less than 90 degrees. It should be appreciated that angle θ_P may vary from 0 degrees to 180 degrees in either clockwise or counterclockwise direction from axis R-R. Angle θ_P can change in real time as the orientation of probe **112** changes.

[0028] FIG. **3** comprises a schematic representation of the display **140** in accordance with an embodiment. The display **140** comprises an image of the ROI **152'**. The center line P-P of image of ROI **152'** is displayed at the angle θ_P with respect to axis R-R. Angle θ_P is the same in both FIGS. **2** and **3**.

[0029] In FIG. **4**, the display **140** is shown in accordance with another embodiment. The display **140** has a display orientation sensor **126** that is configured to determine a display orientation, angle θ_V, with respect to axis R-R. If the display **140** is level, angle θ_V is equal to 0 degrees and a display axis D-D is parallel axis R-R. When the display **140** is tilted with respect to axis R-R, angle θ_V is greater than 0 degrees and axis D-D is no longer parallel to axis R-R. For example, in the depicted embodiment, the angle θ_V is greater than 0 degrees but less than 90 degrees and axis R-R and axis D-D are not parallel. It should be appreciated that angle θ_V may vary from 0 degrees to 180 degrees in either clockwise or counterclockwise direction from axis R-R. Angle θ_V can change in real time as the orientation of display **140** changes.

[0030] The display **140** has an image of the ROI **152"** displayed with center line P-P at angle θ_P with respect to axis R-R and center line P-P at a display angle comprised of the sum of angle θ_P and angle θ_V with respect to axis D-D. Image of ROI **152"** is also displayed so that angle θ_P is the same in both FIGS. **2** and **4**, despite angle θ_V being greater than 0 degrees. The result is that the image of ROI **152"** does not change from the user's perspective despite the angle θ_V of the display **140**.

[0031] Having described various embodiments of the ultrasound system **10**, a method **500** of displaying the ultrasound image will be described in accordance with FIG. **5**. Reference numerals will refer to any of the FIGS. **1-6**. The method **500** may comprise a step **510** comprising scanning with the probe **112** a target ROI **152** and receiving echo data from the ROI **152**. The probe comprises transducer array **118** that is configured to emit pulsed ultrasound signals and receive the backscattered ultrasound signals as echo data. Step **510** may be done according to known techniques in the art.

[0032] The method **500** may include a step **520** comprising sensing, with the sensor **120**, the probe orientation, angle θ_P. The orientation sensor **120** may be an accelerometer, optical tracking, electromagnetic field (EMF) tracking or image tracking device. Sensor **20** may be any other device or technology known to determine the orientation of an object with respect to a vertical gravitational axis. The probe orientation, angle θ_P, can change in real time as the probe **112** moves. When the probe **112** is held parallel to vertical gravitational axis R-R, the angle θ_P is 0 degrees. However, when the probe **112** moves away from such a parallel position, the angle θ_P will be greater than zero.

[0033] The method **500** may include a step **530** comprising generating with the processor **14** an image of the ROI **152'**. Processor **14** receives ROI echo data from the probe **12** and generates an image of the ROI **152'** according to known techniques in the art.

[0034] The method **500** may include a step **540** comprising displaying with the display **16**, **140** the image of the ROI **152'** base on the probe orientation, angle θ_P with respect to axis R-R. Specifically, center line P-P will be displayed at angle θ_P with respect to axis R-R.

[0035] The method **500** may also include an additional step comprising selecting with a user interface a display mode. The display mode may be a standard mode or an orientation-adjusted mode. The standard mode is, as described with respect to the prior art, wherein the center line P-P of image **152'** is parallel with reference axis R-R and angle θ_P therefore equals 0 degrees. The orientation-adjusted mode is depicted in FIG. **3**, wherein the center line P-P of image **152'** is not parallel with reference axis R-R and angle θ_P is therefore greater than 0 degrees.

[0036] Referring to FIG. **6**, a method **600** of displaying the ultrasound image is depicted. Method **600** comprises steps **610**, **620** which are respectively similar to the steps **510** and **520** of method **500**. Method **600** further includes a step **625** comprising sensing with the orientation sensor **26** a display orientation, angle θ_V. The orientation sensor **26** may be an accelerometer or EMF tracking device. Angle θ_V is the angle of display axis D-D with respect to reference axis R-R. This step is particularly important when the display **16** of the ultrasound system **10** is portable or handheld and may not be held with a steady orientation throughout an exam. In this case the display axis D-D is often not parallel with reference axis R-R.

[0037] Method **600** may include a step **630** comprising generating with the processor **14** an image of the ROI. Step **630** is similar to step **530** of method **500**, and may be accomplished according to known techniques in the art.

