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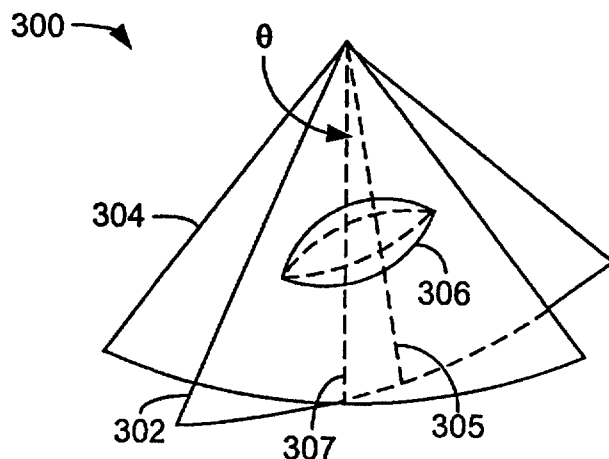
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(54) Title: ULTRASONIC DIAGNOSTIC SYSTEM FOR SELECTIVELY DEVELOPING ULTRASOUND DIAGNOSTIC DATA



(57) Abstract: An ultrasound imaging system (100) in which a user determines a desired ultrasound image (306) to view and communicates (138) that desired view to the ultrasound imaging system (100) is disclosed. The ultrasound imaging system (100) analyzes the request and determines the appropriate scan slices (302, 304) to project to obtain the desired image (306). The desired image (306) approximates a three dimensional view, but is developed without the necessity of obtaining a three dimensional volume set of data.

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Ultrasonic diagnostic system for selectively developing ultrasound diagnostic data

The present invention relates generally to ultrasonic diagnostic systems, and, more particularly, to an ultrasonic diagnostic system that is capable of receiving user input with respect to a particular image desired, and automatically developing ultrasonic data pertaining only to the desired image.

5

Ultrasonic transducers and imaging systems have been available for quite some time and are particularly useful for non-invasive medical diagnostic imaging. Ultrasonic transducers are typically formed of either piezoelectric elements or of micro-machined
10 ultrasonic transducer (MUT) elements. When used in transmit mode, the transducer elements are excited by an electrical pulse and in response, emit ultrasonic energy. When used in receive mode, acoustic energy impinging on the transducer elements is converted to a receive signal and delivered to processing circuitry associated with the transducer. The transducer is typically connected to an ultrasound imaging system that includes processing electronics, one or more
15 input devices and a suitable display on which the ultrasound image is viewed. The processing electronics typically include a transmit beamformer that is responsible for developing an appropriate transmit pulse for each transducer element, and a receive beamformer that is responsible for processing the receive signal received from each transducer element.

An ultrasonic transducer is typically combined with associated electronics in a
20 housing. The assembly is typically referred to as an ultrasonic probe. Typically, ultrasonic probes are classified as either one dimensional (1D) probes having a single element wide array of elements, or two dimensional (2D) probes having a multiple element wide array. Furthermore, a probe referred to as a "bi-plane" probe includes two orthogonally positioned 1D arrays that may or may not intersect. A relatively new 2D probe, referred to as a "matrix probe"
25 includes transducer elements arranged in two dimensions where each element is individually controllable, resulting in an ultrasound probe the scan lines of which can be electronically steered in two dimensions. Each dimension of a matrix probe can be thought of as a continuous stack of linear arrays.

Ultrasound data is typically acquired in frames, where each frame represents a sweep of an ultrasound beam emanating from the face of the transducer. Such a sweep is typically developed by generating a large number of individual scan lines along one scan plane. When displayed together, the set of scan lines form what is typically referred to as a "slice." A slice typically corresponds to one frame. For example, in bi-plane imaging, two slices comprise a frame, while in volume scanning, many slices comprise a frame.

Typically, 1D probes produce a two dimensional rectangular, pie-shaped, trapezoidal, or other shaped slice, while 2D matrix probes develop sets of slices (frames) forming three dimensional shapes. Such three dimensional frames are sometimes referred to as a "volume scan." When conventional ultrasound imaging systems develop this volume scan, they typically generate multiple slices in at least two dimensions. These multiple slices generate ultrasound data for the volume occupied by the slices. To produce three dimensional images, this volume of data is then processed by the ultrasound imaging system to create an image for display on a two dimensional surface (such as the surface of the CRT type display) that has the appearance of being three dimensional. Such processing is typically referred to as a rendering.

Unfortunately, developing this volume data is both taxing to the ultrasound electronics that control the transmit beamformer and requires computationally intensive processing of the receive signals. One of the drawbacks of such a three dimensional rendering system is that in order to display the volume data with meaningful resolution, the frame rate of the collected data must be reduced because of the time delay for collecting the data and the processing delay encountered when rendering the collected data on the display.

Therefore, it would be desirable to have an ultrasound imaging system capable of displaying three dimensional data without the need for processing all of the data collected for a given volume.

The invention includes a system for presenting a desired ultrasound image on a display, comprising a two dimensional matrix probe, circuitry for determining at least two ultrasound scan slices corresponding to the desired ultrasound image, circuitry for developing the desired ultrasound image from data obtained from the ultrasound scan slices, and a display for displaying the desired ultrasound image.

Other systems, methods, features, and advantages of the invention will be or will become apparent to one with skill in the art upon examination of the following drawings and detailed description. It is intended that all such additional systems, methods, features,

and advantages be included within this description, be within the scope of the present invention, and be protected by the accompanying claims.

5 The invention, as defined in the claims, can be better understood with reference to the following drawings. The components within the drawings are not necessarily to scale relative to each other, emphasis instead being placed upon clearly illustrating the principles of the present invention.

10 Figure 1 is a block diagram illustrating an ultrasound imaging system in accordance with an embodiment of the invention.

 Figure 2 is a graphical illustration showing a series of scan slices obtained using the matrix probe of Figure 1.

 Figures 3A through 3C are schematic diagrams collectively illustrating an embodiment of the invention.

15 Figure 4 is a chart of a scan of a single frame of data obtained in accordance with another embodiment of the invention.

 Figure 5 is a graphical illustration showing the image available using the scan geometry shown in Figure 4.

20 Figure 6 is a graphical representation illustrating another embodiment of the invention.

 Figure 7 is a graphical illustration showing another implementation made possible by the graphics generator of Figure 1.

 Figure 8 is a flow diagram illustrating the operation of certain embodiments of the invention.

25 The invention described hereafter is applicable to any ultrasound imaging system that uses a probe having a two dimensional array of individually controllable elements. The following description is presented in terms of routines and symbolic representations of data bits within a memory, associated processors, and possible networks or networked devices. These descriptions and representations are used by those having ordinary skill in the art to effectively convey the substance of their work to others having ordinary skill in the art. A routine is here, and generally, intended to be a self-consistent sequence of steps or actions leading to a desired result. Thus, the term "routine" is generally used to refer to a series of operations stored in a

memory and executed by a processor. The processor can be a central processor of an ultrasound imaging system or can be a secondary processor of the ultrasound imaging system. The term "routine" also encompasses such terms as "program," "objects," "functions," "subroutines," and "procedures."

