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(54) **ULTRASOUND IMAGING CONSOLE**

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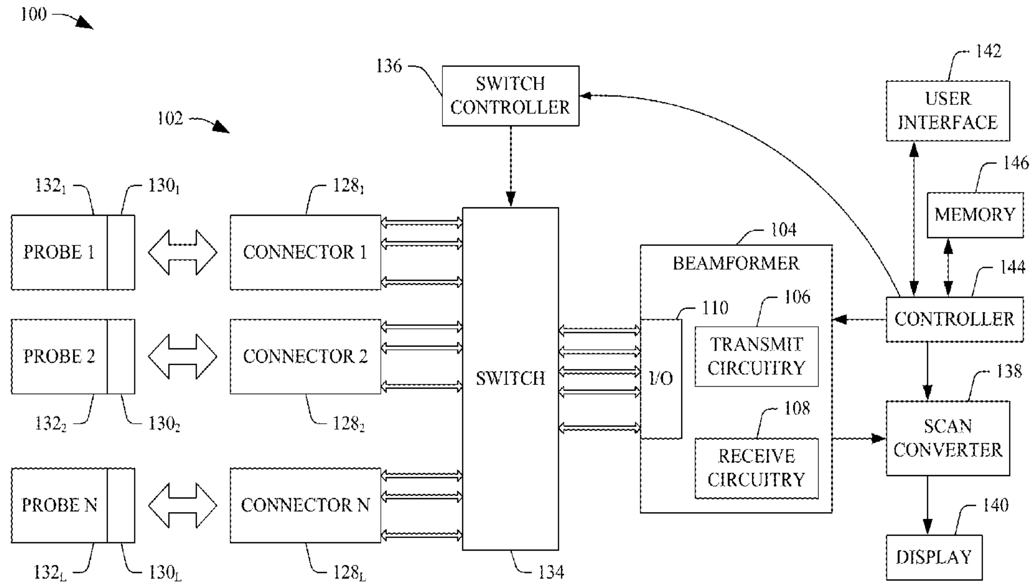
(57) **ABSTRACT**

An ultrasound imaging system includes a beamformer (**104**) configured to beamform ultrasound signals. The beamformer includes input/output (**110**) configured to at least receive ultrasound signals. The ultrasound imaging system further includes a first ultrasound probe connector (**128**) and a second ultrasound probe connector (**128**). The ultrasound imaging system further includes a switch (**134**) that concurrently routes ultrasound signals concurrently received via the first ultrasound probe connector and the second ultrasound probe connector to the beamformer, which processes the ultrasound signals.