[0038] Method **600** may include a step **645** comprising displaying with the display **140** the image of the ROI **152"** based on the probe orientation angle θ_P and the display orientation angle θ_V. The display **140** has an image of the ROI **152"** displayed with center line P-P at angle θ_P with respect to axis R-R and center line P-P at a display angle comprised of the sum of angle θ_P and angle θ_V with respect to axis D-D. The result is that the image of ROI **152"** does not change perspective with respect to the user despite the angle θ_V of the display **140**.

[0039] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

I claim:

1. An ultrasound imaging system, comprising:

a probe configured to transmit ultrasound signals toward a target region of interest (ROI) and receive returned echo data from the target ROI;

a sensor for generating a signal relating to a probe orientation;

a display for displaying an image of the target ROI;

a processor connected to the probe for receiving the echo data and generating the image of the target ROI, the processor further configured to receive the probe orientation signal and display the image of the target ROI based on the probe orientation signal.

2. The ultrasound system of claim **1**, wherein the target ROI has a center line having a first angle with respect to a vertical gravitational axis, and the target ROI is displayed on the display with an image center line at the first angle.

3. The system of claim **2**, wherein the probe comprises at least one row of transducer elements and the center line of the target ROI bisects the at least one row.

4. The system of claim **1**, wherein the probe orientation sensor comprises at least one of an accelerometer, optical tracking, EMF tracking and image tracking devices.

5. The system of claim **2**, wherein the image is acquired and displayed in real-time and the image center line changes as the probe orientation signal changes.

6. The system of claim **2**, wherein the display comprises a sensor for determining a display orientation.

7. The system of claim **6**, wherein the display orientation sensor comprise at least one of an accelerometer or EMF tracking devices.

8. The system of claim **6**, wherein the image is acquired and displayed in real-time and a display angle changes as the display orientation changes.

9. The system of claim **1**, further comprising a user interface for selecting a display mode.

10. A method of displaying an ultrasound image, comprising:

scanning with a probe a target region of interest (ROI) and receiving echo data from the ROI,

sensing with a sensor a probe orientation,

generating with a processor an image of the ROI, and

displaying with a display the image of the ROI based on the probe orientation.

11. The method of claim **10**, wherein the target ROI has a center line having a first angle with respect to a vertical gravitational axis, and the target ROI is displayed on the display with an image center line at the first angle.

12. The method of claim **11**, wherein the probe comprises at least one row of transducers and the center line of the target ROI bisects the at least one row.

13. The method of claim **10**, wherein the probe orientation sensor comprises at least one of an accelerometer, optical tracking, EMF tracking and image tracking devices.

14. The method of claim **11**, wherein the image center line changes as the probe orientation changes.

15. The method of claim **14**, wherein the image is generated and displayed in real-time.

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

sensing with a second sensor a display orientation.

17. The method of claim **16**, wherein the second sensor comprises at least one of an accelerometer and EMF tracking devices.

18. The method of claim **17**, wherein the displaying step is based on the probe orientation and the display orientation.

19. The method of claim **17**, wherein the image is generated and displayed in real-time.

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

selecting with a user interface a display mode.

* * * * *

专利名称(译)	用于显示超声图像的系统和方法		
公开(公告)号	US20150182198A1	公开(公告)日	2015-07-02
申请号	US14/141881	申请日	2013-12-27
[标]申请(专利权)人(译)	通用电气公司		
申请(专利权)人(译)	通用电气公司		
当前申请(专利权)人(译)	通用电气公司		
[标]发明人	SABOURIN THOMAS		
发明人	SABOURIN, THOMAS		
IPC分类号	A61B8/00 A61B8/08 A61B19/00 A61B8/14		
CPC分类号	A61B8/463 A61B8/14 A61B8/469 A61B8/4254 A61B8/4416 A61B2019/5255 A61B19/5244 A61B19/5212 A61B2019/5248 A61B2019/5251 A61B2019/5265 A61B8/5207 A61B8/4245 A61B8/4427 A61B8/461 A61B8/5292 A61B8/54 A61B34/20 A61B90/361 A61B2034/2048 A61B2034/2051 A61B2034/2055 A61B2034/2065		
外部链接	Espacenet USPTO		

摘要(译)

超声成像系统包括探针，该探针被配置为向目标感兴趣区域（ROI）发送超声信号并从目标ROI接收返回的回波数据。该系统还包括：传感器，用于产生与探测器方向有关的信号;显示器，用于显示目标ROI的图像;以及处理器，连接探测器，用于接收回波数据并产生目标ROI的图像。处理器还被配置为接收探针取向信号并基于探针取向信号显示目标ROI的图像。