5 In general, the sequence of steps in the routines requires physical manipulation of physical quantities. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared or otherwise manipulated. Those having ordinary skill in the art refer to these signals as "bits," "values," "elements," "characters," "images," "terms," "numbers," "or the like. It should be understood
10 that these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities.

In the present application, the routines and operations are machine operations performed in conjunction with human operators. In general, the invention relates to method steps, software and associated hardware including a computer readable medium configured to
15 store and execute electrical or other physical signals to generate other desired physical signals.

The apparatus of the invention is preferably constructed for the purpose of ultrasonic imaging. However, the methods of the invention can be performed by a general purpose computer or other networked device selectively activated or reconfigured by a routine stored in the computer and coupled to ultrasound imaging equipment. The procedures presented
20 herein are not inherently related to any particular ultrasonic imaging system, computer or apparatus. In particular, various machines may be used with routines in accordance with the teachings of the invention, or it may prove more convenient to construct more specialized apparatus to perform the method steps. In certain circumstances, when it is desirable that a piece of hardware possess certain characteristics, these characteristics are described more fully
25 below.

With respect to the routines described below, those having ordinary skill in the art will recognize that there exist a variety of platforms and languages for creating instruction sets for performing the routines described below. Those having ordinary skill in the art will also recognize that the choice of the exact platform and language is often dictated by the specifics of
30 the actual system constructed, such that what may work for one type of system may not be efficient on another system.

Figure 1 is a block diagram illustrating an ultrasound imaging system 100 in accordance with an embodiment of the invention. It will be understood by those having ordinary skill in the art that the ultrasound imaging system 100, as illustrated in Figure 1, and the

operation thereof as described below, is intended to be generally representative of such systems and that any particular system may differ significantly from that shown in Figure 1. The ultrasound imaging system 100 includes a transmit beamformer 110 coupled through a transmit receive (T/R) switch 112 to a matrix probe 200. The matrix probe 200 includes a matrix transducer array having a plurality of transducer elements arranged across two dimensions. The matrix probe 200 can be used to randomly select any point on the array as the point from which the ultrasonic energy is projected and is referred to as a fully sampled array. A fully sampled array is one in which each element is individually addressable.

The T/R switch 112 typically includes one switch element for each transducer element or the matrix probe 200 may have multiplexing circuitry, or the like, to reduce the number of leads between the T/R switch 112 and the matrix probe 200, thereby reducing the number of required switches. The transmit beamformer 110 receives pulsed sequences from a pulse generator 116. The matrix probe 200, energized by the transmit beamformer 110, transmits ultrasound energy into a region of interest in a patient's body and receives reflected ultrasound energy, commonly referred to as echoes, from various structures and organs within the body. As is known by those having ordinary skill in the art, by appropriately delaying the waveforms applied to each transducer element by the transmit beamformer 110, a focused ultrasound beam may be transmitted from the matrix probe 200.

The matrix probe 200 is also coupled, through the T/R switch 112, to a receive beamformer 118. Ultrasound energy from a given point within the patient's body is received by the transducer elements at different times. The transducer elements convert the received ultrasound energy to transducer signals which may be amplified, individually delayed and then summed by the receive beamformer 118 to provide a beamformed signal that represents the received ultrasound levels along a desired receive line ("beam"). The receive beamformer 118 may be a digital beamformer including an analog-to-digital converter for converting the transducer signals to digital values, or may be an analog beamformer. As known to those having ordinary skill in the art, the delays applied to the transducer signals may be varied during reception of ultrasound energy to effect dynamic focusing. The process is repeated for multiple scan lines to create a frame of data for generating an image of the region of interest in the patient's body.

Even though known systems employing matrix probes concentrate on scanning complete volumes, the matrix probe 200 is capable of providing a variety of scan patterns such as a sector scan, where scan lines typically originate at the center of the matrix probe 200 and are directed at different angles, a linear scan, a curvilinear scan and other scan patterns.

The receive beamformed signals are then applied to a signal processor 124, which processes the beamformed signal for improved image quality. The receive beamformer 118 and the signal processor 124 constitute an ultrasound receiver 126. The output of the signal processor 124 is supplied to a scan converter 128, which converts sector scan and other scan pattern signals to conventional raster scan display signals. The output of the scan converter 128 is supplied to a display unit 130, which displays an image of the region of interest in the patient's body.

The system controller 132 provides overall control of the system. The system controller 132 performs timing and control functions and typically includes a microprocessor operating under the control of graphics generator 136 and control routines 142, both contained within memory 140. As will be described in further detail below, the control routines 142 and the graphics generator 136, in cooperation with the system controller 132 and input supplied from a user via input element 138, enable the ultrasound imaging system 100 to project only those scan lines required to display a desired image. In such fashion, it is possible for the ultrasound imaging system 100 to generate an approximation of a three dimensional image by scanning only those slices corresponding to the image that is sought to be displayed without the necessity of scanning an entire three dimensional volume. In such a system, as will be described below, superior image quality using less system resources is generally available so that frame rates comparable to two dimensional scanning are used to display an approximation of a three dimensional image. The system controller 132 also uses the memory 140 to store intermediate values, including system variables describing the operation of the ultrasound imaging system 100. Although not shown, an external storage device may be used for permanent and/or transportable storage of data. Examples and devices suitable for use as an external storage element include a floppy disk drive, a CD ROM drive, a video tape unit, *etc.*

In accordance with an aspect of one embodiment of the invention, a scan pattern corresponding to and designed to provide a desired ultrasound image can be generated by the matrix probe 200. Such a desired ultrasound image can be communicated by a user of the ultrasound imaging system 100 via the input element 138. The scan pattern may include a pair of intersecting scan slices that allow an approximation of a three dimensional image to be rendered by the system without the need of interrogating a three dimensional volume. The input element 138 may include a mouse, keyboard, stylus, or may include a combination of input devices, such as keys, sliders, switches, touch screens, a track ball, or other input devices that enable the user of the ultrasound imaging system 100 to communicate to the system controller 132 the desired ultrasound image. When the desired ultrasound image is

communicated to the system controller 132, the system controller 132, in cooperation with the control routines 142 and the graphics generator 136 within memory 140, determines the appropriate scan lines that should be projected by the matrix probe 200 to achieve the desired ultrasound image communicated to the system controller 132 via input element 138. The
5 system controller 132 then communicates with the pulse generator 116 and the transmit beamformer 110 in order to generate such appropriate scan lines.

In an alternative system configuration, different transducer elements are used for transmitting and receiving. In such a configuration, the T/R switch 112 may not be required, and the transmit beamformer 110 and the receive beamformer 118 may be connected directly to
10 the respective transmit and receive transducer elements.

