(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 107 389 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
**14.05.2014 Bulletin 2014/20**

(21) Application number: **09004659.0**

(22) Date of filing: **31.03.2009**

(51) Int Cl.:
***A61B 5/02*** *(2006.01)* ***G01S 7/52*** *(2006.01)*
***A61B 8/08*** *(2006.01)*

(54) **Formation of an elastic image in an ultrasound system**

Bildung eines elastischen Bildes in einem Ultraschallsystem

Formation d'une image élastique dans un système à ultrasons

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK TR**

(30) Priority: **02.04.2008 KR 20080030913**
**02.04.2008 KR 20080030918**
**02.04.2008 KR 20080030921**

(43) Date of publication of application:
**07.10.2009 Bulletin 2009/41**

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EP 2 107 389 B1

Printed by Jouve, 75001 PARIS (FR)

## Description

### TECHNICAL FIELD

**[0001]** The present disclosure relates to ultrasound systems, and more particularly to an ultrasound system and method for forming an elastic image.

### BACKGROUND

**[0002]** Recently, an ultrasound system has been extensively used in the medical field due to its non-invasive and non-destructive nature. Modem high-performance ultrasound imaging systems and techniques are commonly used to produce two dimensional ultrasound images and three-dimensional ultrasound images of internal features of patients.

**[0003]** Generally, the ultrasound image is displayed in a Brightness-mode (B-mode) by using reflectivity caused by an acoustic impedance difference between the tissues of the target object. However, if the reflectivity of the target object is hardly different from those of the neighboring tissues such as tumor, cancer or the like, then it is not easy to recognize the target object in the B-mode image.

**[0004]** When the target object is a blood vessel, an intravascular ultrasound imaging method is adopted to diagnose a lipid or lesion positioned at an inside of the blood vessel. In such a case, a probe is inserted into the inside of the blood vessel to form an ultrasound image of the blood vessel. Although a high resolution of the ultrasound image of the blood vessel may be obtained through the intravascular ultrasound imaging method, there is a problem in that the blood vessel may be damaged.

**[0005]** An ultrasound system according to the preamble of claim 1 and a method of forming an elastic image according to the preamble of claim 11 are known from US 5,615,680.

**[0006]** WO 99/17660 A1 describes an ultrasound system and a method for calculation and display of strain velocity in real time, wherein strain velocity may be determined from tissue velocity.

### SUMMARY

**[0007]** Embodiments for forming an elastic image in an ultrasound system are disclosed herein. In one embodiment, an ultrasound system comprises the features of claim 1.

**[0008]** In another embodiment, a method of forming an elastic image in an ultrasound system including a transmission/reception (Tx/Rx) unit, an image processing unit and an elastic image forming unit, comprises the features of claim 11.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0009]**

FIG. 1 is a block diagram showing an exemplary ultrasound system.

FIG. 2 is a schematic diagram illustrating scan lines in parallel with each other.

FIG. 3 is a schematic diagram illustrating scan lines converged at a specific point when a concave array transducer is adopted.

FIG. 4 is a block diagram showing an image processing unit in accordance with the system of FIG. 1.

FIG. 5 is a schematic diagram showing an example of an ultrasound image.

FIG. 6 is a schematic diagram showing an example of setting radial scan lines with respect to a center of a target object.

FIG. 7 is a schematic diagram showing an example of reconstructing an ultrasound image.

FIG. 8 is a block diagram showing an ultrasound system in accordance with a first embodiment.

FIG. 9 is a schematic diagram illustrating normal scan lines.

FIG. 10 is a schematic diagram illustrating steered scan lines.

FIG. 11 is a block diagram showing a first image processing unit in accordance with the first embodiment.

FIG. 12 is a schematic diagram showing an example of an ultrasound image formed by scanning normal scan lines.

FIG. 13 is a schematic diagram showing an example of setting radial scan lines on an ultrasound image.

FIG. 14 is a schematic diagram showing an example of reconstructing an ultrasound image by using radial scan lines in a first image processing unit in accordance with the first embodiment.

FIG. 15 is a schematic diagram showing an example of interpolating reconstruction images in a first image processing unit in accordance with the first embodiment.

FIG. 16 is a block diagram showing a second image processing unit in accordance with the first embodiment.

FIG. 17 is a schematic diagram showing an example of reconstructing an ultrasound image by using radial scan lines in a second image processing unit in accordance with the first embodiment.

FIG 18 is a schematic diagram showing an example of interpolating reconstruction images in a second image processing unit in accordance with the first embodiment.

FIG. 19 is a schematic diagram showing an example of compounding reconstruction images and interpolation images.

FIG. 20 is a schematic diagram showing an example of forming elastic images by using the compound images.

FIG. 21 is a block diagram showing an ultrasound system in accordance with a second embodiment.

FIG. 22 is a block diagram showing a first image

processing unit in accordance with the second embodiment.

FIG 23 is a block diagram showing a second image processing unit in accordance with the second embodiment.

FIG. 24 is a schematic diagram showing an example of compounding ultrasound images and forming elastic images by using compound images.

## DETAILED DESCRIPTION

**[0010]** A detailed description is provided with reference to the accompanying drawings. One of ordinary skill in the art may realize that the following description is illustrative only and is not in any way limiting. Other embodiments of the present invention may readily suggest themselves to such skilled persons having the benefit of this disclosure.

### Exemplary ultrasound system

**[0011]** Referring to FIG 1, an exemplary ultrasound system 100 is shown. As depicted therein, the ultrasound system 100 includes a transmission/reception (Tx/Rx) unit 110 configured to transmit/receive an ultrasound beam to/from a target object to thereby output electrical receive signals.

**[0012]** The ultrasound system 100 includes a control unit 120 configured to control the Tx/Rx of the ultrasound beam in the Tx/Rx unit 110. The control unit 120 is operable to control the Tx/Rx of the ultrasound beam to be consecutively performed in synchronization with an ECG signal provided from an electrocardiograph (not shown). Specially, the Tx/Rx of the ultrasound beam are performed in synchronization with an ECG signal outputted when a left ventricular is in a maximum contraction and/or maximum relaxation.

**[0013]** The Tx/Rx unit 110 is operable to perform the Tx/Rx of the ultrasound beam multiple times under the control of the control unit 120. The Tx/Rx unit 110 includes a probe (not shown) containing an array transducer for generating the ultrasound beam and the electrical receive signals. A linear array transducer may be adopted to generate the ultrasound beam. In such a case, the control unit 120 sets the scan lines $S_1$-$S_{11}$ to be parallel with each other, as illustrated in FIG. 2. Also, a concave array transducer 122 may be adopted to generate the ultrasound beam. In such a case, the control unit 120 sets the scan line $S_1$-$S_{11}$ to be converged at a specific point, e.g., a center of the target object, as illustrated in FIG 3. The Tx/Rx unit 100 further includes a beam former (not shown) for performing transmit focusing and receive focusing to form a transmit beam and a receive beam. The control unit 120is further operable to control the entire operations of the ultrasound system 100.

**[0014]** The ultrasound system 100 further includes an image processing unit 130. The image processing unit 130 is configured to consecutively form a plurality of ultrasound images by using the receive signals outputted from the Tx/Rx unit 120 under the control of the control unit 120. For the sake of convenience, a blood vessel will be referred to as an example of the target object. However, the target object may be not limited thereto.

**[0015]** FIG. 4 is a block diagram showing an exemplary image processing unit 130. Referring to FIG 4, the image processing unit 130 includes an ultrasound image forming section 131. The ultrasound image forming section 131 is operable to consecutively form a plurality of ultrasound images based on the receive signals. Each of the ultrasound images 210 contains a blood vessel 212 and a lipid 214, as illustrated in FIG. 5.

**[0016]** The image processing unit 130 further includes a boundary detecting section 132, a center setting section 133, a radial scan line setting section 134 and an image reconstructing section 135. The boundary detecting section 132 is operable to detect boundaries of the blood vessel on the ultrasound image 210. The boundaries are detected based on a variation of brightness determined by using a differential operator. In one embodiment, the boundary detecting section 132 is operable to detect the boundaries of the blood vessel 212 by using edge masks such as Sobel, Prewitt, Robert, Laplacian of Gaussian, Canny and the like. In another example, the boundary detecting section 132 is operable to detect the boundaries of the blood vessel 212 based on a difference of eigenvalues using a structure tensor.

**[0017]** The center setting section 133 is operable to set a center "O" of the blood vessel 212 by using detected boundaries of the blood vessel 212, as illustrated in FIG. 6. Also, in another example, the center of the blood vessel 212 is set in response to a user instruction inputted through a user input unit (not shown).

**[0018]** The radial scan line setting section 134 is configured to set a plurality of scan lines 220 in radial directions (hereinafter, referred to as "radial scan lines") with respect to the center "O" on the first ultrasound image 210, as illustrated in FIG 6. The radial scan line setting section 134 sets a plurality of sampling points on each of the radial scan lines 220 and acquires position information of the sampling points and image data of the sampling points based on the receive signals.

**[0019]** The image reconstructing section 135 is operable to reconstruct the radial scan lines 220 to be parallel with each other, as illustrated in FIG. 7. The image reconstructing section 135 is operable to form a reconstruction image corresponding to the first ultrasound image by using the reconstructed radial scan lines 220 and the image data of the sampling points on the radial scan lines.