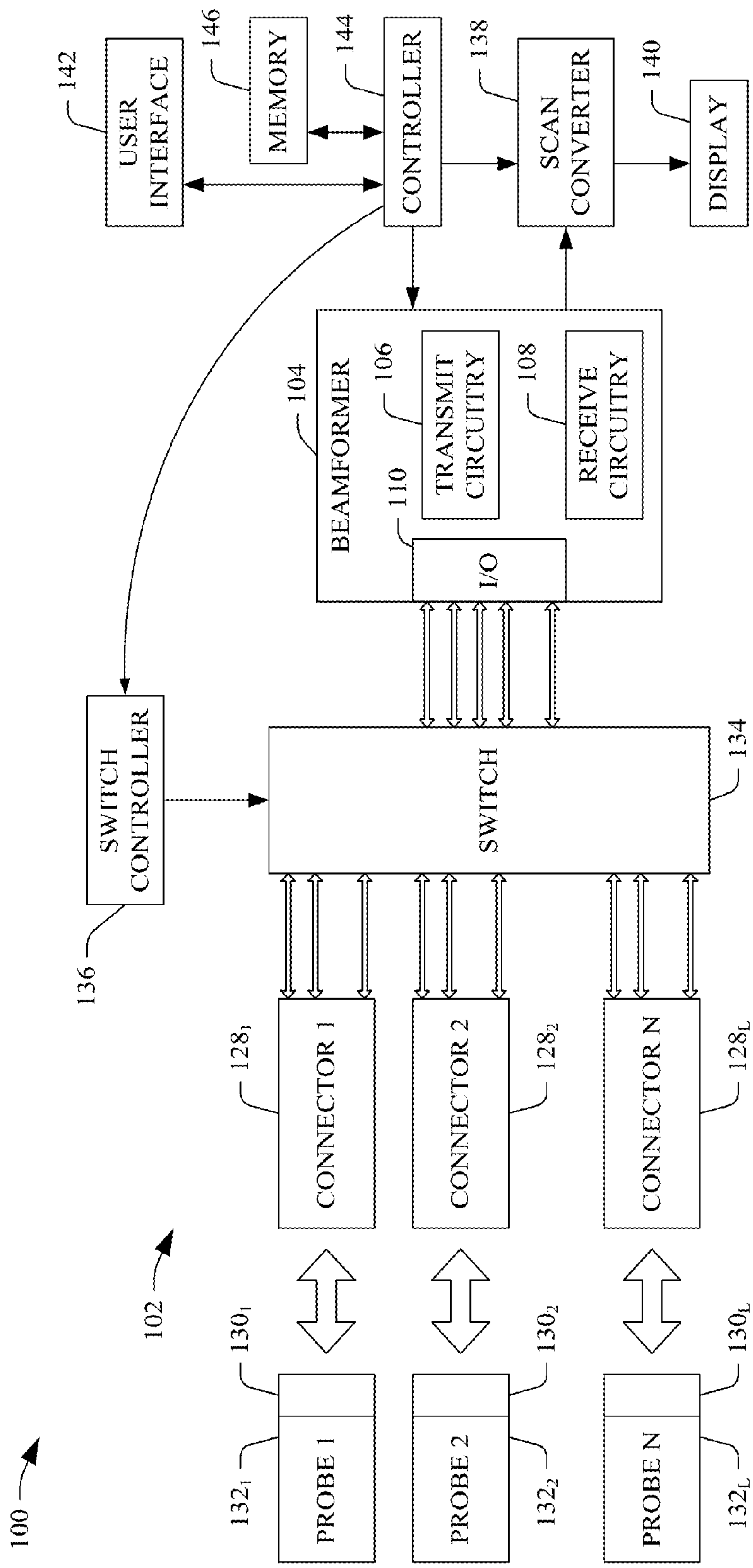
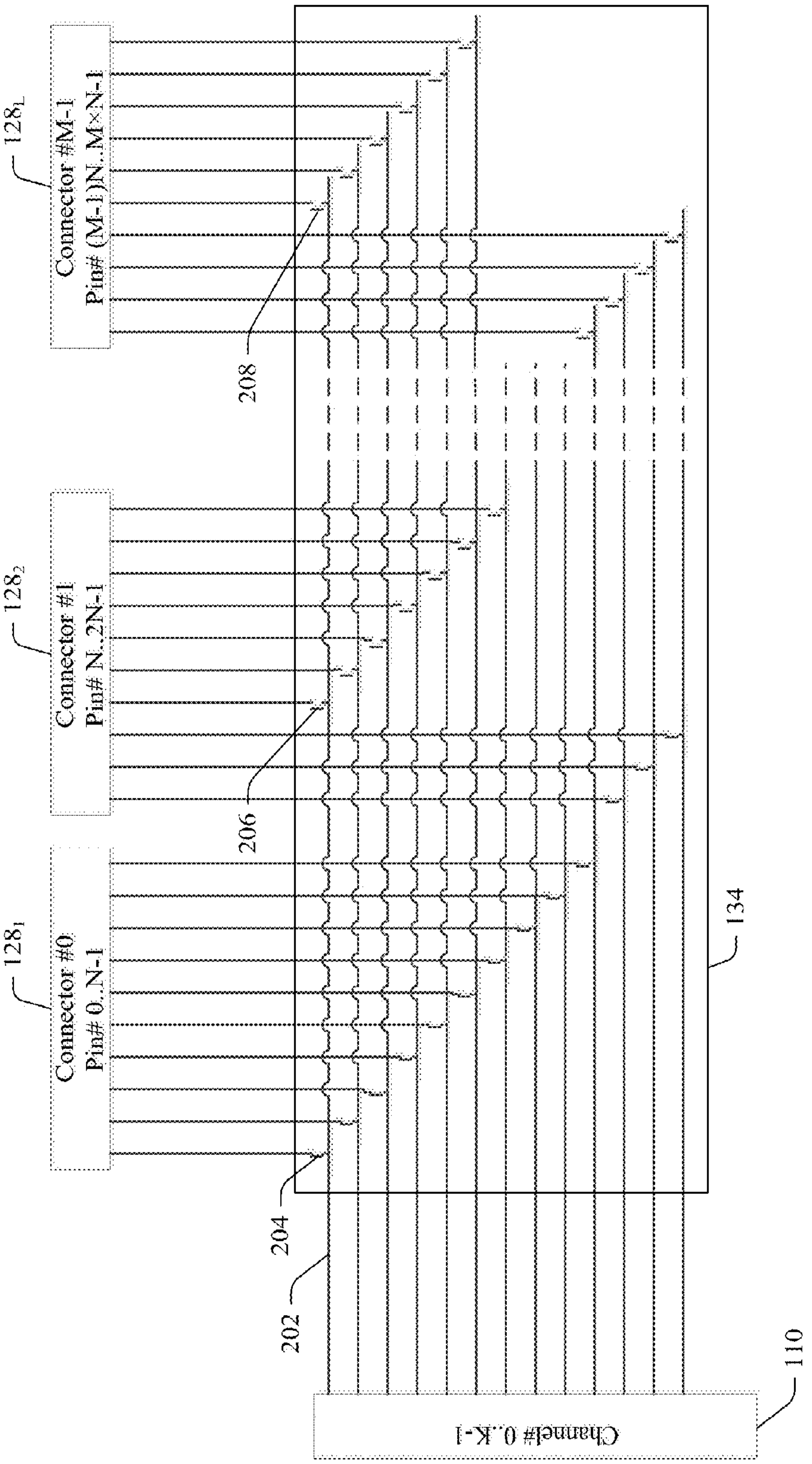

USER INTERFACE
142
MEMORY
146
CONTROLLER
144
SCAN CONVERTER
138
DISPLAY
140
BEAMFORMER
104
TRANSMIT CIRCUITRY
106
RECEIVE CIRCUITRY
108
I/O
110
SWITCH CONTROLLER
136
SWITCH
134
CONNECTOR 1
128_1
CONNECTOR 2
128_2
CONNECTOR N
128_L
PROBE 1
132_1
130_1
PROBE 2
132_2
130_2
PROBE N
132_L
130_L
102
100

FIGURE 1



128_1
Connector #0
Pin# 0..N-1
128_2
Connector #1
Pin# N..2N-1
128_L
Connector #M-1
Pin# (M-1)N..M×N-1
202
204
206
208
134
110
Channel# 0..K-1