Figure 2 is a graphical illustration showing a series of scan slices obtained using the matrix probe 200 of Figure 1. Figure 2 shows a matrix probe 200 acquiring three slices 202, 204 and 206. In general, each slice 202, 204 and 206 includes a series of individual scan lines 208-1 through 208-n, 210-1 through 210-n, and 212-1 through 212-n, respectively. In this
15 case, each slice is in the shape of a sector, and the apexes of the sectors are at the middle of the matrix probe 200. In effect, each slice 202, 204 and 206 represents a traditional two dimensional sweep, with each sweep being displaced in elevation from the neighboring sweep. Those having ordinary skill in the art will recognize that trapezoidal or parallelogram shapes can be generated for each of the slices instead of sectors. Furthermore, a large number of such
20 slices, slightly displaced in elevation, can be used to interrogate a volume. Unfortunately, due to the large number of scan slices that are necessary to interrogate a volume, interrogating a volume requires a large amount of processing resources and typically generates significantly more data than is required to display the desired image. In accordance with an embodiment of the invention, and to be described in further detail below, the ultrasound imaging system 100
25 enables user input to determine a desired image, and then instructs the matrix probe 200 to project only the individual scan slices necessary to display the desired image.

In the example shown in Figure 2, there are only three slices, 202, 204 and 206 conjoined at a single apex but otherwise separated in elevation. Each of the scan lines 208-n, 210-n and 212-n in each of the slices 202, 204 and 206, respectively, has a matching (or
30 "indexed") scan line in the other slices. For example, scan line 210-1 in slice 204 is matched with scan line 212-1 and slice 206. Preferably, each matched scan line is at the same lateral position. To render an approximation of a three dimensional image, the system controller determines the appropriate set of matched scan lines and causes only the scan lines necessary to display the desired image to be projected. In accordance with an embodiment of the invention,

the system controller 132 along with the graphics generator 136 and the control routines 142 instruct the matrix probe 200 to project only the scan lines required to display the desired image.

Figures 3A through 3C are schematic diagrams collectively illustrating an embodiment of the invention. Figure 3A includes two sector scan slices 302 and 304. The sector scan slices 302 and 304 are illustrated as being orthogonal to each other, but this need not be the case as the sector scan slices 302 and 304 may be separated by any angle, referred to herein as θ . The angle θ represents the angle of tilt between sector scan slice 304 and sector scan slice 302. The sector scan slice 302 includes a centerline 305 and the sector scan slice 304 includes a centerline 307. The image 306 is a roughly pear-shaped hollow signature meant to represent a simplified cardiac left ventricle.

As shown in Figure 3A, instead of interrogating an entire volume, only the two sector scan slices 302 and 304 are generated by the system controller 132. The two sector slices 302 and 304 are generated in response to user input communicated to the ultrasound imaging system 100. The user input determines a desired ultrasound image and the system controller determines the sector scan slices (in this example, sector scan slices 302 and 304) that correspond to the desired image.

One of the sector scan slices (sector scan slice 302 in this example) is a fixed reference slice (or a fixed reference plane) while the position of the sector scan slice 304 can be varied in elevation and rotational position with respect to the sector scan slice 302. In response to user input supplied to the ultrasound imaging system 100 via the input element 138, the position of the sector scan slice 304 with respect to the sector scan slice 302 can be adjusted in elevation and rotational position so that the desired pair of images (shown in Figures 3B and 3C) is produced by the sector scan slices 302 and 304. To communicate the desired image to the system controller 132 (Figure 1) the user of the ultrasound imaging system 100 could, for example, but not limited to, rotate the sector slice 304 with respect to sector slice 302 using a control knob located on the input element 138. The control knob may be labeled, for example, "2nd slice rotation angle." The desired image is the image that the user sets by adjusting the control knob while scanning. The image slices (sector slices 302 and 304 in this example) may be displayed side-by-side as shown in FIGS. 3B and 3C, or overlaid as shown in Figure 5.

Figures 3B and 3C collectively illustrate the images captured using the sector scan slices 302 and 304 of Figure 3A. As shown in Figure 3B and Figure 3C, an ultrasound image 306 is shown as related to each of the scan slices 302 and 304. As shown, the image 306 associated with scan slice 302 looks different than the image 306 associated with scan slice 304. The images 306 in Figures 3B and 3C are two orthogonal sections of the roughly pear-shaped

hollow signature meant to represent a simplified cardiac left ventricle, and correspond to the image 306 in Figure 3A. The two images 306 in Figures 3B and 3C appear different because the scan slices 302 and 304 are orthogonally related to each other and are interrogating a different section of the element 306. Thought of another way, the display shown in Figure 3B is oriented to the acoustic acquisition of sector scan slice 302 and the display shown in Figure 3C is oriented to the acoustic acquisition of sector scan slice 304. In this manner, an approximation of a three dimensional rendering can be obtained by only projecting two individual scan slices based on user input. The resolution of the images in Figures 3B and 3C represents an improvement over that available from systems that need to scan a three dimensional volume in order to render a three dimensional image. For example, the images in Figure 3B and Figure 3C can be a wide 90 degree view, having $\frac{3}{4}$ degree resolution with a 50Hz frame rate. The wider field of view combined with the high frame rate is available because scanning of the entire volume is not necessary.

Furthermore, in accordance with another embodiment of the invention, a graphical reference that correlates the two images can be provided. For example, the line labeled 312 in Figure 3B refers to the location of the sector scan slice 304 and corresponds to the centerline 307 of sector scan slice 304. Similarly, the line labeled 314 in Figure 3C correlates to the sector scan slice 302 of Figure 3B and corresponds to the center line 305 of sector scan slice 302.

With respect to the fixed reference slice 302 and the position of the sector scan slice 304 determined by user input, by moving the line 312 of Figure 3B a different plane can be created in the image of Figure 3C. Such a graphical representation can be provided by the graphics generator 136 of Figure 1 and can allow control of the orientation of sector scan slice 304.

Further, the efficient acquisition of the two images is useful when performing a cardiac stress echo test on a patient. In such a test, the patient is exerted and the quick collection and rendering of the heart is required to provide an adequate diagnosis. The system of the invention allows such imaging due to the increased frame rate obtainable by only needing to project two sector scan slices. Further, the images depicted in Figures 3A and 3B can provide automatic boundary detection and can show color flow velocity information and ultrasound ANGIO information. Automatic boundary detection refers to the ability of the system to automatically detect and display a boundary between tissue and blood. The term "ANGIO" refers to a form of color flow imaging that trades flow direction information for flow sensitivity

information. This mode of operation may also be referred to as “Power Color Doppler” imaging.

Figure 4 is a chart of a scan of a single frame of data obtained in accordance with another embodiment of the invention. Figure 4 includes a matrix probe 400 that is used to obtain a slice 402 containing two sub-slices 404 and 406. A first sub-slice 404 is taken in plane, while a second sub-slice 406 is orthogonal to the first sub-slice 404. The two sub-slices 404 and 406 join at a centerline 408. Such a scan sequence renders what is referred to as a “corner view.”