**[0020]** Referring again to FIG. 1, the ultrasound system 100 further includes an elastic image forming unit 140. The elastic image forming unit 140 is operable to perform auto correlation upon an $n^{th}$ reconstruction image and an $(n+1)^{th}$ reconstruction image to thereby compute an elastic modulus, wherein n is an integer equal to or greater than 1. The elastic image forming unit 140 is further operable to form an elastic image based on the computed

elastic modulus. That is, the elastic image forming unit 140 computes the elastic modulus corresponding to displacement of the blood vessel, the lipid and neighboring tissues caused by contraction and relaxation of the blood vessel, and then form the elastic image based on the computed elasticity modulus.

**[0021]** A display unit 150 may be one of a liquid crystal display, a cathode ray tube, a plate panel display and the like capable of displaying the elastic image formed in the elastic image forming unit 140. However, the display unit 150 may not be limited thereto. Also, the first ultrasound image and the second image may be displayed on the display unit 150.

FIRST EMBODIMENT

**[0022]** FIG. 8 is a block diagram showing an illustrative embodiment of an ultrasound system. As depicted in FIG. 8, the ultrasound system 800 further includes an image compounding unit 850 compared to the ultrasound system 100 of FIG 1. Also, the ultrasound system 800 includes a first image processing unit 830 and a second image processing unit 840.

**[0023]** The ultrasound system 800 includes a Tx/Rx unit 810. The Tx/Rx unit 810 includes a probe (not shown) for transmitting an ultrasound beam along scan lines in a target object and receive ultrasound echoes reflected from the target object to thereby output electrical receive signals. For the sake of convenience, a blood vessel will be referred to as an example of the target object. The probe may include a linear array transducer containing a plurality of elements. The Tx/Rx unit 810 further includes a beam former for performing transmit focusing and receive focusing.

**[0024]** The ultrasound system 800 further includes a control unit 820 operable to control the Tx/Rx of the ultrasound beam. The control unit 820 is operable to set scan lines $S_1$-$S_{11}$ ("normal scan lines") in the normal directions to a linear array transducer (not shown) in the probe, as illustrated in FIG 9. The control unit 820 is operable to control the ultrasound beam to be scanned along the normal scan lines.

**[0025]** Also, the control unit 820 is configured to set the scan lines $S'_1$-$S'_{11}$ to be steered ("steered scan lines"), as illustrated in FIG. 10. The control unit 820 is operable to control the Tx/Rx unit 810 such that the ultrasound beam is transmitted along the scan lines. Detailed description for setting the steered scan lines $S'_1$-$S'_{11}$ will be described later. The Tx/Rx unit 810 outputs first electrical receive signals obtained by scanning the normal scan lines and second electrical receive signals obtained by scanning the steered scan lines. In one embodiment, the scanning of the normal scan lines and the steered scan lines may be alternately carried out.

**[0026]** The ultrasound system 800 includes a first image processing 830 that may receive the first receive signals. Referring to FIG 11, the first image processing unit 830 includes a first ultrasound image forming section 831. The first ultrasound image forming section 831 is operable to form a first ultrasound image 210 based on the first receive signals, as illustrated in FIG. 12.

**[0027]** The first processing unit 830 further includes a boundary detecting section 832, which is configured to detect boundaries of a blood vessel 212 on the first ultrasound image 210. The boundaries may be detected based on the variation of brightness determined by using a differential operator. In one embodiment, the boundary detecting section 832 is operable to detect the boundaries of the blood vessel 212 by using edge masks such as Sobel, Prewitt, Robert, Laplacian of Gaussian, Canny and the like. In another embodiment, the boundary detecting section 832 is operable to detect the boundaries of the blood vessel 212 based on a difference of eigen values using a structure tensor. The first image processing unit 830 further includes a center setting section 833. In one embodiment, the center setting section 833 is operable to set a center "O" of the blood vessel 212 by using detected boundaries of the blood vessel 212, as illustrated in FIG. 13. However, the center setting of the blood vessel 212 is not limited thereto. In another embodiment, the center of the blood vessel 212 may be set in response to a user instruction inputted through a user input unit (not shown).

**[0028]** The first image processing unit 830 further includes a radial scan line setting section 834. The radial scan line setting section 834 is operable to set a plurality of scan lines $RS_1$-$RS_{34}$ in radial directions (hereinafter, referred to as "radial scan lines") with respect to the center on the first ultrasound image 210, as illustrated in FIG. 13. The number of radial scan lines may be determined according to an interval of the radial scan lines, i.e., a steered angle, which may be set by the control unit 820. The radial scan line setting section 834 sets a plurality of sampling points on each of the radial scan lines $RS_1$-$RS_{34}$ and acquire position information of the sampling points and image data at the sampling points based on the first receive signals.

**[0029]** The image processing unit 830 further includes a first image reconstructing section 835. The first image reconstructing section 835 is operable to reconstruct the radial scan lines $RS_1$-$RS_{34}$ to be in parallel with each other. The first image reconstructing section 835 is operable to form a first reconstruction image corresponding to the first ultrasound image by using the reconstructed radial scan lines $RS_1$-$RS_{34}$ and the image data of the sampling points on the radial scan lines. In one embodiment, the first image reconstructing section 835 is operable to form the first reconstruction image 230 by using the image data corresponding to the radial scan lines $RS_8$-$RS_{13}$ and $RS_{25}$-$RS_{30}$, which are not overlapped with the steered scan lines $S'_1$-S'11 shown in FIG. 10. The radial scan lines $RS_8$-$RS_{13}$ and $RS_{25}$-$RS_{30}$ may be determined based on the property of the array transducer and the center of the blood vessel.

**[0030]** The image processing unit 830 further includes a first image interpolating section 836. The first image

interpolating section 836 is operable to interpolate two consecutive first reconstruction images to thereby form a first interpolation image. As illustrated in FIG. 15, the first image processing unit 830 is configured to perform interpolation upon the first reconstruction image $M_1$ and the first reconstruction image $M_2$ to thereby form the first interpolation image $MI_1$. Also, the first image processing unit 830 is operable to perform interpolation upon the first reconstruction image $M_2$ and the first reconstruction image $M_3$ to thereby form the first interpolation image $MI_2$. Similar to the above, a plurality of the first interpolation images $MI_3$, $MI_4$ ... is formed through the interpolation of the first reconstruction images.

**[0031]** Referring back to FIG. 8, the control unit 820 is further operable to set the steered scan lines $S'_1$-$S'_{11}$, which are illustrated in FIG. 8, based on the center information of the blood vessel. That is, the control unit 820 is operable to set the steered scan lines $S'_1$-$S'_{11}$ to be converged at the center of the blood vessel. The control unit 820 controls the Tx/Rx unit 810 such that the ultrasound beam is transmitted along the steered scan lines $S'_1$-$S'_{11}$. In such a case, the electrical receive signal outputted from the Tx/Rx unit 810 will be referred to as "second receive signals."

**[0032]** The ultrasound system 800 further includes a second image processing unit 840, which may receive the second receive signals. Referring to FIG. 16, the second image processing unit 840 includes a second ultrasound image forming section 841 that receives the second receive signals. The second ultrasound image forming section 841 is operable to form a second ultrasound image based on the second receive signals.

**[0033]** The second image processing unit 840 further includes a boundary detecting section 842 that is operable to detect boundaries of the blood vessel in the same manner of the boundary detection in the boundary detecting section 832 of the first image processing unit 830.

**[0034]** The second image processing unit 840 further includes a center setting section 843. In one embodiment, the center setting section 843 is operable to set a center of the blood vessel based on the center set by the center setting section 833 of the first image processing unit 830.

**[0035]** The second image processing unit 840 further includes a radial scan line setting section 844. The radial scan line setting section 844 is operable to set a plurality of scan lines $RS_1$-$RS_{34}$ in radial directions (hereinafter, referred to as "radial scan lines") with respect to the center of the blood vessel, as illustrated in FIG. 13. The number of the radial scan lines may be determined according to an interval of the radial scan lines, i.e., a steering angle, which may be set by the control unit 820. In one embodiment, the steering angle of the radial scan lines $RS_1$-$RS_{34}$ is set to be equal to a steering angle of the steered scan lines $S'_1$-$S'_{11}$ shown in FIG 10. The radial scan line setting unit 844 sets the radial scan lines $RS_1$-$RS_7$, $RS_{14}$-$RS_{24}$ and $RS_{31}$-$RS_{34}$, which are matched with the steered scan lines $S'_1$-$S'_{11}$. The radial scan line setting section 844 sets a plurality of sampling points on each of the radial scan lines and acquire position information of the sampling points and image data at the sampling points based on the second receive signals.

**[0036]** The image processing unit 840 further includes a second image reconstructing section 845. The second image reconstructing section 845 is operable to reconstruct the radial scan lines $RS_1$-$RS_{34}$ to be in parallel with each other, as illustrated in FIG 17. The second image reconstructing section 845 is further operable to form a second reconstruction image corresponding to the second ultrasound image by using the reconstructed radial scan lines $RS_1$-$RS_{34}$ and the image data of the sampling points on the radial scan lines. In one embodiment, the second image reconstructing section 845 is operable to form the second reconstruction image 240 by using the image data corresponding to the radial scan lines $RS_1$-$RS_7$, $RS_{14}$-$RS_{24}$ and $RS_{31}$-$RS_{34}$.