FIGURE 2

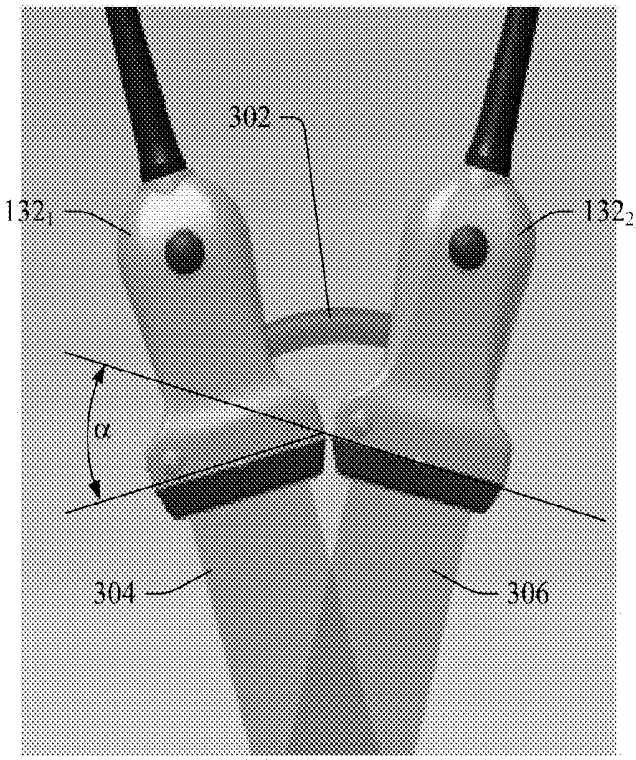


FIGURE 3

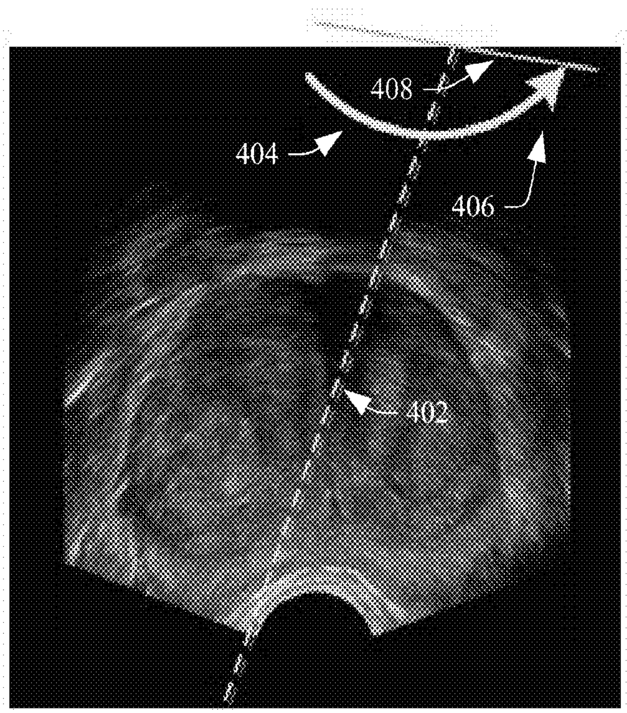


FIGURE 4

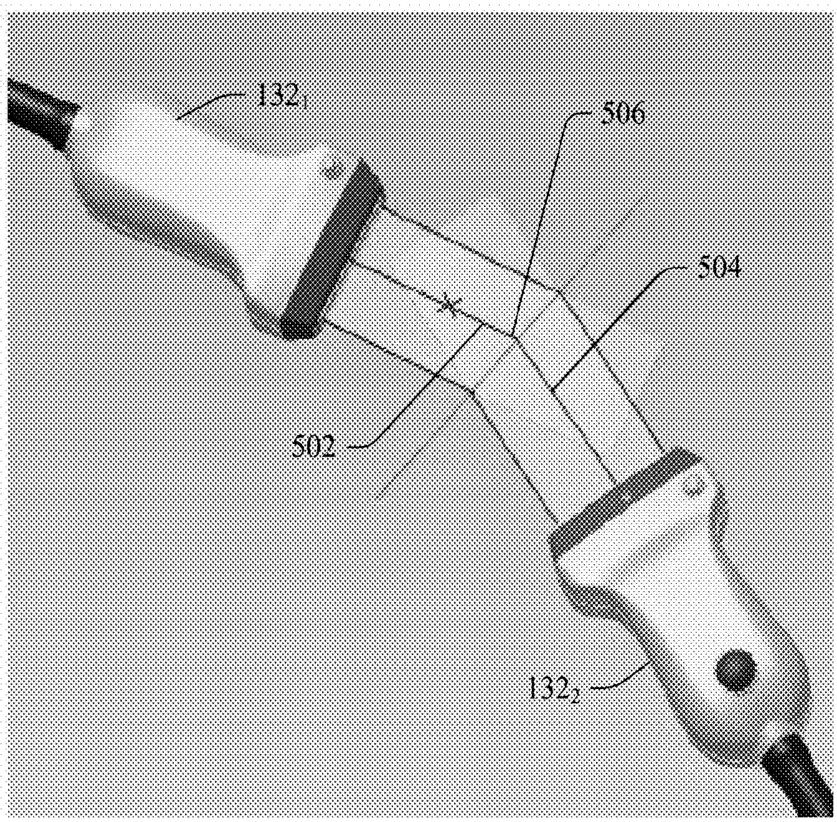


FIGURE 5

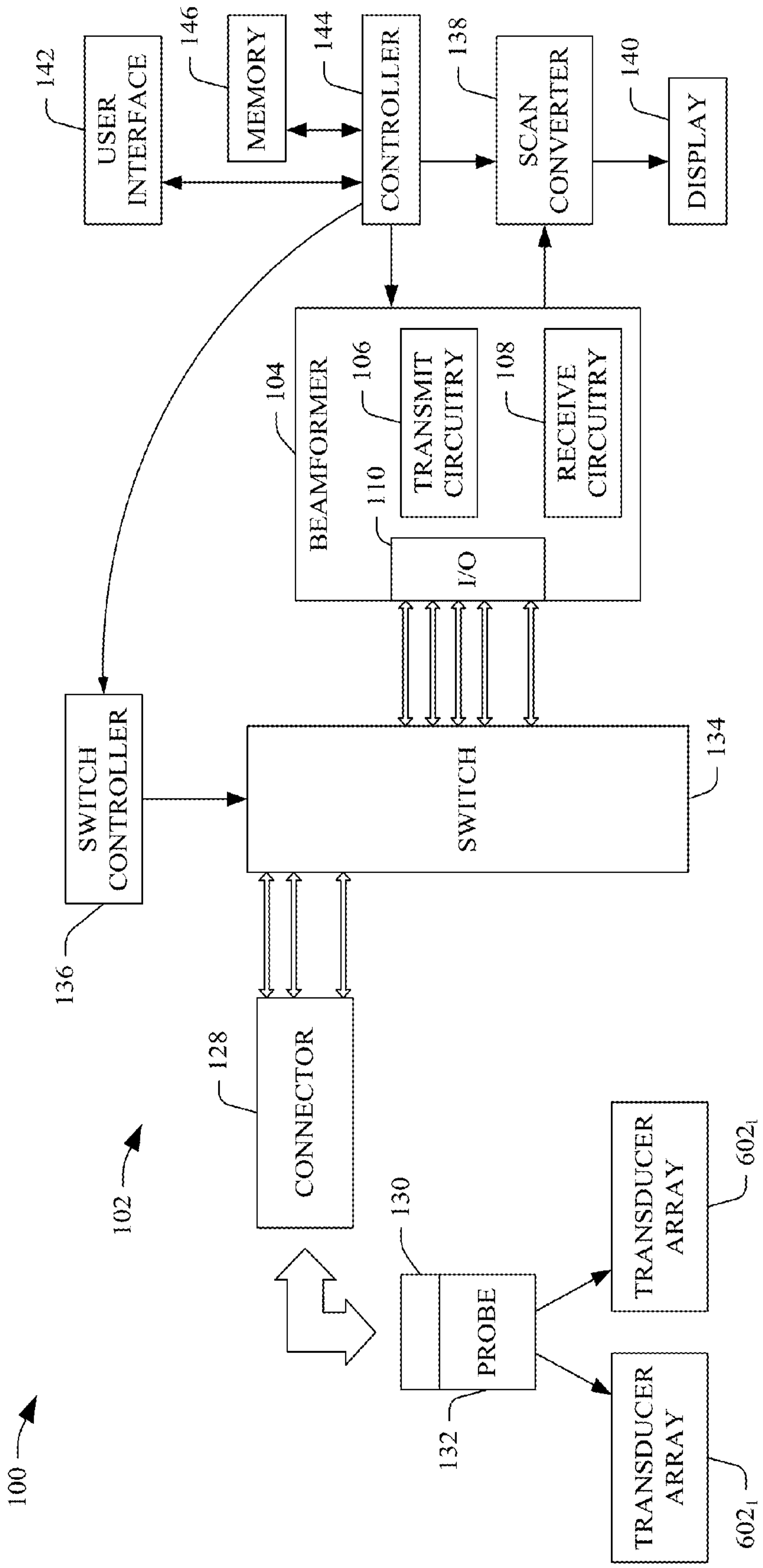

100
102
USER INTERFACE
142
MEMORY
146
CONTROLLER
144
SCAN CONVERTER
138
DISPLAY
140
BEAMFORMER
104
TRANSMIT CIRCUITRY
106
RECEIVE CIRCUITRY
108
I/O
110
SWITCH CONTROLLER
136
SWITCH
134
CONNECTOR
128
PROBE
130
132
TRANSDUCER ARRAY
602_1
TRANSDUCER ARRAY
602_1

FIGURE 6

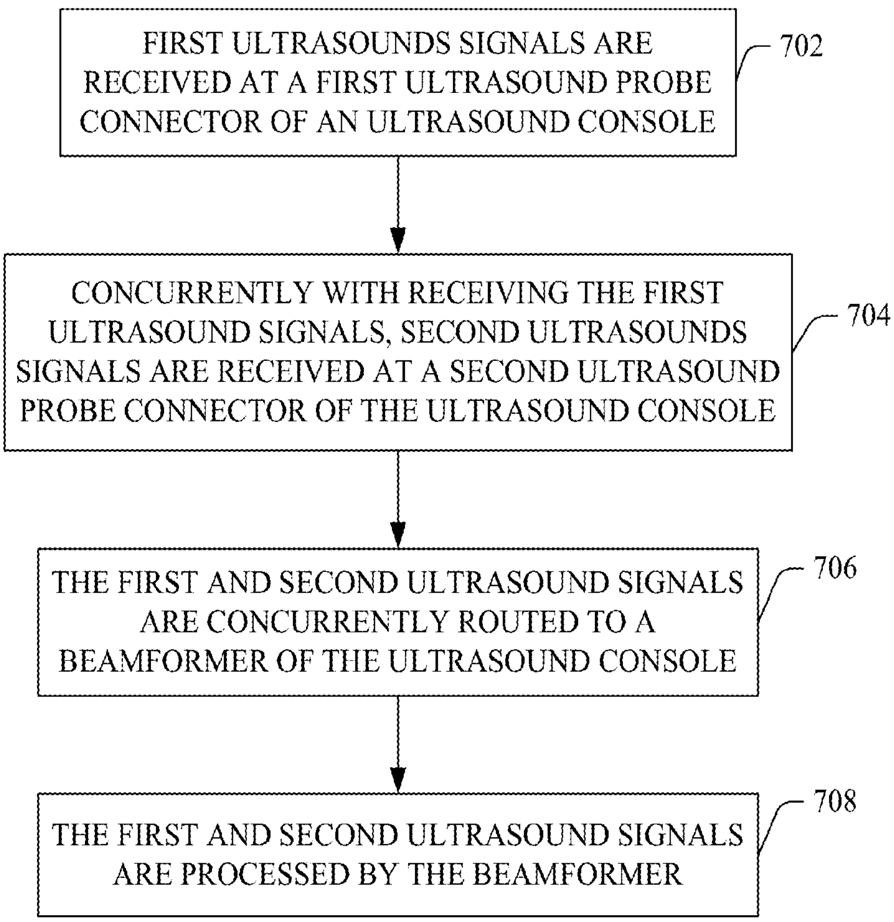

FIRST ULTRASOUNDS SIGNALS ARE RECEIVED AT A FIRST ULTRASOUND PROBE CONNECTOR OF AN ULTRASOUND CONSOLE
702
CONCURRENTLY WITH RECEIVING THE FIRST ULTRASOUND SIGNALS, SECOND ULTRASOUNDS SIGNALS ARE RECEIVED AT A SECOND ULTRASOUND PROBE CONNECTOR OF THE ULTRASOUND CONSOLE
704
THE FIRST AND SECOND ULTRASOUND SIGNALS ARE CONCURRENTLY ROUTED TO A BEAMFORMER OF THE ULTRASOUND CONSOLE
706
THE FIRST AND SECOND ULTRASOUND SIGNALS ARE PROCESSED BY THE BEAMFORMER
708

FIGURE 7

ULTRASOUND IMAGING CONSOLE

TECHNICAL FIELD

[0001] The following generally relates to ultrasound (US) imaging and more particularly to an US console configured to concurrently scan using multiple probes respectively connected to different probe connectors of the console and/or multiple transducer arrays of a single probe connected to a connector of the console.

[0002] BACKGROUND

[0003] An ultrasound (US) imaging system generally includes a console with a connector(s) configured to receive a complementary connector of an ultrasound probe having a transducer array. The transducer array has been used to transmit ultrasound signals and acquire ultrasound echoes corresponding to a plane (e.g., axial) of an organ(s) and/or structure (s) (e.g., a biopsy needle) in the body. In B-mode imaging, the echoes have been processed to generate scanlines, which have been used to generate a scanplane (or 2D image of the plane), which can be visually presented via a display.