Since only the single, folded slice is scanned, and no other slices or planes are scanned, the frame rate can be as high as with a standard two dimensional scanning in the range of 50Hz.

The scan shown in Figure 4 can be displayed as two connected half-sections of the target, revealing orthogonal tissue structures moving relative to each other in real time.

Figure 5 is a graphical illustration showing the image available using the scan geometry shown in Figure 4. An example of how such geometry may be indicated is shown by display 500 in which two scan halves 502 and 504 are displayed as two side-by-side, foreshortened sectors, sometimes referred to as “half-plane” images. Construction line frames 506 and 508 surround the scan planes of the half slices. The display 500 is similar to the view into a corner of a box in which the half-sector images are painted on the sidewalls.

Figure 6 is a graphical representation illustrating another embodiment of the invention. By using the graphics generator 136 associated with the system controller 132, a display image 600 can be generated on a display 602. The display 602 includes the ultrasound image 606 being displayed and also illustrates that the shape of the probe 604 can be applied on the display 602. In this manner, a user of the ultrasound imaging system 100 can view the position of the probe 604 directly on the display 602, thereby enabling more precise alignment and positioning of the probe 604 on the body of the patient being imaged.

Figure 7 is a graphical illustration showing another implementation made possible by the graphics generator 136 of Figure 1. The image 700 of Figure 7 includes a first scan slice 702 and a second scan slice 704 depicted in a dotted line. The second scan slice 704 is shown as rotated with respect to the scan slice 702. The scan slice 704 is rotated about cursor line 706 with respect to the scan slice 702. The dotted line 704 is a depiction of a rotated sector that rotates about the cursor line 706. For example, as illustrated in Figure 7, there is a 78 degree rotational offset between slices 702 and 704. The slice 704 would disappear when the angle is 90 degrees. Further, the image 700 can show tilt of the scan slice 704 with respect to scan slice 702.

Figure 8 is a flow diagram 800 illustrating the operation of certain embodiments of the invention. In block 802 an operator of the ultrasound imaging system 100 selects a desired ultrasound image to be displayed. To determine the appropriate sector scan slices that will result in the desired image, the system controller 132, executes the appropriate control routine 142 in order to select a new rotation vector or elevation angle relative to the fixed reference plane (302 of Figure 3A) that will render the desired ultrasound image. In block 802, it is assumed that the fixed reference plane 302 provides one of the ultrasound images and, in response to the operator inputting commands via the input element 138 that communicate to the system the certain desired ultrasound images, the system controller 132 in cooperation with the control routines 142 and the graphics generator 136 (Figure 1) will determine the appropriate location and position of the sector scan slice 304 relative to the fixed sector scan slice 302 (*i.e.*, the fixed reference plane).

In block 804, it is determined whether the corner view option described above with respect to Figures 4 and 5 is selected. If the corner view option is not selected, then in block 806 the scan line sequence is changed by the system controller 132 in order to generate the requested full plane images using the matrix probe 200. In such an instance, the two sector scan planes 302 and 304 (Figure 3A) will be projected in order to acquire the desired ultrasound image 306 (Figures 3B and 3C).

If, in block 804, it is determined that the corner view option is activated, then, in block 808, the system controller 132 will change the scan line sequence to generate the half plane images using the matrix probe 200 in accordance with the procedure described with respect to FIGS. 4 and 5.

In block 810, the scan converter 128 and the system controller 132 will update the graphics, using the graphics generator 136, to show the orientation of the second (*i.e.*, sector scan slice 304) sector scan slice relative to the fixed reference plane of sector scan slice 302. If the corner view option is off, then a third, fourth, fifth, etc. sector scan slice orientation could be shown on the display 130. In block 812, the ultrasound imaging system 100 scans and displays the requested image.

It will be apparent to those skilled in the art that many modifications and variations may be made to the present invention, as set forth above, without departing substantially from the principles of the present invention. For example, the present invention can be used with piezoelectric ceramic and MUT transducer elements. Furthermore, the invention is applicable to various ultrasound imaging systems and components. All such modifications and variations are intended to be included herein.

CLAIMS:

1. A system (100) for presenting a desired ultrasound image on a display (130), comprising:
 - a two dimensional matrix probe (200);
 - a system controller (132) for determining at least two ultrasound scan
 - 5 slices (302, 304) corresponding to the desired ultrasound image (306);
 - a scan converter (128) for developing the desired ultrasound image (306) from data obtained from the at least two ultrasound scan slices (302, 304); and
 - a display (130) for displaying the desired ultrasound image (306).
- 10 2. The system (100) of claim 1, wherein the displayed ultrasound image (306) comprises a corresponding image oriented to each of the at least two ultrasound scan slices (302, 304).
3. The system (100) of claim 1, wherein the at least two ultrasound scan
- 15 slices (302, 304) are arbitrarily positioned with respect to one another.
4. The system (100) of claim 1, wherein the at least two ultrasound scan slices (302, 304) provide color flow velocity information.
- 20 5. The system (100) of claim 1, wherein the at least two ultrasound scan slices (302, 304) form a corner view (500).
6. A method for presenting a desired ultrasound image (306) on a display (130), comprising:
 - 25 - generating at least two ultrasound scan slices (302, 304) with a matrix transducer probe (200), the at least two ultrasound scan slices (302, 304) corresponding to a desired image (306); and

- developing the desired image (306) from the at least two ultrasound scan slices (302, 304), the desired image (306) being displayed as a plurality of views, each view corresponding to one of the at least two ultrasound scan slices (302, 304).

5 7. The method of claim 6, further comprising arbitrarily positioning the at least two ultrasound scan slices (302, 304) with respect to one another.

8. The method of claim 6, further comprising positioning a first ultrasound scan slice (302) in a consistent position for each ultrasound image (306).

10

9. The method of claim 6, further comprising using the at least two ultrasound scan slices (302, 304) to form a corner view (500).

10. The method of claim 6, further comprising displaying a graphical
15 reference (604) for denoting the position of the matrix probe (200) with respect to the corresponding image oriented to each of the at least two ultrasound scan slices (302, 304).