**[0037]** The second image processing unit 840 further includes a second image interpolating section 846. The second image interpolating section 846 is configured to interpolate two consecutive second reconstruction images to form a second interpolation image. As illustrated in FIG. 18, the second image interpolating section 846 is operable to perform the interpolation upon the second reconstruction image $N_1$ and the second reconstruction image $N_2$ to thereby form the second interpolation image $NI_1$. Also, the second image interpolating section 846 is operable to perform the interpolation upon the second reconstruction image $N_2$ and the second reconstruction image $N_3$ to thereby form the second interpolation image $NI_2$. In the same manner as above, the second interpolation images $NI_3$, $NI_4$ ... are formed through the interpolation of the second reconstruction images.

**[0038]** Referring once again to FIG. 8, the image compounding unit 850 is operable to compound an $i^{th}$ first interpolation image $MI_i$ formed in the first image processing unit 830 and an $i^{th}$ second reconstruction image $N_i$ to thereby form a compound image (hereinafter, referred to as "first compound image"). Also, the image compounding unit 850 is further operable to compound an $(i+1)^{th}$ first reconstruction image $M_{i+1}$ formed in the first image processing unit 830 and an $i^{th}$ second interpolation image $MI_i$ to thereby form a compound image (hereinafter, referred to as "second compound image"). In one embodiment, the first and second compound images may be formed at the same time. As illustrated in FIG. 19, the image compounding unit 850 is operable to compound the first interpolation image $MI_1$ formed in the first image processing unit 830 and the second reconstruction image $N_1$ formed in the second image processing unit 840 to thereby form the first compound image $MC_1$. In the same manner as above, the image compounding unit 850 is operable to form a plurality of first compound images $MC_3$, ... Also, the image compounding unit 850 is operable to compound the first reconstruction image $M_2$ formed in the first image processing unit 830 and the

second interpolation image $NI_1$ formed in the second image processing unit 840 to thereby form the second compound image $NC_1$. In the same manner as above, the image compounding unit 850 is operable to form a plurality of second compound images $NC_2$, $NC_3$, ... The image compounding unit 850 includes a first image compounding unit (not shown) for forming the first compound images and a second image compounding unit (not shown) for forming the second compound images.

**[0039]** The ultrasound system 100 further includes an elastic image forming unit 860. The elastic image forming unit 860 is configured to perform autocorrelation to compute an elasticity modulus between a $j^{th}$ first compound image $MC_j$ and a $j^{th}$ second compound image $NC_j$, which are formed in the image compounding unit 850, wherein j is an integer equal to or greater than 1. The elastic image forming unit 860 is further operable to form an elastic image $E_i$ by using the computed elasticity modulus. That is, the elasticity image forming unit 860 is configured to compute the elasticity modulus corresponding to a displacement of the blood vessel, the lipid and peripheral tissues caused by the contraction and the relaxation of the blood vessel. It then forms the elastic image based on the computed elasticity modulus, In the same manner as above, the elastic image forming unit 860 is operable to form a plurality of elastic images $E_1$, $E_2$, $E_3$, $E_4$, $E_5$... as illustrated in FIG. 20.

**[0040]** The ultrasound system 800 further includes a display unit 870 that may display the elastic image formed in the elastic image forming unit 860. The display unit 870 also displays the first and second ultrasound images, the first and second reconstruction images and the first and second interpolation images.

**[0041]** The first image processing unit 830, the second image processing unit 840, the image compounding unit 850 and the elastic image forming unit 860 of the ultrasound system 800 will be embodied with a single processor or a plurality of processors.

## SECOND EMBODIMENT

**[0042]** FIG. 21 is a block diagram showing an illustrative embodiment of an ultrasound system. As depicted in FIG. 21, the ultrasound system 900 further includes an electrocardiogram (ECG) signal providing unit 910 compared to the ultrasound system 800 of FIG. 8. The ECG signal providing unit 910 is configured to provide an ECG signal containing a P wave, QRS waves and a T wave. The P wave, QRS waves and T wave are well known to a person to skilled in the art. Thus, detailed descriptions thereof will be omitted herein.

**[0043]** The ultrasound system 900 includes a Tx/Rx unit 920. The Tx/Rx unit 920 includes a probe (not shown) for transmitting an ultrasound beam along scan lines in a target object and receiving ultrasound echoes reflected from the target object to thereby output electrical receive signals. For the sake of convenience, a blood vessel will be referred to as an example of the target object. The probe may include a linear array transducer containing a plurality of elements. The Tx/Rx unit 920 further includes a beam former for performing transmit focusing and receive focusing. In the third embodiment, the scan lines may be set to be steered. That is, the Tx/Rx unit 920 is operable to transmit the ultrasound beam along scan lines $S_1$-$S_{11}$ ("normal scan lines") such as shown in FIG. 9 and scan lines, which are steered ("steered scan lines) $S'_1$-$S'_{11}$ such as shown in FIG. 10. The setting of the steered scan lines will be described later. The Tx/Rx unit 920 outputs first electrical receive signals obtained by scanning the normal scan lines and second electrical receive signals obtained by scanning the steered scan lines. In one embodiment, the scanning of the normal scan lines is carried out in synchronization with the P and T waves at a $(2n-1)^{th}$ cardiac cycle and the scanning of the steered scan lines may be carried out in synchronization with the P and T waves at a $(2n)^{th}$ cardiac cycle, wherein n is an integer equal to or greater than 1.

**[0044]** The ultrasound system 900 further includes a control unit 930 that is operable to control the transmission and reception of the ultrasound beam. The control unit 930 is configured to set the normal scan lines. It may also control the Tx/Rx unit 920 such that the ultrasound beam is transmitted along the normal scan lines in synchronization with the P and T waves at the $(2n-1)^{th}$ cardiac cycle. In such a case, the electrical receive signal outputted from the Tx/Rx unit 920 will be referred to as "first receive signals."

**[0045]** The ultrasound system 900 includes a first image processing 940 that may receive the first receive signals. Referring to FIG. 22, the first image processing unit 940 includes a first ultrasound image forming section 941. The first ultrasound image forming section 941 is operable to form a first ultrasound image based on the first receive signals such as shown in FIG 12.

**[0046]** The first processing unit 940 further includes a boundary detecting section 942 that may be operable to detect boundaries of a blood vessel 212 on the first ultrasound image 210. The boundary detection is performed similar to the boundary detection by the boundary detecting section 832 of FIG 9. Thus, detailed descriptions of the boundary detection will be omitted herein.

**[0047]** The first image processing unit 940 further includes a center setting section 943. The center setting section 943 is operable to set a center of the blood vessel by using detected boundaries. The center setting may be performed similar to the center setting by the center setting section 833 of FIG 9. Thus, detailed descriptions of the center setting will be omitted herein.

**[0048]** The first image processing unit 940 further includes a radial scan line setting section 944. The radial scan line setting section 944 is operable to set a plurality of scan lines $RS_1$-$RS_{34}$ in radial directions with respect to the center (hereinafter, referred to as "radial scan lines") on the first ultrasound image 210, as illustrated in FIG 11. The number of the radial scan lines may be de-

termined according to an interval of the radial scan lines, i.e., an angle, which may be set by the control unit 930. The radial scan line setting section 944 sets a plurality of sampling points on each of the radial scan lines $RS_1$-$RS_{34}$ and acquire position information of the sampling points and image data at the sampling points based on the first receive signals.

**[0049]** The image processing unit 940 further includes a first image reconstructing section 945. The fist image reconstructing section 945 is operable to reconstruct the radial scan lines $RS_1$-$RS_{34}$ to be in parallel with each other. The first image reconstructing section 945 is configured to form a first reconstruction image corresponding to the first ultrasound image by using the reconstructed radial scan lines $RS_1$-$RS_{34}$ and the image data of the sampling points on the radial scan lines. In one embodiment, the first image reconstructing section 945 is operable to form the first reconstruction image by using the image data corresponding to the radial scan lines $RS_8$-$RS_{13}$ and $RS_{25}$-$RS_{30}$, which are not overlapped with the steered scan lines $S'_1$-$S'_{11}$ shown in FIG 10.

**[0050]** Referring back to FIG. 21, the control unit 930 is further operable to set the steered scan lines $S'_1$-$S'_{11}$, which are illustrated in FIG. 10, based on the center information of the blood vessel. That is, the control unit 930 is configured to set the steered scan lines $S'_1$-$S'_{11}$ to be converged at the center of the blood vessel. The control unit 930 controls the Tx/Rx unit 920 such that the ultrasound beam is transmitted along the steered scan lines $S'_1$-$S'_{11}$ in synchronization with the P and T waves at the $2n^{th}$ cycle. In such a case, the electrical receive signal outputted from the Tx/Rx unit 920 will be referred to as "second receive signals."

**[0051]** The ultrasound system 900 further includes a second image processing unit 950 that receives the second receive signals. Referring to FIG. 23, the second image processing unit 950 includes a second ultrasound image forming section 951 that receives the second receive signals. The second ultrasound image forming section 951 is operable to form a second ultrasound image based on the second receive signals.