[0004] In order to additionally view a plane in another orientation (e.g., sagittal), the user has to move the probe to the other orientation and perform a scan at the other orientation. In response to moving the probe and scanning in the other orientation, the displayed image in the first orientation is replaced by another image from the other orientation. In order to concurrently utilize the images from both orientations, the clinician has to make a mental image of the first image (i.e., memorize it) and then mentally construct an image based on the mental image and the displayed second image.

[0005] Another approach includes using a second probe connected to a second connector of the console. Unfortunately, ultrasound consoles only scan on one connector at a time. As such, images of different planes are acquired at different times and have to be mentally combined to construct an image. Another approach includes using a biplane probe, which is a probe that includes two arrays angularly arranged with respect to each other to acquire data from different planes (e.g., axial and sagittal planes). With a biplane probe, either both arrays have a reduced set of elements such that the total number of elements is the same as a single array probe or a multiplexer is used to alternately operate the arrays.

SUMMARY

[0006] Aspects of the application address the above matters, and others.

[0007] In one aspect, an ultrasound imaging system includes a beamformer configured to beamform ultrasound signals. The beamformer includes input/output configured to at least receive ultrasound signals. The ultrasound imaging system further includes a first ultrasound probe connector and a second ultrasound probe connector. The ultrasound imaging system further includes a switch that concurrently routes ultrasound signals concurrently received via the first ultrasound probe connector and the second ultrasound probe connector to the beamformer, which processes the ultrasound signals.

[0008] In another aspect, a method includes routing a first signal between a first transducer array of a first ultrasound probe connected to a first connector of the ultrasound console and a beamformer of the ultrasound console through a switch of the ultrasound console and routing, concurrently with routing the first signal, a second signal between a second transducer array of a second ultrasound probe connected to a second connector of the ultrasound console and the beamformer through the switch.

[0009] In another aspect, an ultrasound imaging system includes a beamformer, which includes transmit circuitry configured to generate an ultrasound transducer element excitation signal, receive circuitry configured to process an ultrasound echo and input/output configured to transmit the ultrasound transducer element excitation signal and receive the ultrasound echo. The ultrasound imaging system further includes at least one ultrasound probe connector respectively configured to receive a complementary connector of an ultrasound probe and having at least two transducer arrays. The ultrasound imaging system further includes a switch that routes signals between the at least two transducer arrays and the input/output, wherein the switch concurrently routes a first signal between a first of the at least two transducer arrays and the beamformer and a second signal between a second of the at least two transducer arrays and the beamformer.

[0010] In another aspect, a method of ultrasound tracking includes concurrently employing at least two ultrasound probes connected to two different connectors of an ultrasound console in a medium, wherein the at least two ultrasound probes share input/output channels of the ultrasound console such that a first set of the channels is used by a first of the at least two probes concurrently while a second different set of the channels is used by a second of the at least two probes. The method further includes employing data received by the at least two probes to estimate a relative position of the at least two probes.

[0011] Those skilled in the art will recognize still other aspects of the present application upon reading and understanding the attached description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The application is illustrated by way of example and not limitation in the figures of the accompanying drawings, in which like references indicate similar elements and in which:

[0013] FIG. **1** schematically illustrates an example imaging system configured to concurrently scan with multiple probes respectively connected to different connectors of the console;

[0014] FIG. **2** schematically illustrates an example switch of the console configured to switch channels of the console amongst the multiple probes;

[0015] FIG. **3** illustrates a support configured to support multiple probes;

[0016] FIG. **4** illustrates an image and indicia superimposed thereon showing what to do to make the planes coincide;

[0017] FIG. **5** illustrates two probes aligned such that their center scan lines coincide;

[0018] FIG. **6** schematically illustrates an example imaging system configured to concurrently scan with multiple transducer arrays of a single probes; and

[0019] FIG. **7** illustrates an example for concurrently scanning with multiple transducer probes of an ultrasound console.

DETAILED DESCRIPTION

[0020] FIG. **1** schematically illustrates an imaging system **100**, such as an ultrasound imaging system, which includes a console **102**.

[0021] The console **102** includes a beamformer **104** with transmit circuitry **106** and receive circuitry **108**. In another embodiment, the transmit circuitry **106** and the receive circuitry **108** are not part of the same beamformer. The transmit circuitry **106** generates electrical signals which control transducer element phasing and/or time of actuation, which allows for steering and/or focusing an ultrasound beam from predetermined origins and at predetermined angles.

[0022] The receive circuitry **108** processes received ultrasound echoes. For B-mode applications, this has included delaying and summing echoes to produce a sequence of focused, coherent echo samples along focused scanlines of a scanplane. The receive circuitry **108** may also be configured to process the scanlines to lower speckle and/or improve specular reflector delineation via spatial compounding and/or perform other processing such as FIR filtering, IIR filtering, etc.

[0023] The beamformer **104** also includes I/O **110**, including a plurality of channels (not visible), for conveying the electrical signals and receiving the echoes.

[0024] The imaging system **102** further includes a plurality of connectors $\mathbf{128}_1$, $\mathbf{128}_2$, . . . , $\mathbf{128}_L$ (or connectors **128**), where L is an integer equal to or greater than two. The connectors **128** each include elements (not visible) such as pins, sockets, etc. that mechanically and/or electrically connect with complementary elements (not visible) of probe connectors $\mathbf{130}_1$, $\mathbf{130}_2$, . . . , $\mathbf{130}_L$ (or probe connectors **130**) of ultrasound probes $\mathbf{132}_1$, $\mathbf{132}_2$, $\mathbf{132}_L$ (or ultrasound probes **132**).

[0025] An individual one of the probes **132** may include one or more transducer arrays, each having one or more transducer elements such as 16, 64, 128, 196, 256, and/or other number of transducer elements. Individual arrays may include linear, curved, and/or rotary transducer arrays, and the different arrays can be employed individually, simultaneously or in an interleaved manner to acquire data.