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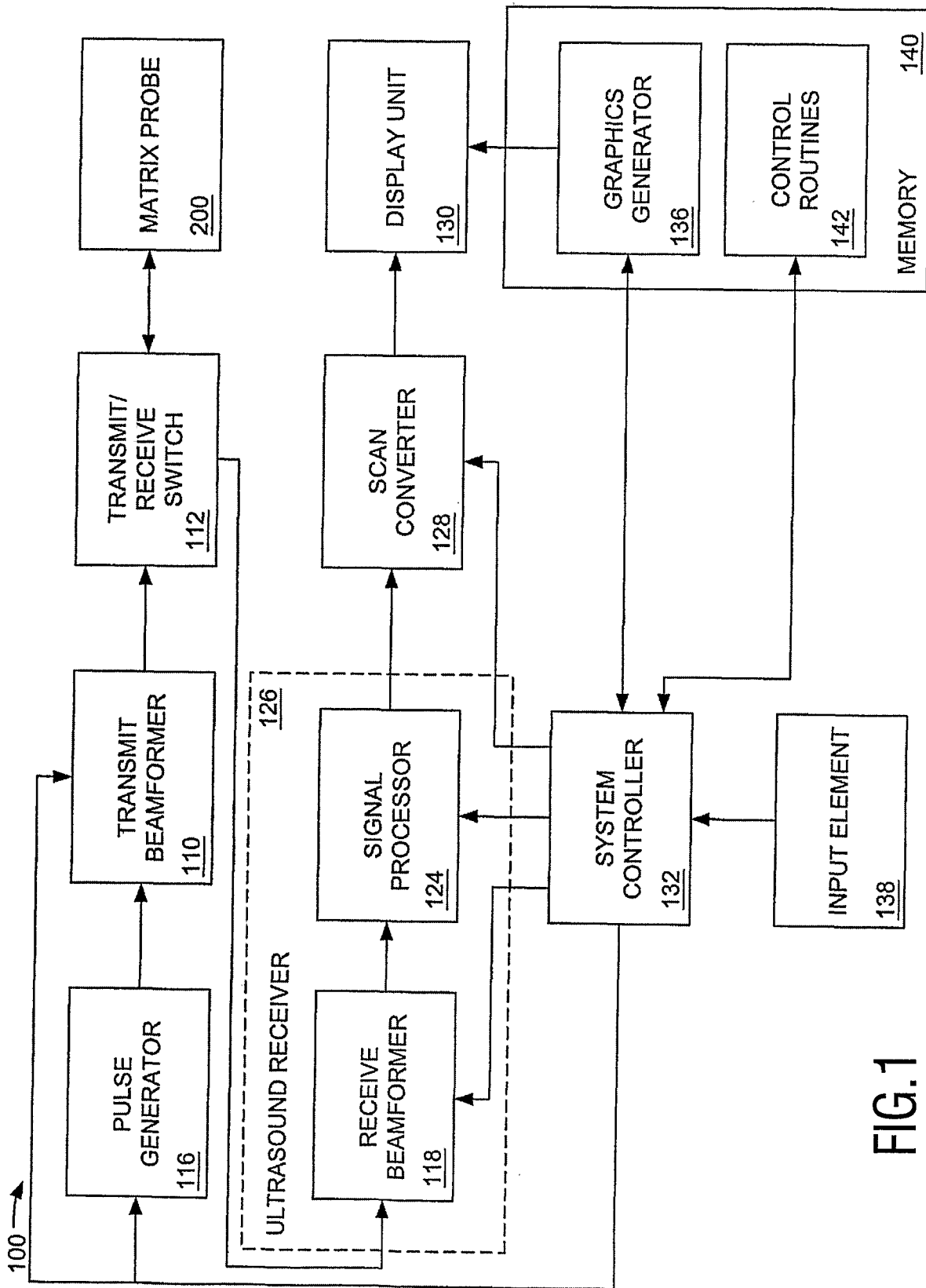