**[0052]** The second image processing unit 950 further includes a boundary detecting section 952 that is operable to detect boundaries of the blood vessel similar to the boundary detection in the boundary detecting section 942 of the first image processing unit 940.

**[0053]** The second image processing unit 950 further includes a center setting section 953. In one embodiment, the center setting section 953 is operable to set a center of the blood vessel based on the center set by the center setting section 943 of the first image processing unit 940.

**[0054]** The second image processing unit 950 further includes a radial scan line setting section 954. The radial scan line setting section 954 is operable to set a plurality of scan lines $RS_1$-$RS_{34}$ in radial directions with respect to the center (hereinafter, referred to as "radial scan lines") such as shown in FIG. 13. The number of the radial scan lines may be determined according to an interval of the radial scan lines, i.e., a steering angle, which may be set by the control unit 930. In one embodiment, the steering angle of the radial scan lines $RS_1$-$RS_{34}$ is set to be equal to a steering angle of the steered scan lines. The radial scan line setting section 954 sets the radial scan lines $RS_1$-$RS_7$, $RS_{14}$-$RS_{24}$ and $RS_{31}$-$RS_{34}$ to be matched with the steered scan lines $S'_1$-$S'_{11}$. The radial scan line setting section 954 sets a plurality of sampling points on each of the radial scan lines $RS_1$-$RS_{34}$ and acquire position information of the sampling points and image data at the sampling points based on the second receive signals.

**[0055]** The second image processing unit 950 further includes a second image reconstructing section 955. The second image reconstructing section 955 is operable to reconstruct the radial scan lines $RS_1$-$RS_{34}$ to be in parallel with each other such as shown in FIG. 15. The second image reconstructing section 955 is configured to form a second reconstruction image corresponding to the second ultrasound image by using the reconstructed radial scan lines $RS_1$-$RS_{34}$ and the image data of the sampling points on the radial scan lines. In one embodiment, the second image reconstructing section 955 is operable to form the second reconstruction image by using the image data corresponding to the radial scan lines $RS_1$-$RS_7$, $RS_{14}$-$RS_{24}$ and $RS_{31}$-$RS_{34}$, which are overlapped with the steered scan lines $S'_1$-S'11 shown in FIG. 10.

**[0056]** Referring once again to FIG. 21, the ultrasound system 900 further includes an image compounding unit 960, which is operable to compound the first reconstruction image formed in the first image processing unit 940 and the second reconstruction image formed in the second image processing unit 950. In such a case, the image compounding unit 960 is configured to perform motion estimation and compensation between the first and second reconstruction images for compensating motion, which may occur in the compound image. The motion estimation and compensation may be carried out by using the well-know techniques. As such, detailed descriptions thereof will be omitted herein. The image compounding unit 960 is operable to compound the first reconstruction image $M_{P1}$ formed in synchronization with the P wave of the first cardiac cycle and the second reconstruction image $N_{P2}$ formed in synchronization with the P wave of the second cardiac cycle to thereby form a compound image $C_{P1}$. Also, the image compounding unit 960 is operable to compound the first reconstruction image $M_{T1}$ formed in synchronization with the T wave of the first cardiac cycle with the second reconstruction image $N_{T2}$ formed in synchronization with the T wave of the second cardiac cycle to thereby form a compound image $C_{T1}$. In the same manner as above, the image compounding unit 960 is configured to form a plurality of compound images $C_{P2}$, $C_{T2}$, $C_{P3}$, $C_{T3}$ ... as illustrated in FIG. 24.

**[0057]** Referring back to FIG. 21, the ultrasound system 900 further includes an elastic image forming unit

970. The elastic image forming unit 970 is operable to perform autocorrelation to compute an elasticity modulus between a $k^{th}$ compound image and a $(k+1)^{th}$ compound image, which are formed in the image compounding unit 960, wherein k is an integer equal to or greater than 1. The elastic image forming unit 970 is further operable to form an elastic image by using the computed elasticity modulus. For example, the elasticity image forming unit 970 is operable to compute the elasticity modulus by using the first compound image $C_{P1}$ and the second compound image $C\text{-}_{T1}$, and then form the elastic image $E_1$ based on the computed elasticity modulus. In the same manner as above, the elastic image forming unit 970 is operable to form a plurality of elastic images $E_2$, $E_3$, $E_4$, $E_5$... as illustrated in FIG. 24.

**[0058]** The ultrasound system 900 further includes a display unit 980 that may display the elastic image formed in the elastic image forming unit 970. The display unit 980 displays the first and second ultrasound images, the first and second reconstruction images and the compound images.

**[0059]** The first image processing unit 940, the second image processing unit 950, the image compounding unit 960 and the elastic image forming unit 970 of the ultrasound system 800 may be implemented by a single processor or a plurality of processors.

**[0060]** As mentioned above, the lipid or lesion at inside of the blood vessel may be examined through the elastic image without inserting the probe into the inside of the blood vessel. Also, since the ultrasound images formed in synchronization with the ECG signal are used to form the elastic image, a more accurate elastic image may be formed.

## Claims

**1.** An ultrasound system (800, 900), comprising:

a transmission and reception, Tx and Rx, unit (810, 920) configured to repeatedly transmit an ultrasound beam along first scan lines in a target object and receive echo signals from the target object to output first receive signals;
an image processing unit (830, 840, 940, 950) configured to form a plurality of consecutive first ultrasound images based on the first receive signals and set a center of the target object on each of the first ultrasound images,
**characterized in that**:
the first scan lines are set to be parallel with each other;
the image processing unit (830, 840, 940, 950) being further configured to set first radial lines in radial directions with respect to the center on each of the first ultrasound images, set a plurality of first sampling points on each of the first radial lines, acquire position information and image data of the first sampling points and reconstruct the ultrasound images based on the acquired position information and image data of the first sampling points such that the first radial lines are in parallel with each other to form first reconstruction images; and
the ultrasound system (800, 900) further comprises an elastic image forming unit (860, 970) configured to form at least one elastic image based on the first reconstruction images; and
the Tx and Rx unit (810, 920) is further configured to repeatedly transmit an ultrasound beam along second scan lines each passing the center in the target object and receive echo signals from the target object to output second receive signals for forming elastic images.

**2.** The ultrasound system (800, 900) of Claim 1, wherein the image processing unit (830, 840, 940, 950) includes a first image processing unit (830) for receiving the first receive signals and a second image processing unit (840) for receiving the second receive signals.

**3.** The ultrasound system (800) of Claim 2, wherein the first image processing unit (830) includes:

a first ultrasound image forming section (831) configured to consecutively form the first ultrasound images based on the first receive signals;
a first boundary detecting section (832) configured to detect first boundaries of the target object on each of the first ultrasound images;
a first center setting section (833) configured to set the center of the target object based on the first detected boundaries;
a first radial line setting section (834) configured to set the first radial lines in the first radial directions with respect to the center on each of the first ultrasound images, set the plurality of first sampling points on each of the first radial lines, and acquire the position information and the image data of the first sampling points;
a first image reconstructing section (835) configured to reconstruct the first ultrasound images based on the position information and the image data of the first sampling points such that the first radial lines are in parallel with each other to form the first reconstruction images; and
a first image interpolating section (836) configured to interpolate the first reconstruction images to form first interpolation images.

**4.** The ultrasound system (800) of Claim 3, wherein the second image processing unit (840) includes:

a second ultrasound image forming section (841) configured to consecutively form second

ultrasound images based on the second receive signals;
a second boundary detecting section (842) configured to detect second boundaries of the target object on each of the second ultrasound images;
a second center setting section (843) configured to set the center of the target object based on the second detected boundaries;
a second radial line setting section (844) configured to set second radial lines in second radial directions with respect to the center on each of the second ultrasound images, set a plurality of second sampling points on each of the second radial lines, and acquire position information and image data of the second sampling points;
a second image reconstructing section (845) configured to reconstruct the second ultrasound images based on the position information and the image data of the second sampling points such that the second radial lines are in parallel with each other to form second reconstruction images; and
a second image interpolating section (846) configured to interpolate the second reconstruction images to form second interpolation images.

**5.** The ultrasound system (800) of Claim 4, further comprising an image compounding unit (850) configured to form compound images by using the first and second reconstruction images and the first and second interpolation images, wherein the image compounding unit includes:

a first image compounding section configured to compound an ith first interpolation image and an ith second reconstruction image to form a first compound image, wherein i is an integer equal to or greater than 1; and
a second image compounding section configured to compound an $(i+1)^{th}$ first reconstruction image and an ith second interpolation image to form a second compound image.

**6.** The ultrasound system (800) of Claim 5, wherein the elastic image forming unit (860) is configured to compute an elasticity modulus by using a jth first compound image and a jth second compound image and form elastic images by using the elasticity modulus, wherein j is an integer equal to or greater than 1.