[0026] The imaging system **102** further includes a switch **134**. One side of the switch **134** is in electrical communication with the elements (not visible) of the connectors **128**, and the other side of the switch **134** switch is in electrical communication with the I/O **110** of the beamformer **104**. Generally, the I/O **110** includes fewer or the same number of channels (not visible) as the aggregate number of the elements (not visible) of all the connectors **128**. The I/O **110** may have less, the same number or more channels than there are elements in any one of the individual connectors **128**. Where the I/O **110** has fewer channels than there are elements in any one of the individual connectors **128**, a fraction of the channels can be used on one connector **128** with the other channels used on one or more other of the connectors **128**.

[0027] As described in greater detail below, the switch **134** routes signals between the beamformer **104** and multiple connectors **128** as if the elements (not visible) of the connectors **128** were part of a single connector and the I/O **104** had a number of channels (not visible) equal to that of the elements of the multiple connectors **128** such that any number of probes **132** can be concurrently employed by the console **102**, where individual channel (not visible) of the I/O **104** are switched between connector elements (not visible) using fast switching, for example, solid state multiplexers or the like.

[0028] In one non-limiting instance, this includes changing the state of the switch **134** during a transmission, so one channel transmits with one element and receives with another element from the same or a different connector **128**. In another non-limiting instance, the state of the switch **134** is changed so that one channel is used to transmit on different elements in the same transmission and/or to receive from different elements during the same transmission, for example, when using neighboring elements in parallel or otherwise. Still other instance are contemplated herein. It is to be appreciated that the connectors **128** can also be operated alternately and/or in an interleaved manner.

[0029] A switch controller **136** transmits signals to the switch **134**, which control the switching of the switch **134**. Such control can be based on a selected imaging protocol, use of the probes **132** by an operator, and/or otherwise.

[0030] A scan converter **138** converts raw and/or processed echoes to generate data for display, for example, by converting the data to the coordinate system of the display. The scan converter **116** can be configured to employ analog and/or digital scan converting techniques. A display **140** can be used to present the scan converted data, including multiple images and simultaneous updates of the images.

[0031] A user interface **142** includes various input and/or output devices, for example, to select a data processing and presentation mode, a data acquisition mode (e.g., B-mode), initiate scanning, etc. The user interface **142** may include buttons, knobs, a keypad, a touch screen, etc. The user interface **122** may also include various types of visual (e.g., LCD, LED, etc.) and/or audible displays.

[0032] A main controller ("controller") **144** includes a processor (not visible) or the like which executes one or more instructions embedded or encoded on computer readable medium such as physical memory **146**. The processor can additionally or alternatively execute instructions carried by a carrier wave, a signal or other transitory medium. The controller **138** can control the beamformer **104**, the switch controller **136**, the scan converter, and/or the user interface.

[0033] FIG. **2** schematically illustrates a non-limiting example of the switch **134** in connection with the I/O **110** of the beamformer **104** and the connectors **128**. In this example, the I/O **110** includes k channels, channel 0 . . . channel K−1. The connector $\mathbf{128}_1$ includes N pins (i.e., pin 0 . . . N−1), the connector $\mathbf{128}_2$ includes N pins (i.e., pin N . . . 2N−1), and the connector $\mathbf{128}_L$ includes N pins (i.e., pin (M−1)N M×N−1). The total number of pins is M×N. In another embodiment, two or more of the connectors **128** may include a different number of pins.

[0034] As shown, an electrical pathway **202** alternately electrically connects channel 0 of the I/O **110** to pin 0 of connector $\mathbf{128}_1$ through a switch **204**, to pin N+3 of connector $\mathbf{128}_2$ through a switch **206**, . . . , and to pin (M−1)×5 of the connector $\mathbf{128}_3$ through a switch **208**. In the illustrated embodiment, the switch **204** is closed, establishing an electrical connection between channel 0 and pin 0, and switches **206**, . . . , **208** are open such that no electrical connection is established between channel 0 and pin N+3 or pin (M−1)N+5. Other electrical pathways similarly connect other channels of the I/O **110** with other pins of the connector $\mathbf{128}_2$ . . . connector $\mathbf{128}_1$.

[0035] Where the next connector **128** to communicate over channel 0 is connector $\mathbf{128}_2$, the switch controller **136** (FIG. **1**) sends a signal to the switch **134** which causes switch **204** to open and switch **206** to close such that an electrical connection is established between channel 0 and pin N+3, and no electrical connection exists between channel 0 and pin 0 or channel 0 and pin (M−1)N+5. Where the next connector **128** to communicate over channel 0 is connector $\mathbf{128}_3$, the switch controller **136** (FIG. **1**) sends a signal to the switch **134** which causes switch **206** to open and switch **208** to close such that an electrical connection is established between channel 0 and pin (M−1)N+5, and no electrical connection exists between channel 0 and pin 0 or channel 0 and pin N+3.

[0036] In the illustrated example, all the pins of the connector $\mathbf{128}_1$ are connected to the I/O **110** and a sub-set of the pins of the connector $\mathbf{128}_2$ are connected to the I/O **110**. In another instance, all the pins of the connector $\mathbf{128}_2$ are connected to the I/O **110** and a sub-set of the pins of the connector $\mathbf{128}_1$ are connected to the I/O **110**. In yet another instance, some of the pins of one or more of the other connectors **128** are connected to the I/O **110**. Generally, through one or more predetermined switching patterns, pins of two to M of the connectors **128** can be concurrently connected to the I/O **134** and concurrently employed to concurrently scan.

[0037] Suitable connectors **128** include connectors with pins that generally are inaccessible such as zero insertion force (ZIF) integrated circuit (IC) sockets, low insertion force (LIF) IC sockets, and/or other connectors.

[0038] There are a number of situations where concurrently employing two or more of the probes **132** using the system **100** can add value to an examination. For example, with lithotripsy, during treatment using a first one of the probes **132**, if the operator is unsure whether there really is a kidney stone at a target point, a second different one of the probes **132** can be concurrently used to verify the presence of the stone at the target point.

[0039] This can save time and improve certainty relative to a configuration in which the switch **134** is omitted and the treatment is interrupted so that a second probe can be used to verify presence of the stone. Another example is the combination of abdominal and endo scanning where the endo scanning is used to monitor cryo-therapy or HIFU. Generally, the system **100** can be used for any application in which concurrent use of multiple probes maybe of interest.