FIG.1

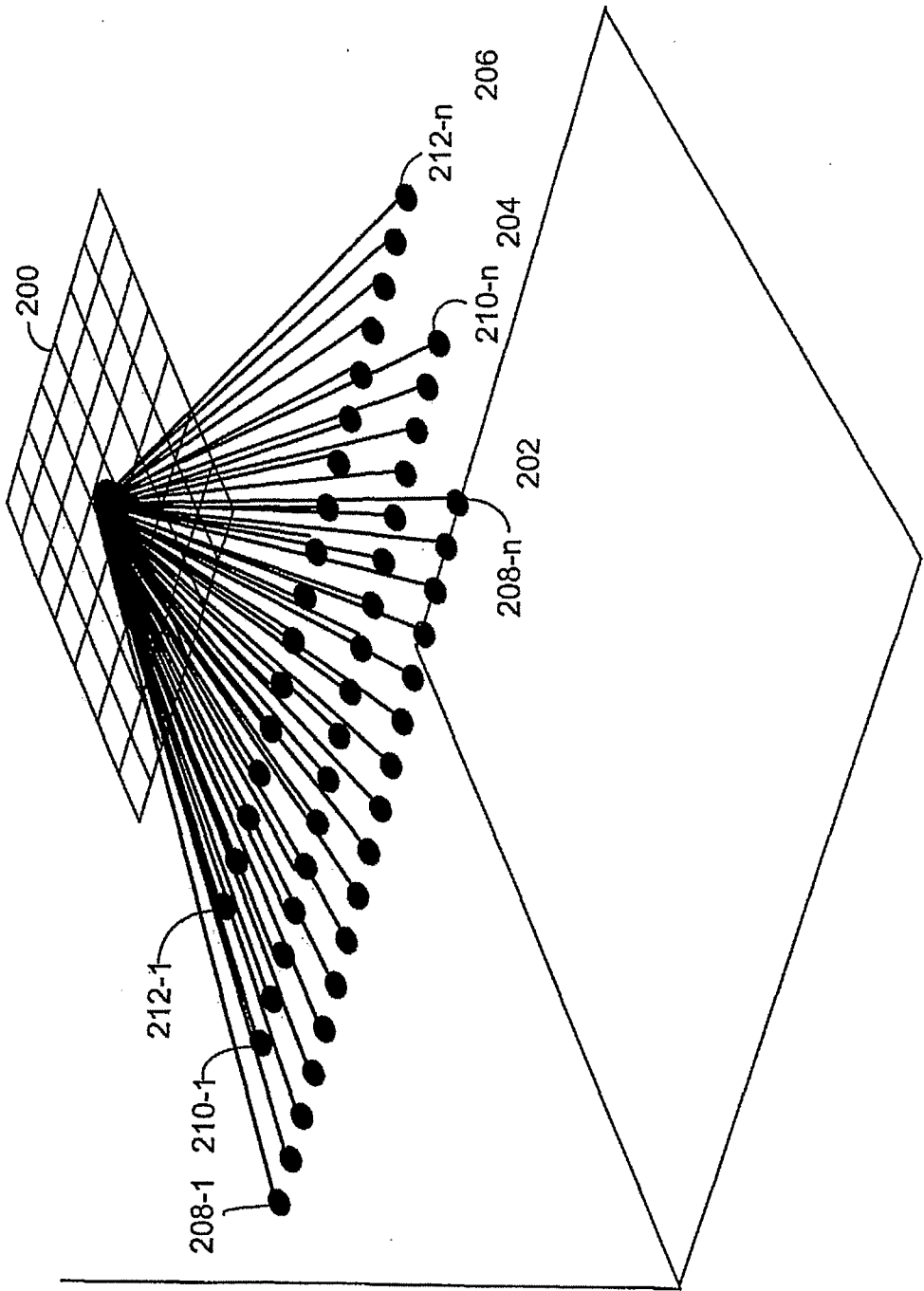


FIG.2

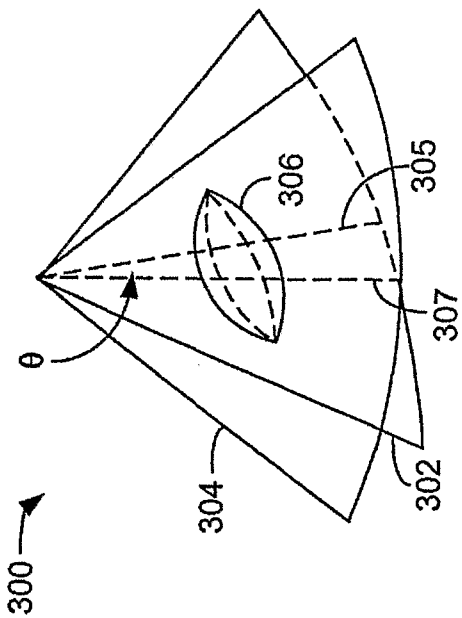


FIG. 3A

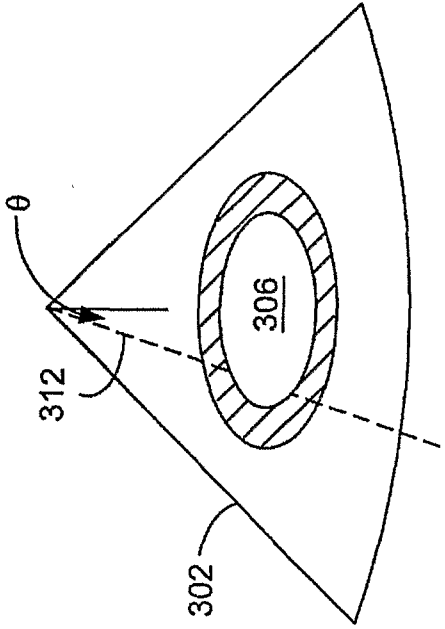


FIG. 3B

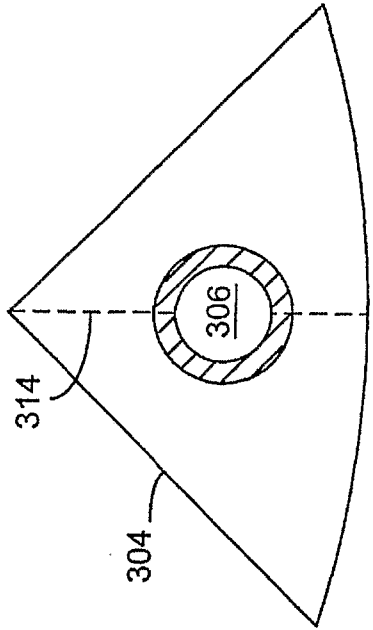


FIG. 3C

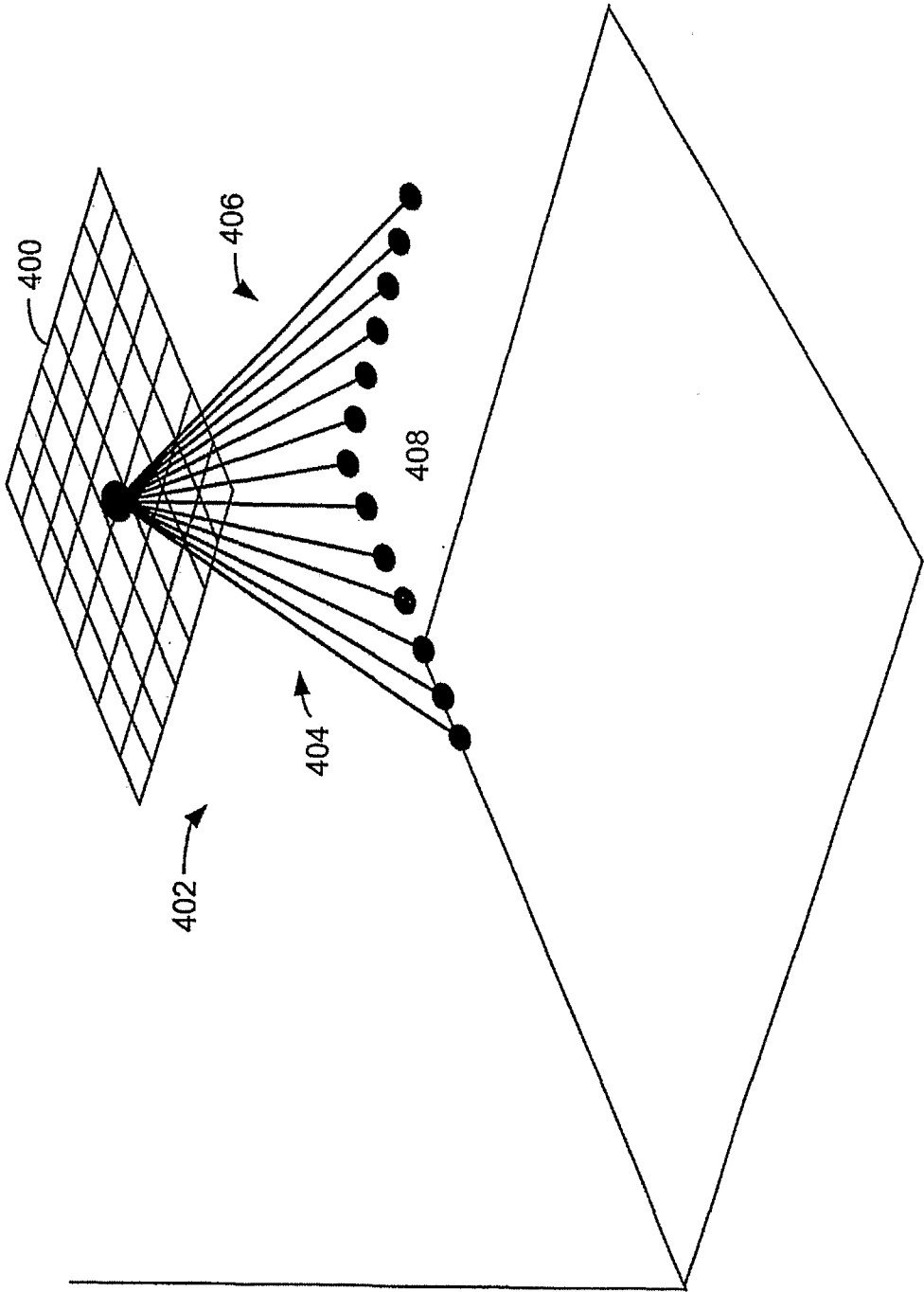


FIG.4