**7.** The ultrasound system (900) of Claim 1, further comprising an electrocardiogram ,ECG, signal providing unit (910) configured to provide an ECG signal representing a cardiac cycle,
wherein the ECG signal includes a first wave generated before contraction of a left ventricle and a second wave generated before relaxation of the left ventricle, wherein the Tx and Rx unit (920) is configured to transmit an ultrasound beam along the first scan lines in synchronization with the first and second wave at a $(2n-1)^{th}$ cardiac cycle to thereby output the first receive signals, the Tx and Rx unit (920) being further configured to transmit an ultrasound beam along the second scan lines in synchronization with the first and second waves at a 2nth cardiac cycle to thereby output the second receive signals,
wherein n is an integer equal to or greater than 1, and wherein the image processing unit (940, 950) includes a first image processing unit (940) receiving the first receive signals and a second image processing unit (950) receiving the second receive signals.

**8.** The ultrasound system (900) of Claim 7, wherein the first image processing unit (940) includes:

a first ultrasound image forming section (941) configured to consecutively form the first ultrasound images based on the first receive signals corresponding to the first and second waves, respectively, at the $(2n-1)^{th}$ cardiac cycle;
a first boundary detecting section (942) configured to detect first boundaries of the target object on each of the first ultrasound images;
a first center setting section (943) configured to set the center of the target object based on the first detected boundaries;
a first radial line setting section (944) configured to set the first radial lines in the first radial directions with respect to the center on each of the first ultrasound images, set the plurality of first sampling points on each of the first radial lines, and acquire the position information and the image data of the first sampling points; and
a first image reconstructing section (945) configured to reconstruct the first ultrasound images based on the position information and the image data of the first sampling points such that the first radial lines are in parallel with each other to form the first reconstruction images,
wherein the first image reconstruction section (945) is configured to form the first reconstruction images by using the first radial lines which are not matched with the second scan lines.

**9.** The ultrasound system (900) of Claim 8, wherein the second image processing unit (950) includes:

a second ultrasound image forming section (951) configured to consecutively form the second ultrasound images based on the second receive signals corresponding to the first and second waves, respectively, at the 2nth cardiac cycle;
a second boundary detecting section (952) configured to detect second boundaries of the target object on each of the second ultrasound images;

a second center setting section (953) configured to set the center of the target object based on the second detected boundaries;
a second radial line setting section (954) configured to set second radial lines in second radial directions with respect to the center on each of the second ultrasound images, set a plurality of second sampling points on each of the second radial lines, and acquire position information and image data of the second sampling points; and
a second image reconstructing section (955) configured to reconstruct the second ultrasound images based on the position information and the image data of the second sampling points such that the second radial lines are in parallel with each other to form second reconstruction images,
wherein the second image reconstruction section (955) is configured to form the second reconstruction images by using the second radial lines which are matched with the second scan lines.

**10.** The ultrasound system (900) of Claim 9, further comprising an image compounding unit (960) configured to compound the first reconstruction images formed in synchronization with the first wave and the second reconstruction images formed in synchronization with the first wave to output first compound images, the image compounding unit being further configured to compound the first reconstruction images formed in synchronization with the second wave and the second reconstruction images formed in synchronization with the second wave to output second compound images,
wherein the elastic image forming unit (970) is configured to compute an elasticity modulus through autocorrelation upon the first and second compound images and form elastic images by using the elasticity modulus.

**11.** A method of forming an elastic image in an ultrasound system (800, 900) including a transmission and reception, Tx and Rx unit (810, 920), an image processing unit (830, 840, 940, 950) and an elastic image forming unit (860, 970), comprising:

a) using the transmission and reception, Tx and Rx, unit (810, 920) within the ultrasound system (800, 900) to repeatedly transmit an ultrasound beam along first scan lines in a target object and receive echo signals from the target object to output first receive signals;
b) using the image processing unit (830, 840, 940, 950) within the ultrasound system (100) to form a plurality of consecutive first ultrasound images based on the first receive signals and set a center of the target object on each of the first ultrasound images,
**characterized by**
the first scan lines being set to be parallel with each other;
c) using the image processing unit (830, 840, 940, 950) within the ultrasound system (800, 900) to set radial lines in radial directions with respect to the center on each of the ultrasound images, set a plurality of sampling points on each of the radial lines, acquire position information and image data of the sampling points and reconstruct the ultrasound images based on the acquired position information and image data of the sampling points such that the radial lines are in parallel with each other to form reconstruction images; and
d) using the elastic image forming unit (860, 970) within the ultrasound system to form at least one elastic image based on the reconstruction images; and
e) using the Tx and Rx unit (810, 920) to repeatedly transmit an ultrasound beam along second scan lines each passing the center in the target object and receive echo signals from the target object to output second receive signals for forming elastic images.

**12.** The method of Claim 11, wherein the step d) includes using the elastic image forming unit (860, 970) to compute an elasticity modulus between two consecutive reconstruction images and form an elastic image based on the computed elastic modulus.

**13.** The method of Claim 12, wherein the step a) includes using the Tx and Rx unit (970) to transmit the ultrasound beam in synchronization with an ECG signal provided from an electrocardiogram (ECG) signal providing unit.

**Patentansprüche**

**1.** Ultraschallsystem (800, 900), welches folgendes aufweist:

Übertragungs- und Empfangs-, Tx- und Rx-Einheit (810, 920), die dafür vorgesehen ist, wiederholt einen Ultraschallstrahl entlang erster Scanlinien in einem Zielobjekt zu übertragen und Echosignale von dem Zielobjekt zu empfangen, um erste Empfangssignale auszugeben;
eine Bildverarbeitungseinheit (830, 840, 940, 950), die dafür vorgesehen ist, eine Vielzahl von aufeinanderfolgenden ersten Ultraschallbildern basierend auf den ersten Empfangssignalen zu erzeugen und einen Mittelpunkt des Zielobjekts auf jedem der ersten Ultraschallbilder festzulegen,

**dadurch gekennzeichnet, dass**
die ersten Scanlinien so eingestellt sind, dass sie parallel zueinander sind; die Bildverarbeitungseinheit (830, 840, 940, 950) des Weiteren dafür vorgesehen ist, erste radiale Linien in radialen Richtungen in Bezug auf den Mittelpunkt auf jedem der ersten Ultraschallbilder festzulegen, eine Vielzahl von ersten Abtastpunkten auf jeder der ersten radialen Linien festzulegen, Positionsinformationen und Bilddaten der ersten Abtastpunkte zu erlangen und
die Ultraschallbilder basierend auf den erlangten Positionsinformationen und den Bilddaten der ersten Abtastpunkte auf eine solche Art und Weise zu rekonstruieren, dass die ersten radialen Linien parallel zueinander sind, um erste Rekonstruktionsbilder zu erzeugen; und
wobei das Ultraschallsystem (800, 900) des Weiteren eine elastische Bilderzeugungseinheit (860, 970) aufweist, die dafür vorgesehen ist,
wenigstens ein elastisches Bild basierend auf den ersten Rekonstruktionsbildern zu erzeugen; und
die Tx- und Rx-Einheit (810, 920) des Weiteren dafür vorgesehen ist, einen Ultraschallstrahl entlang zweiter Scanlinien, die jeweils durch den Mittelpunkt in dem Zielobjekt verlaufen, wiederholt zu übertragen und Echosignale von dem Zielobjekt zu empfangen, um zweite Empfangssignale zum Erzeugen elastischer Bilder auszugeben.

**2.** Ultraschallsystem (800, 900) nach Anspruch 1, wobei die Bildverarbeitungseinheit (830, 840, 940, 950) eine erste Bildverarbeitungseinheit (830) zum Empfangen der ersten Empfangssignale und eine zweite Bildverarbeitungseinheit (840) zum Empfangen der zweiten Empfangssignale aufweist.

**3.** Ultraschallsystem (800) nach Anspruch 2, wobei die erste Bildverarbeitungseinheit (830) folgendes aufweist:

einen ersten Ultraschallbilderzeugungsabschnitt (831), der dafür vorgesehen ist, die ersten Ultraschallsignale basierend auf den ersten Empfangssignalen aufeinanderfolgend zu erzeugen;
einen ersten Begrenzungsermittlungsabschnitt (832), der dafür vorgesehen ist, erste Begrenzungen des Zielobjekts auf jedem der ersten Ultraschallsignale zu ermitteln;
einen ersten Mittelpunktfestlegungsabschnitt (833), der dafür vorgesehen ist, den Mittelpunkt des Zielobjekts basierend auf den ersten detektierten Begrenzungen festzulegen;
einen ersten Radiallinienfestlegungsabschnitt (834), der dafür vorgesehen ist, die ersten radialen Linien in den ersten radialen Richtungen in Bezug auf den Mittelpunkt von jedem der ersten Ultraschallbilder festzulegen, die Vielzahl von ersten Abtastpunkten auf jeder der ersten radialen Linien festzulegen und die Positionsinformationen und die Bilddaten der ersten Abtastpunkte zu verfangen;
einen ersten Bildrekonstruktionsabschnitt (835), der dafür vorgesehen ist, die ersten Ultraschallbilder basierend auf den Positionsinformationen und den Bilddaten der ersten Abtastpunkte auf eine solche Art und Weise zu rekonstruieren, dass die ersten radialen Linien parallel zueinander sind, um die ersten Rekonstruktionsbilder zu erzeugen; und
einen ersten Bildinterpolierabschnitt (836), der dafür vorgesehen ist, die ersten Rekonstruktionsbilder zu interpolieren, um erste Interpolafionsbilder zu erzeugen.