[0040] FIG. **3** shows an example in which a probe support **302** supports two probes $\mathbf{132}_1$ and $\mathbf{132}_2$ at fixed relative positions that are angularly offset from each other by an angleα. In other embodiments, the support **302** can support more than two of the probes **132**. Where the support **302** is configured to hold the probes **132** such that their image planes **304** and **306** coincide, compounding can be achieved with large compound angles, or a limited degree of tomography can be achieved if the angle a is large enough that the elements in one of the probes **132** is within sight of the elements of the other of the probes **132**.

[0041] For tomography, the support **302** can extend such that the two probes $\mathbf{132}_1$ and $\mathbf{132}_2$ can be angularly oriented with respect to each other (e.g., 180 degrees apart) such that the transducers are face-to-face with a suitable distance there between. Tomography can be used to provide velocity and attenuation maps, which are weakly correlated to the scattering information that is used to form B-mode images, so it provides complementary information, and potentially the velocity map can be used to improve the focusing in the B-mode image.

[0042] If the axes of the two probes $\mathbf{132}_1$ and $\mathbf{132}_2$ are near orthogonal (e.g., α~90 degrees), side scattering can be measured. Where the support **302** is configured to hold the two probes $\mathbf{132}_1$ and $\mathbf{132}_2$ such that their transducers are held with the same orientation but with parallel or almost parallel image planes, flow or motion normal to the image plane can be measured using Doppler techniques or tracking methods.

[0043] Although the illustrated two probes $\mathbf{132}_1$ and $\mathbf{132}_2$ are shown as the same type of probes, it is to be appreciated that the two probes $\mathbf{132}_1$ and $\mathbf{132}_2$ can be different types of probes. The support **302** may be configured to support the probes **132** at designated static positions or one or more of the probes **132** can be manually placed at a position of interest and removeably secured in place. A robot, operator, and/or holding device can be used to hold a probe **132** in place.

[0044] Concurrently using multiple probes **132** for spectral Doppler allows for simultaneous Doppler imaging of different organs, which allows the propagation speed of the pulsations to be measured, which is different from measuring flow velocity.

[0045] Concurrent free hand scanning with two or more of the probes **132** (scanning without using the support **302** to hold the probes **132** at fixed relative positions) can be achieved with having each of the probes **132** track the position of the other probe **132**. For visual presentation or display, the intersecting image planes can be identified or highlighted using as a dotted line, a dashed line **402** as shown in FIG. **4**, and/or other line and/or other indicia.

[0046] Additionally or alternatively, a distance between planes can be shown through use of a bar, a circle and/or other indicia, within or outside of the image area. Additionally or alternatively, indicia showing what to do to make the planes coincide as a displacement direction and a rotation can be displayed. For example, as shown in FIG. **4**, an arc **404** with an arrow tip **406** can be used to indicate rotation around a transducer axis **408**.

[0047] Another option is to show both images in pseudo 3D (e.g., 2D images shown in 3D space) in separate views. In the case of a tracked freehand transducer for lithotripsy, the location and offset to the shock wave focus can be superimposed on the image from the free hand probe **132**. The position can be shown as a crosshair used for targeting in combination with an indication of the offset between the image plane and the shock wave focus.

[0048] If there is no external tracking, the probes **132** can be used to estimate their relative positions. This is done by measuring the time of flight from a set of elements on one transducer probe **132** to another set of elements on another transducer probe **132**. In a homogeneous medium, this can be achieved through triangulation. In an inhomogeneous medium, the propagation path may not be straight lines and the propagation velocity may not be the same, but due to the principle of reciprocity the path in both directions is the same, and therefore the tracking of a common region of interest in images made with the transducer probes **132** is more accurate than a geometrically accurate tracking system would provide.

[0049] As an example, and as shown in connection with FIG. **5**, where the two transducer probes $\mathbf{132}_1$ and $\mathbf{132}_2$ are scanning in two different media with different sound velocities causing refraction at the interface between the two media, the probes $\mathbf{132}_1$ and $\mathbf{132}_2$ can be aligned such that the center scan lines **502** and **504** coincide at a region **506**. The propagation along the center line is substantially the same in both directions. Therefore, the propagation time to a point on that scan line can be estimated accurately from both transducers as the sum is known. This also holds for the lateral position.

[0050] If a point is on the center scan line this is true for both transducer probes $\mathbf{132}_1$ and $\mathbf{132}_2$. If the point is not on the center scan line, the two probes $\mathbf{132}_1$ and $\mathbf{132}_2$ will largely agree on the lateral position even though the scan line is not straight, so the error caused by refraction is eliminated and the residual error is small. As such, tracking with the system **100** will to some degree compensate for inhomogeneous velocity in the media between the transducer probes $\mathbf{132}_1$ and $\mathbf{132}_2$ and thereby be more accurate than other methods without tracking.

[0051] On two linear array transducers the triangulation alone cannot align the mutual roll angles. This can be overcome by optimizing the signal strength as it is very dependent on the roll angle. Alternatively the transducers can have a single transducer element that is not in-line with the transducer array, to provide this additional information.

[0052] Variations are Contemplated.

[0053] FIG. **6** shows a variation in which a single probe **132** having multiple transducer arrays $\mathbf{602}_1 \ldots \mathbf{602}_j$ (transducer arrays **602**), where j is an integer equal to or greater than one, is connected to a single connector **128**. In this instance, the different transducer arrays **602** can be employed as described herein in a similar manner as the different probes **132** in that multiple ones of the transducer arrays **602** can be concurrently employed via suitable switching via the switch **134** between the connector **128** and the I/O **110**.

[0054] In another variation, the embodiments of FIGS. **1** and **6** are combined in that one or more of the individual probes **132** of FIG. **1** can include two or more transducer arrays **602** as shown in FIG. **6**. In this instance, the switch **134** switches the channels of the I/O **110** such that two or more probes **132** and/or two or more transducer arrays of two or more probes are concurrently employed.

[0055] FIG. **7** illustrates a method for concurrently scanning with multiple transducer probes of an ultrasound console.

[0056] It is to be appreciated that the order of the method acts is provided for explanatory purposes and is not limiting. As such, one or more of the following acts may occur in a different order. Furthermore, one or more of the following acts may be omitted and/or one or more additional acts may be added.

[0057] At **702**, first ultrasound signals are received at a first ultrasound probe connector of the ultrasound console. The first ultrasound signals are received from a first ultrasound probe installed in the first ultrasound probe connector.