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500 →

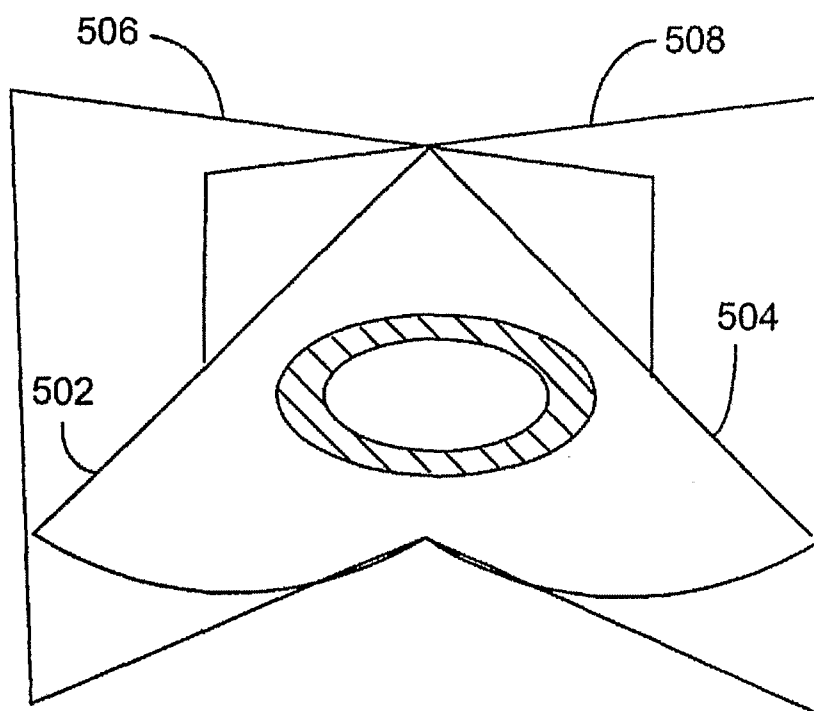


FIG. 5

600 →

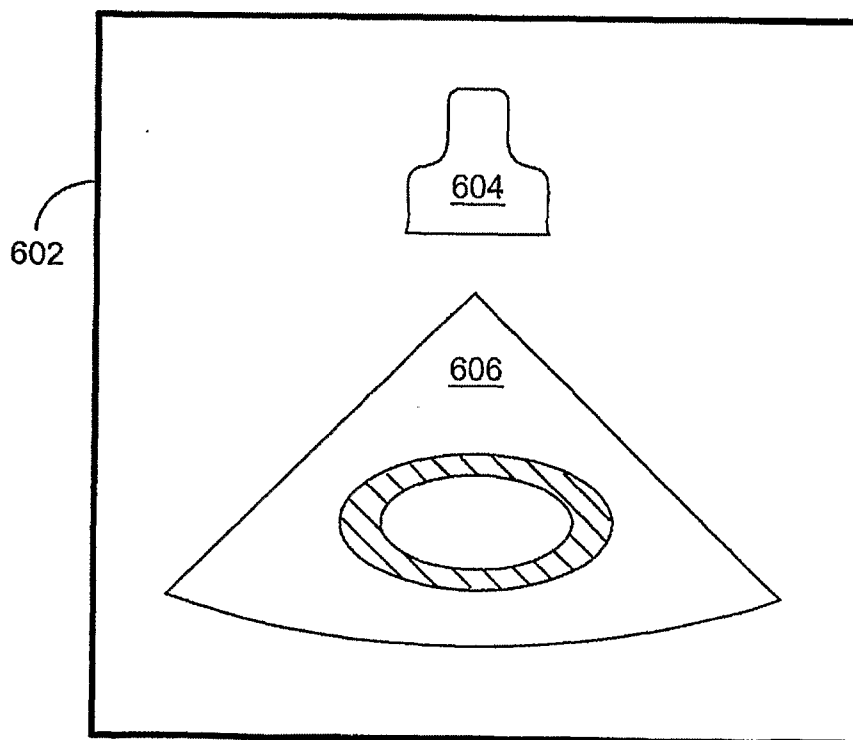


FIG. 6

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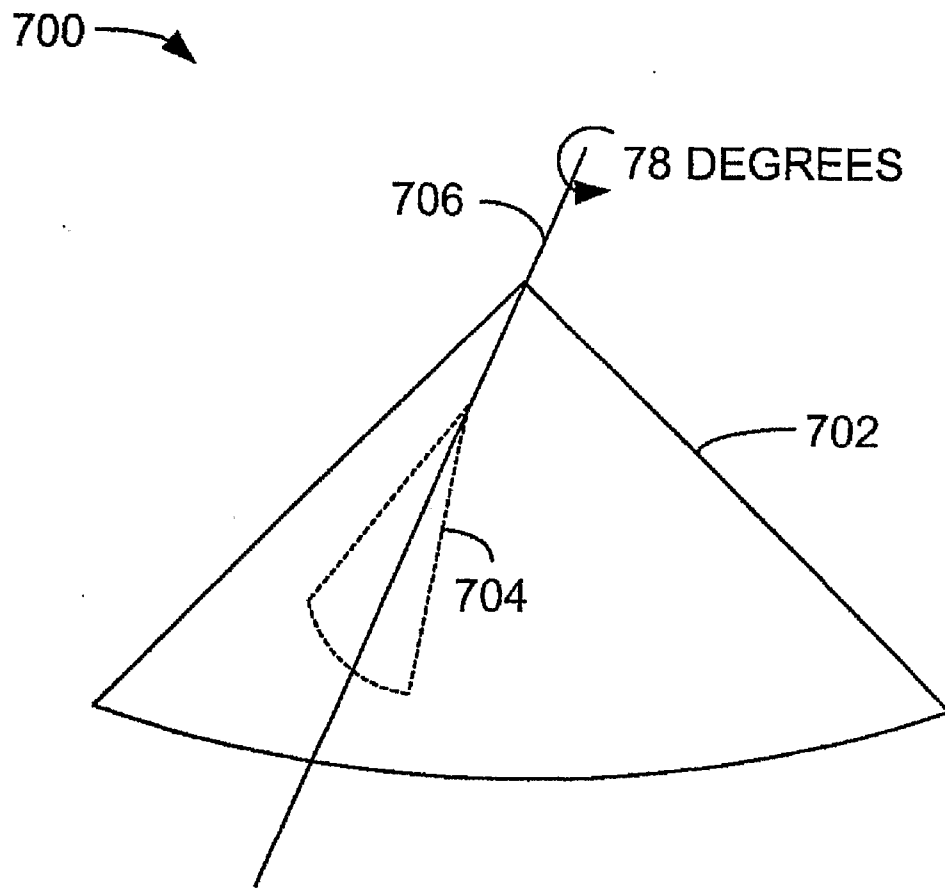