**4.** Ultraschallsystem (800) nach Anspruch 3, wobei der zweite Büdverarbeitungsabschnitt (840) folgendes aufweist:

einen zweiten Ultraschallbilderzeugungsabschnitt (841), der dafür vorgesehen ist, die zweiten Ultraschallsignale basierend auf den ersten Empfangssignalen aufeinanderfolgend zu erzeugen;
einen zweiten Begrenzungsermittlungsabschnitt (842), der dafür vorgesehen ist, zweite Begrenzungen des Zielobjekts auf jedem der zweiten Ultraschallsignale zu ermitteln;
einen zweiten Mittelpunktfestlegungsabschnitt (843), der dafür vorgesehen ist, den Mittelpunkt des Zielobjekts basierend auf den zweiten detektierten Begrenzungen festzulegen;
einen zweiten Radiallinienfestiegungsabschnitt (844), der dafür vorgesehen ist, die zweiten radialen Linien in den zweiten radialen Richtungen in Bezug auf den Mittelpunkt von jedem der zweiten Ultraschall bilder festzulegen, die Vielzahl von zweiten Abtastpunkten auf jeder der zweiten radialen Linien festzulegen und die Positionsinformationen und die Bilddaten der zweiten Abtastpunkte zu erlangen;
einen zweiten Bildrekonstruktionsabschnitt (845), der dafür vorgesehen ist, die zweiten Ultraschallbilder basierend auf den Positionsinformationen und den Bilddaten der zweiten Abtastpunkte auf eine solche Art und Weise zu rekonstruieren, dass die zweiten radialen Linien parallel zueinander sind, um die zweiten Rekonstruktionsbilder zu erzeugen; und
einen zweiten Bildinterpolierabschnitt (846), der dafür vorgesehen ist, die zweiten Rekonstruktionsbilder zu interpolieren, um zweite Interpolationsbilder zu erzeugen.

**5.** Ultraschallsystem (800) nach Anspruch 4, welches des Weiteren eine Bildverbindungseinheit (850) aufweist, die dafür vorgesehen ist, durch Verwenden der ersten und zweiten Rekonstruktionsbilder und der ersten und zweiten Interpolationsbilder Verbundbilder zu erzeugen, wobei die Bildverbindungseinheit folgendes aufweist:

einen ersten Bildverbindungsabschnitt, der dafür vorgesehen ist, ein i-tes erstes Interpolationsbild und ein i-tes zweites Rekonstruktionsbild zu verbinden, um ein erstes Verbundbild zu erzeugen, wobei eine ganze Zahl gleich oder größer als 1 ist; und
einen zweiten Bildverbindungsabschnitt, der dafür vorgesehen ist, ein (i+1)-tes erstes Rekonstruktionsbild und ein i-tes zweites Interpolationsbild zu verbinden, um ein zweites Verbundbild zu erzeugen.

**6.** Ultraschallsystem (800) nach Anspruch 5, wobei die elastische Bilderzeugungseinheit (860) dafür vorgesehen ist, einen Elastizitätsmodul durch Verwendung eines j-ten ersten Verbundbildes und eines j-ten zweiten Verbundbildes zu berechnen und elastische Bilder durch Verwenden des Elastizitätsmodus zu erzeugen, wobei j eine ganze Zahl gleich oder größer als 1 ist.

**7.** Ultraschallsystem (900) nach Anspruch 1, welches des Weiteren eine Elektrokardiogramm, ECG, Signalerzeugungseinheit (910) aufweist, die dafür vorgesehen ist, ein ECG-Signal zur Verfügung zu stellen, das einen Herzzyklus darstellt,
wobei das ECG-Signal eine erste Welle beinhaltet, die vor der Kontraktion einer linken Herzkammer erzeugt wurde, und eine zweite Welle aufweist, die vor der Entspannung der linken Herzkammer erzeugt wurde, wobei die Tx- und Rx-Einheit (920) dafür vorgesehen ist, einen Ultraschallstrahl entlang der ersten Scanlinien synchron zu der ersten und zweiten Welle in einem (2n-1)-ten Herzzyklus zu übertragen, um dadurch die ersten Empfangssignale auszugeben, wobei die Tx- und Rx-Einheit (920) des Weiteren dafür vorgesehen ist, einen Ultraschallstrahl entlang der zweiten Scanlinien synchron zu den ersten und zweiten Wellen in einem 2n-ten Herzzyklus zu übertragen, um dadurch die zweiten Empfangssignale auszugeben,
wobei n eine ganze Zahl gleich oder größer als 1 ist, und wobei die Bildverarbeitungseinheit (940, 950) eine erste Bildverarbeitungseinheit (940), welche die ersten Empfangssignale empfängt, und eine zweite Bildverarbeitungseinheit (950) aufweist, welche die zweiten Empfangssignale empfängt.

**8.** Ultraschallsystem (900) nach Anspruch 7, wobei die erste Bildverarbeitungseinheit (940) folgendes aufweist:

einen ersten Ultraschallbilderzeugungsabschnitt (941), der dafür vorgesehen ist, die ersten Ultraschallbilder basierend auf den ersten Empfangssignalen entsprechend den jeweiligen ersten und zweiten Wellen in dem (2n-1)-ten Herzzyklus aufeinanderfolgend zu erzeugen;
einen ersten Begrenzungsermittlungsabschnitt (942), der dafür vorgesehen ist, erste Begrenzungen des Zielobjekts auf jedem der ersten Ultraschallbilder zu ermitteln;
einen ersten Mittelpunktfestlegungsabschnitt (943), der dafür vorgesehen ist, den Mittelpunkt des Zielobjekts basierend auf den ersten ermittelten Begrenzungen festzulegen;
einen ersten Radiallinienfestlegungsabschnitt (944), der dafür vorgesehen ist, die ersten radialen Linien in den ersten radialen Richtungen mit Bezug auf den Mittelpunkt auf jedem der ersten Ultraschallbilder festzulegen, die Vielzahl der ersten Abtastpunkte auf jeder der ersten radialen Linien festzulegen und die Positionsinformationen und die Bilddaten der ersten Abtastpunkte festzulegen; und
einen ersten Bildrekonstruktionsabschnitt (945), der dafür vorgesehen ist, die ersten Ultraschallbilder basierend auf den Positionsinformationen und den Bilddaten der ersten Abtastpunkte derart zu rekonstruieren, dass die ersten radialen Linien parallel zueinander sind, um die ersten Rekonstruktionsbilder zu erzeugen,
wobei die erste Bidrekonstruktionseinheit (945) dafür vorgesehen ist, die ersten Rekonstruktionsbilder durch Verwenden der ersten radialen Linien, welche nicht mit den zweiten Scanlinien übereinstimmen, zu erzeugen.

**9.** Ultraschallsystem (900) nach Anspruch 8, wobei die zweite Bildverarbeitungseinheit (950) folgendes aufweist:

einen zweiten Ultraschallbilderzeugungsabschnitt (951), der dafür vorgesehen ist, die zweiten Ultraschallbilder basierend auf den zweiten Empfangssignalen entsprechend den jeweiligen ersten und zweiten Wellen in dem 2n-ten Herzzyklus aufeinanderfolgend zu erzeugen;
einen zweiten Begrenzungsermittlungsabschnitt (952), der dafür vorgesehen ist, zweite Begrenzungen des Zielobjekts auf jedem der zweiten Ultraschallbilder zu ermitteln;
einen zweiten Mittelpunktfestlegungsabschnitt (953), der dafür vorgesehen ist, den Mittelpunkt des Zielobjekts basierend auf den zweiten ermittelten Begrenzungen festzulegen;
einen zweiten Radiallinienfestlegungsabschnitt (954), der dafür vorgesehen ist, die zweiten ra-

dialen Linien in den zweiten radialen Richtungen mit Bezug auf den Mittelpunkt auf jedem der zweiten Ultraschallbilder festzulegen, die Vielzahl der zweiten Abtastpunkte auf jeder der zweiten radialen Linien festzulegen und die Positionsinformationen und die Bilddaten der zweiten Abtastpunkte festzulegen; und

einen zweiten Bildrekonstruktionsabschnitt (955), der dafür vorgesehen ist, die zweiten Ultraschallbilder basierend auf den Positionsinformationen und den Bilddaten der zweiten Abtastpunkte derart zu rekonstruieren, dass die zweiten radialen Linien parallel zueinander sind, um die zweiten Rekonstruktionsbilder zu erzeugen, wobei die zweite Bildrekonstruktionseinheit (955) dafür vorgesehen ist, die zweiten Rekonstruktionsbilder durch Verwenden der zweiten radialen Linien, welche mit den zweiten Scanlinien übereinstimmen, zu erzeugen.

**10.** Ultraschallsystem (900) nach Anspruch 9, welches des Weiteren eine Bildverbindungseinheit (960) aufweist, die dafür vorgesehen ist, die ersten Rekonstruktionsbilder, die synchron zu der ersten Welle gebildet wurden, und die zweiten Rekonstruktionsbilder, die synchron mit der ersten Welle gebildet wurden, zu verbinden, um erste Verbundbilder auszugeben, wobei die Bildverbindungseinheit des Weiteren dafür vorgesehen ist, die ersten Rekonstruktionsbilder, die synchron zu der zweiten Welle gebildet wurden, und die zweiten Rekonstruktionsbilder, die synchron mit der zweiten Welle gebildet wurden, zu verbinden, um zweite Verbundbilder auszugeben,

wobei die elastische Bilderzeugungseinheit (970) dafür vorgesehen ist, einen Elastizitätsmodus durch Autokorrelation an den ersten und zweiten Verbundbildern zu berechnen und elastische Bilder durch Verwenden des Elastizitätsmodus zu erzeugen.