[0058] At **704**, second ultrasound signals are received, concurrently with act **702**, at a second ultrasound probe connector of the ultrasound console. The second ultrasound signals are received from a second ultrasound probe installed in the second ultrasound probe connector.

[0059] At **706**, the first and second ultrasound signals are concurrently routed, via a switch, to a beamformer of the console.

[0060] At **708**, the first and second ultrasound signals are processed by the beamformer. It is to be appreciated that the methods herein may be implemented by one or more processors executing computer executable instructions stored, encoded, embodied, etc. on computer readable storage medium such as computer memory, non-transitory storage, etc. In another instance, the computer executable instructions are additionally or alternatively stored in transitory or signal medium.

[0061] The application has been described with reference to various embodiments. Modifications and alterations will occur to others upon reading the application. It is intended that the invention be construed as including all such modifications and alterations, including insofar as they come within the scope of the appended claims and the equivalents thereof.

1. An ultrasound imaging system, comprising:

a beamformer configured to beamform ultrasound signals, the beamformer, including: input/output configured to at least receive ultrasound signals;

a first ultrasound probe connector;

a second ultrasound probe connector;

a switch that concurrently routes ultrasound signals concurrently received via the first ultrasound probe connector and the second ultrasound probe connector to the beamformer, which processes the ultrasound signals.

2. The system of claim **1**, wherein the ultrasound signals correspond to ultrasound echo signals.

3. The system of claim **1**, wherein the switch includes sub-switches between the first and second ultrasound probe connectors and a channel of the input/output, and further comprising:

a switch controller that controls switching of the sub-switches so that only a single one of the ultrasound probe elements is connected to a channel at any given moment in time based on a switching algorithm.

4. The system of claim **3**, further comprising:

a third ultrasound probe connector;

wherein the switch concurrently routes ultrasound signals concurrently received via the first, second and third ultrasound probe connectors to the beamformer.

5. The system of claim **1**, the input/output comprising a first number of channels, the first connector comprising a first number of pins, and the second connector comprising a second number of pins, wherein the first number of channels is less than a summation of the first and second number of pins.

6. The system of claim **5**, wherein the pins of at least one of the first or second connectors are inaccessible.

7. The system of claim **1**, further comprising:

a probe support configured to support probes connected to the first and second ultrasound probe connectors such that the probes are offset from each other.

8. The system of claim **7**, wherein the probes are angularly offset from each other by approximately ninety degrees.

9. The system of claim **7**, wherein the probes are angularly offset from each other by approximately one hundred and eighty degrees.

10. The system of claim **7**, wherein the probes are parallel to each other.

11. The system of claim **7**, wherein the probes are different types of probes.

12. The system of claim **7**, wherein the probes are a same type of probe.

13. The system of claim **1**, wherein the switch is configured to concurrently route a first signal from a first transducer array of a first probe connected to the first ultrasound probe connector and a second signal from a second transducer array of the first probe connected to the first ultrasound probe connector to the beamformer.

14. A method, comprising:

routing a first signal between a first transducer array of a first ultrasound probe connected to a first connector of the ultrasound console and a beamformer of the ultrasound console through a switch of the ultrasound console; and

routing, concurrently with routing the first signal, a second signal between a second transducer array of a second ultrasound probe connected to a second connector of the ultrasound console and the beamformer through the switch.

15. The method of claim **14**, wherein the first signal and the second signal correspond to ultrasound echo signals.

16. The method of claim **14**, wherein the first signal and the second signal correspond to ultrasound transducer element excitation signals.

17. The method of claim **14**, wherein one of the first or second signals corresponds to an ultrasound transducer element excitation signal and the other of the first or second signal corresponds to an ultrasound echo signal.

18. The method of claim **14**, further comprising:

routing, concurrently with routing the first signal, a third signal between a third transducer array of a third ultrasound probe connected to a third connector of the ultrasound console and the beamformer through the switch.

19. The method of claim **18**, wherein the third signal is routed in place of the second signal.

20. The method of claim **14**, further comprising:

electrically connecting at least one channel of a beamformer of the ultrasound console alternately to either the first or the second connectors.

21. The method of claim **14**, further comprising:

electrically connecting at least one channel of a beamformer of the ultrasound console alternately to either the first or the second transducer arrays, wherein the first and the second ultrasound probes are the same probe.

22. An ultrasound imaging system, comprising:

a beamformer, including:

transmit circuitry configured to generate an ultrasound transducer element excitation signal;

receive circuitry configured to process an ultrasound echo; and

input/output configured to transmit the ultrasound transducer element excitation signal and receive the ultrasound echo;

at least one ultrasound probe connector respectively configured to receive a complementary connector of an ultrasound probe and having at least two transducer arrays; and

a switch that routes signals between the at least two transducer arrays and the input/output, wherein the switch concurrently routes a first signal between a first of the at least two transducer arrays and the beamformer and a second signal between a second of the at least two transducer arrays and the beamformer.

23. The system of claim **22**, further comprising:

at least a second ultrasound probe connector respectively configured to receive a complementary connector of a second ultrasound probe, wherein the switch concurrently routes a third signal between a first of the at least two ultrasound probe connectors and the beamformer and a fourth signal between a second of the at least two ultrasound probe connectors and the beamformer.

24. A method of ultrasound tracking, comprising:

concurrently employing at least two ultrasound probes connected to two different connectors of an ultrasound console in a medium, wherein the at least two ultrasound probes share input/output channels of the ultrasound console such that a first set of the channels is used by a first of the at least two probes concurrently while a second different set of the channels is used by a second of the at least two probes; and

employing data received by the at least two probes to estimate a relative position of the at least two probes.

25. The method of claim **24**, further comprising:

estimating the relative position by measuring a time of flight from a set of elements on one the at least two probe to another set of elements on another of the at least probes.

26. The method of claim **25**, wherein the medium is a homogeneous medium, and further comprising:

estimating the relative position through triangulation.

27. The method of claim **25**, wherein the medium is an inhomogeneous medium, and further comprising:

estimating the relative position by tracking a common region of interest in images generated with the at least two probes.

28. The method of claim **27**, wherein the at least two probes are aligned such that center scan lines of the respective probes coincide at the common region of interest.

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摘要(译)

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