FIG. 7

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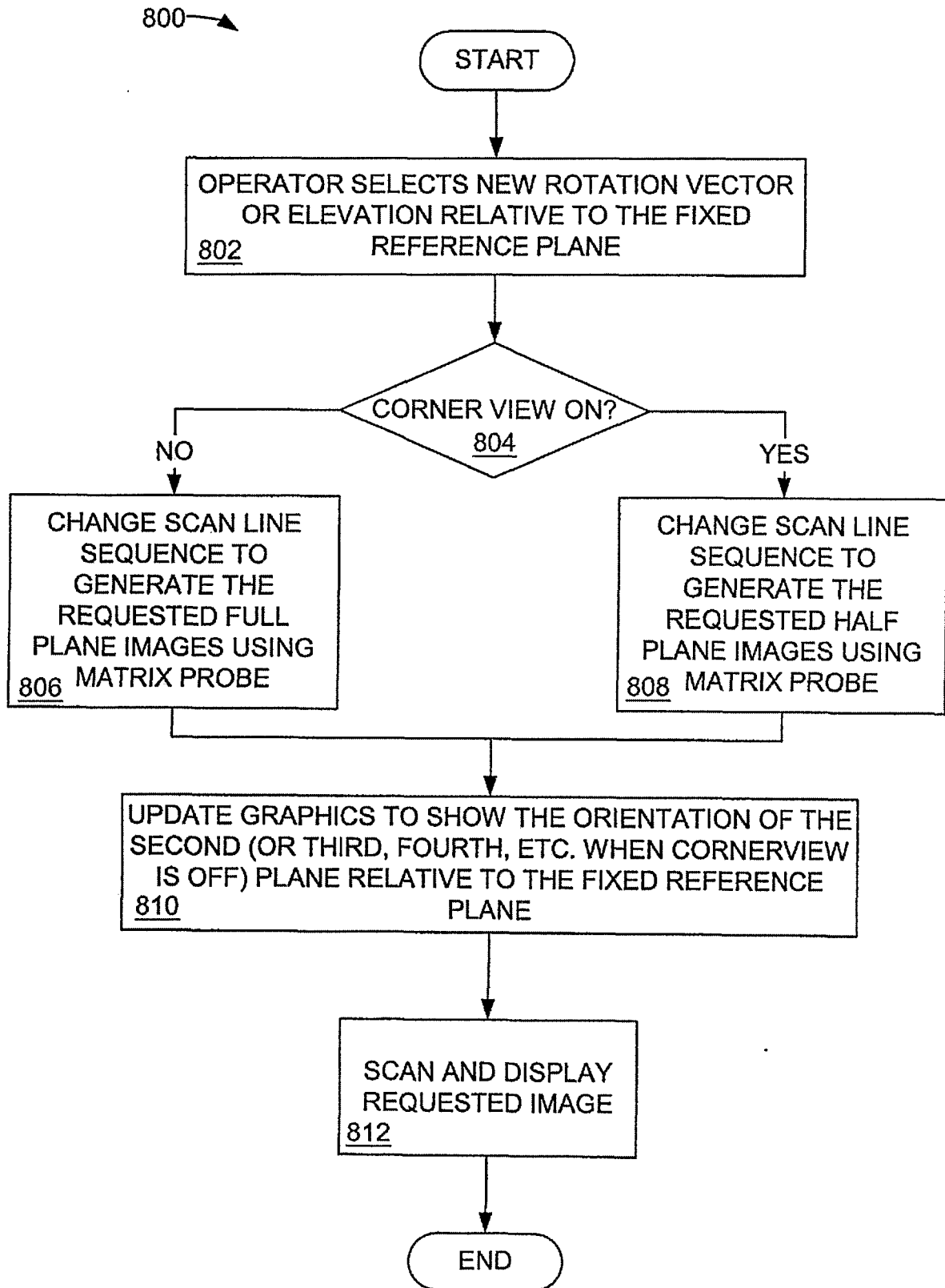


FIG.8

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IB 02/02413

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G01S15/89 G01S7/52

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G01S

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

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

EPO-Internal, INSPEC, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 245 017 B1 (ABE YASUHIKO ET AL) 12 June 2001 (2001-06-12) abstract; figures 1,10-20 column 3, line 59 -column 4, line 34 column 6, line 65 -column 10, line 34 column 11, line 6 -column 13, line 24 ---	1-10
X	US 5 546 807 A (BLAKER DAVID M ET AL) 20 August 1996 (1996-08-20) abstract; figures 3,6 column 4, line 18-41 column 6, line 55 -column 7, line 54 --- -/--	1-4,6,7

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents:

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

E earlier document but published on or after the international filing date

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

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

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

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

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

Z document member of the same patent family

Date of the actual completion of the international search

25 September 2002

Date of mailing of the international search report

04/10/2002

Name and mailing address of the ISA

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INTERNATIONAL SEARCH REPORT

In International Application No

PCT/IB 02/02413

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 00 58754 A (GEN ELECTRIC) 5 October 2000 (2000-10-05) abstract; figures 13-8,10 page 1, line 18-20 page 4, line 5-7 page 6, line 22 -page 8, line 30 page 10, line 20-29 ---	1-7,9
A	MELTON H E JR ET AL: "Real-time automatic boundary detection in echocardiography" ULTRASONICS SYMPOSIUM, 1992. PROCEEDINGS., IEEE 1992 TUCSON, AZ, USA 20-23 OCT. 1992, NEW YORK, NY, USA, IEEE, US, 20 October 1992 (1992-10-20), pages 1113-1117, XP010103733 ISBN: 0-7803-0562-0 the whole document -----	1,6

INTERNATIONAL SEARCH REPORT

Information on patent family members

In International Application No

PCT/IB 02/02413

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US 6245017	B1	JP 2000135217 A	16-05-2000
		JP 2000139906 A	23-05-2000
US 5546807	A	WO 9745724 A1	04-12-1997
		EP 1012596 A1	28-06-2000
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		US 6413219 B1	02-07-2002
		EP 1046929 A2	25-10-2000
		JP 2000325346 A	28-11-2000

专利名称(译)	用于选择性地开发超声诊断数据的超声诊断系统		
公开(公告)号	EP1402284A1	公开(公告)日	2004-03-31
申请号	EP2002738499	申请日	2002-06-20
[标]申请(专利权)人(译)	皇家飞利浦电子股份有限公司		
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优先权	09/886291 2001-06-21 US		
外部链接	Espacenet		

摘要(译)

公开了一种超声成像系统 (100) , 其中用户确定期望的超声图像 (306) 以查看并向超声成像系统 (100) 传送 (138) 所需视图。超声成像系统 (100) 分析该请求并确定要投影的适当扫描切片 (302,304) 以获得所需图像 (306) 。期望的图像 (306) 近似于三维视图 , 但是在不需要获得三维体数据集的情况下被开发。