**11.** Verfahren zum Erzeugen eines elastischen Bildes in einem Ultraschallsystem (800, 900) weiches eine Übertragungs- und Empfangs-, Tx- und Rx-Einheit (810, 920), eine Bildverarbeitungseinheit (830, 840, 940, 950) und eine elastische Bilderzeugungseinheit (860, 970) aufweist, mit folgenden Merkmalen:

a) Verwenden der die Übertragungs- und Empfangs-, Tx- und Rx-Einheit (810, 920) innerhalb des Ultraschallsystems (800, 900), um wiederholt einen Ultraschallstrahl entlang erster Scanlinien in einem Zielobjekt zu übertragen und Echosignale von dem Zielobjekt zu empfangen, um erste Empfangssignale auszugeben;

b) Verwenden der Bildverarbeitungseinheit (830, 840, 940, 950) innerhalb des Ultraschallsystems (800, 900), um eine Vielzahl von aufeinanderfolgenden ersten Ultraschallbildern basierend auf den ersten Empfangssignalen zu erzeugen und einen Mittelpunkt des Zielobjekts auf jedem der ersten Ultraschallbilder festzulegen,

**dadurch gekennzeichnet, dass**

die ersten Scanlinien parallel zueinander eingestellt werden;

c) Verwenden der Bildverarbeitungseinheit (830, 840, 940, 950) innerhalb des Ultraschallsystems (800, 900), um radiale Linien in radialen Richtungen in Bezug auf den Mittelpunkt auf jedem der Ultraschallbilder festzulegen, eine Vielzahl von Abtastpunkten auf jeder der radialen Linien festzulegen, Positionsinformationen und Bilddaten der Abtastpunkte zu erlangen und die Ultraschallbilder basierend auf den erlangten Positionsinformationen und den Bilddaten der Abtastpunkte auf eine solche Art und Weise zu rekonstruieren, dass die radialen Linien parallel zueinander sind, um Rekonstruktionsbilder zu erzeugen; und

d) Verwenden der elastischen Bilderzeugungseinheit (860, 970) innerhalb des Ultraschallsystems, um wenigstens ein elastisches Bild basierend auf den Rekonstruktionsbildern zu erzeugen; und

e) Verwenden der Tx- und Rx-Einheit (810, 920), um einen Ultraschallstrahl entlang zweiter Scanlinien, die jeweils durch den Mittelpunkt und dem Zielobjekt verlaufen, wiederholt zu übertragen, und Echosignale von dem Zielobjekt zu empfangen, um zweite Empfangssignale zum Erzeugen elastischer Bilder auszugeben.

**12.** Verfahren nach Anspruch 11, wobei der Schritt d) das Verwenden der elastischen Bilderzeugungseinheit (860, 970) aufweist, um einen Elastizitätsmodus zwischen zwei aufeinanderfolgenden Rekonstruktionsbildern zu berechnen und ein elastisches Bild basierend auf den berechneten Elastizitätsmodus zu erzeugen.

**13.** Verfahren nach Anspruch 12, wobei der Schritt a) das Verwenden der Tx- und Rx-Einheit (970) beinhaltet, um den Ultraschallstrahl synchron mit einem ECG-Signal, das von einer Elektrokardiogramm (ECG)-Signalerzeugungseinheit zur Verfügung gestellt wird, zu übertragen.

**Revendications**

**1.** Système ultrasonique (800, 900) comportant ;

une unité de transmission et de réception Tx et Rx (810, 920) agencée pour transmettre de façon répétitive un faisceau ultrasonique le long de premières lignes de balayage dans un objet cible et pour recevoir des signaux écho de l'objet cible pour émettre

des premiers signaux de réception;
une unité de traitement d'image (830, 840, 940, 950) agencée pour former une pluralité de premières images ultrasoniques consécutives basées sur les premiers signaux de réception et placer un centre de l'objet cible sur chacune des premières images ultrasoniques;
**caractérisé en ce que**
les premières lignes de balayage sont déterminées de telle manière qu'elles soient parallèles entre elles ;
l'unité de traitement d'image (830, 840, 940, 950) étant en outre configurée pour fixer des premières lignes radiales dans des directions radiales par rapport au centre de chacune des premières images ultrasoniques, fixer une pluralité de premiers points d'échantillonnage sur chacune des premières lignes radiales, acquérir l'information de position et les données image des premiers points d'échantillonnage et reconstruire les premières images ultrasoniques basées sur les informations de position acquises et les données image des premiers points d'échantillonnage de telle manière que les premières lignes radiales soient parallèles entre elles pour former des premières images reconstruites ; et
le système ultrasonique (800, 900) comportant en outre une unité (860, 970) de formation d'une image élastique configurée pour former au moins une image élastique basée sur les premières images reconstruites, et
l'unité Tx et Rx (810, 920) est en outre configurée pour transmettre de façon répétitive un faisceau ultrasonique le long de secondes lignes de balayage passant chacune par le centre de l'objet cible et recevoir des signaux écho de l'objet cible pour émettre des seconds signaux de réception pour former des images élastiques.

**2.** Système ultrasonique (800, 900) selon la revendication 1, dans lequel l'unité de traitement d'image (830, 840, 940, 950) comporte une première unité de traitement d'image (830) pour recevoir les premiers signaux et une seconde unité de traitement d'image (840) pour recevoir les seconds signaux.

**3.** Système ultrasonique (800) selon la revendication 2, dans lequel la première unité de traitement d'image (830) comporte :

une première section de formation d'image ultrasonique (831) configurée pour former de premières images ultrasoniques basées sur les premiers signaux de réception ;
une première section de détection de bord (832) agencée pour détecter des premiers bords de l'objet cible sur chacune des premières images ultrasoniques ;
une première section de détermination du centre (833) configurée pour déterminer les centres des objets cibles basés sur les premiers bords détectés ;
une première section de détermination des lignes radiales (834) configurée pour déterminer les premières lignes radiales dans les premières directions radiales par rapport au centre sur chacune des premières images ultrasoniques, déterminer la pluralité de premiers points d'échantillonnage sur chacune des premières lignes radiales, et acquérir l'information de position et les données image des premiers points d'échantillonnage ;
une première section de reconstruction d'image (835) configurée pour reconstruire les premières images ultrasoniques basées sur l'information de position et les données image des premiers points d'échantillonnage, de sorte que les premières lignes radiales sont parallèles entre elles pour former les premières images de reconstruction ; et
une première section d'interpolation d'image (836) pour interpoler les premières images reconstruites pour former des premières images d'interpolation.

**4.** Système ultrasonique (800) selon la revendication 3, dans lequel la seconde unité de traitement d'image (840) comporte :

une seconde section de formation d'image ultrasonique (841) configurée pour former de secondes images ultrasoniques basées sur les seconds signaux de réception ;
une seconde section de détection de bord (842) agencée pour détecter des seconds bords de l'objet cible sur chacune des secondes images ultrasoniques ;
une seconde section de détermination du centre (843) configurée pour déterminer les centres des objets cibles basés sur les seconds bords détectés ;
une seconde section de détermination des lignes radiales (844) configurée pour déterminer les secondes lignes radiales dans les secondes directions radiales par rapport au centre sur chacune des secondes images ultrasoniques, déterminer la pluralité de seconds points d'échantillonnage sur chacune des secondes lignes radiales, et acquérir l'information de position et les données image des seconds points d'échantillonnage ;
une seconde section de reconstruction d'image (845) configurée pour reconstruire les secondes images ultrasoniques basées sur l'information de position et les données image des seconds points d'échantillonnage, de sorte que les secondes lignes radiales sont parallèles entre el-

les pour former les secondes images de reconstruction ; et
une seconde section d'interpolation d'image (846) pour interpoler les premières images reconstruites pour former des secondes images d'interpolation.

**5.** Système ultrasonique (800) selon la revendication 4, comportant en outre une unité (850) de composition d'image configurée pour réaliser des images composées en utilisant les premières et les secondes images reconstruites et les premières et secondes images interpolées, dans lequel l'unité de composition d'image comporte :

une première section de composition d'image configurée pour composer une ième première image d'interpolation composée et une ième seconde image d'interpolation composée, dans lequel i est un nombre entier plus grand que 1 ; et
une seconde section de composition d'image configurée pour composer une (i+1)ème première image reconstruite et une seconde image d'interpolation pour former une seconde image composée.

**6.** Système ultrasonique (800) selon la revendication 5, dans lequel l'unité de formation de l'image élastique (860) est configurée pour composer un module d'élasticité en utilisant une jème première image composée et une jème seconde image composée et constitue le module d'élasticité en utilisant le module d'élasticité dans lequel j est un nombre entier égal ou supérieur à 1.

**7.** Système ultrasonique (900) selon la revendication 1, comportant en outre une unité (910) fournissant un signal ECG d'électrocardiogramme, configuré pour un signal ECG représentant un cycle cardiaque, dans lequel le signal ECG inclut une première onde générée avant la contraction du ventricule gauche et une seconde onde générée avant la relaxation du ventricule gauche, dans lequel l'unité Tx et Rx (920) est configurée pour transmettre un faisceau ultrasonique le long des premières lignes de balayage en synchronisation avec la première et la seconde onde au cours d'un (2n-1)ème cycle cardiaque afin d'émettre de ce fait, les premiers signaux de réception, l'unité Tx et Rx (920) étant en outre configurée pour transmettre un faisceau ultrasonique le long des secondes lignes de balayage en synchronisation avec les premières et secondes ondes au cours d'un 2nème cycle cardiaque afin d'émettre de ce fait, les seconds signaux de réception,
dans lequel n est un nombre entier égal ou supérieur à 1 et dans lequel, l'unité de traitement d'image (940, 950) inclut une première unité de traitement d'image (940) recevant les premiers signaux de réception et une seconde unité de traitement d'image (950) recevant les seconds signaux de réception.

**8.** Système ultrasonique (900) selon la revendication 7, dans lequel l'unité de traitement d'image (940) comporte :

une première section de formation d'image ultrasonique (941) configurée pour former consécutivement des images ultrasoniques basées sur les premiers signaux de réception correspondant aux premières et secondes ondes, respectivement au cours du (2n-1)ème cycle cardiaque ;
une première section de détection de bord (942) agencée pour détecter des premiers bords de l'objet cible de chacune des premières images ultrasoniques ;
une première section de détermination du centre (943) configurée pour déterminer les centres des objets cibles basés sur les premiers bords détectés ;
une première section de détermination des lignes radiales (944) configurée pour déterminer les premières lignes radiales dans les premières directions radiales par rapport au centre sur chacune des premières images ultrasoniques, déterminer la pluralité de premiers points d'échantillonnage sur chacune des premières lignes radiales, et acquérir l'information de position et les données image des premiers points d'échantillonnage; et
une première section de reconstruction d'image (945) configurée pour reconstruire les premières images ultrasoniques basées sur l'information de position et les données image des premiers points d'échantillonnage, de sorte que les premières lignes radiales sont parallèles entre elles pour former les premières images de reconstruction ;
dans lequel la première section de reconstruction d'image (945) est configurée pour reconstruire les premières images en utilisant les premières lignes radiales qui ne coïncident pas avec les secondes lignes de balayage.

**9.** Système ultrasonique (900) selon la revendication 8, dans lequel la seconde unité de traitement d'image (950) comporte :

une seconde section de formation d'image ultrasonique (951) configurée pour former consécutivement des secondes images ultrasoniques basées sur les seconds signaux de réception correspondant aux premières et secondes ondes respectivement du 2n ème cycle cardiaque;
une seconde section de détection de bord (952) agencée pour détecter des seconds bords de

l'objet cible sur chacune des secondes images ultrasoniques ;
une seconde section de détermination du centre (953) configurée pour déterminer les centres des objets cibles basés sur les seconds bords détectés ;
une seconde section de détermination des lignes radiales (954) configurée pour déterminer les secondes lignes radiales dans les secondes directions radiales par rapport du centre sur chacune des secondes images ultrasoniques, déterminer une pluralité de seconds points d'échantillonnage sur chacune des secondes lignes radiales, et acquérir l'information de position et les données image des seconds points d'échantillonnage ;
une seconde section de reconstruction d'image (955) configurée pour reconstruire les secondes images ultrasoniques basées sur l'information de position et les données image des seconds points d'échantillonnage, de sorte que les secondes lignes radiales sont parallèles entre elles pour former les secondes images de reconstruction ;
dans lequel la seconde section (955) de reconstruction d'image est configurée pour former les secondes images reconstruites en utilisant les secondes lignes radiales qui ne coïncident pas avec les secondes lignes de balayage.

**10.** Système ultrasonique (900) selon la revendication 9,comportant en outre, une unité de composition d'image (960) configurée pour composer les premières images reconstruites formées en synchronisation avec la première onde et les secondes images reconstruites formées en synchronisation avec la première onde pour émettre les premières images de composition, l'unité de composition d'image étant en outre configurée pour composer les premières images reconstruites en synchronisation avec la seconde onde et les secondes images reconstruites formées en synchronisation avec la seconde onde pour émettre les secondes images composées,
dans lequel l'unité de formation (970) d'image élastique étant configurée pour composer un module d'élasticité au moyen d'une auto-corrélation sur les premières et secondes images composées et pour former des images élastiques en utilisant le module d'élasticité.

**11.** Procédé pour former une image élastique dans un système ultrasonique (800, 900) comportant une unité de transmission et de réception Tx et Rx (810, 920), une unité de traitement d'image (830, 840, 940, 950) et une unité de formation d'une image élastique (860, 970), comportant :

a) l'utilisation de l'unité de transmission et de réception Tx et Rx (810, 920) du système ultrasonique (800, 900) pour transmettre de façon répétitive un faisceau ultrasonique le long de premières lignes de balayage dans un objet cible et pour recevoir des signaux écho de l'objet cible pour émettre des premiers signaux de réception;
b) l'utilisation de l'unité de traitement d'image (830, 840, 940, 950) du système ultrasonique (800, 900) pour former une pluralité de premières images ultrasoniques consécutives basées sur les premiers signaux de réception et placer un centre de l'objet cible sur chacune des premières images ultrasoniques;
**caractérisé en ce que**
les premières lignes de balayage sont déterminées de telle manière qu'elles soient parallèles entre elles ;
c) l'utilisation de l'unité de traitement d'image (830, 840, 940, 950) du système ultrasonique (800, 900) pour fixer des premières lignes radiales dans des directions radiales par rapport au centre de chacune des premières images ultrasoniques, fixer une pluralité de premiers points d'échantillonnage sur chacune des premières lignes radiales, acquérir l'information de position et les données image des premiers points d'échantillonnage et reconstruire les premières images ultrasoniques basées sur les informations de position acquises et les données image des premiers points d'échantillonnage de telle manière que les premières lignes radiales soient parallèles entre elles pour former des premières images reconstruites ; et
d) l'utilisation de l'unité de formation d'une image élastique du système ultrasonique (860, 970) pour former au moins une image élastique basée sur les premières images reconstruites, et
e) l'utilisation de l'unité Tx et Rx (810, 920) pour transmettre de façon répétitive un faisceau ultrasonique le long de secondes lignes de balayage passant chacune par le centre de l'objet cible et recevoir des signaux écho de l'objet cible pour émettre des seconds signaux de réception pour former des images élastiques.

**12.** Procédé selon la revendication 11, dans lequel l'étape d) inclut l'utilisation de l'unité de formation (860, 970) de l'image élastique pour calculer un module d'élasticité entre deux reconstructions consécutives d'images et pour former une image élastique sur la base du module élastique calculé.

**13.** Procédé selon la revendication 12, dans lequel l'étape a) inclut l'utilisation de l'unité Tx et Rx (970) pour transmettre le faisceau ultrasonique en synchronisation avec le signal ECG produit par une unité produisant un signal (ECG) d'électrocardiogramme.

FIG. 1

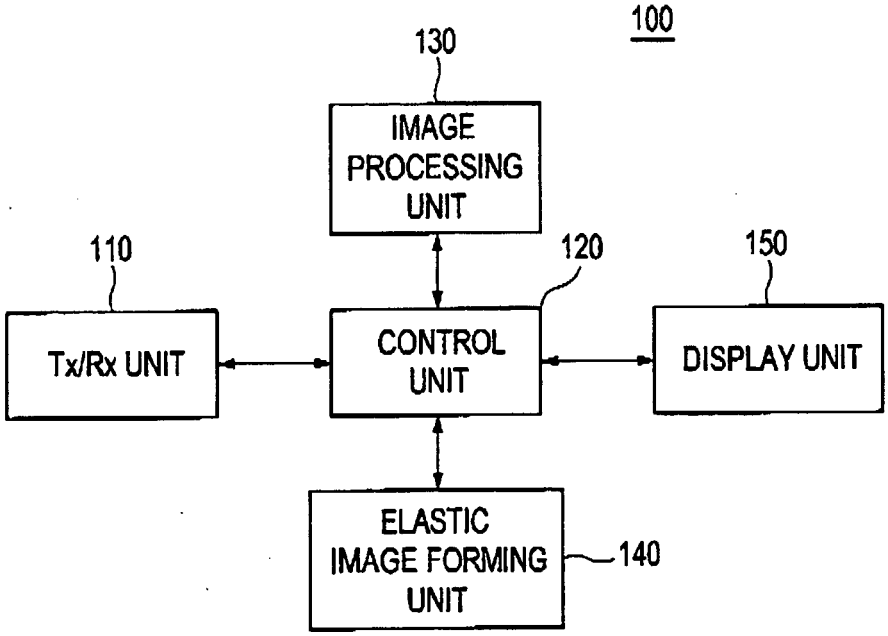

100
130
IMAGE PROCESSING UNIT
110
120
150
Tx/Rx UNIT
CONTROL UNIT
DISPLAY UNIT
ELASTIC IMAGE FORMING UNIT
140

FIG. 2

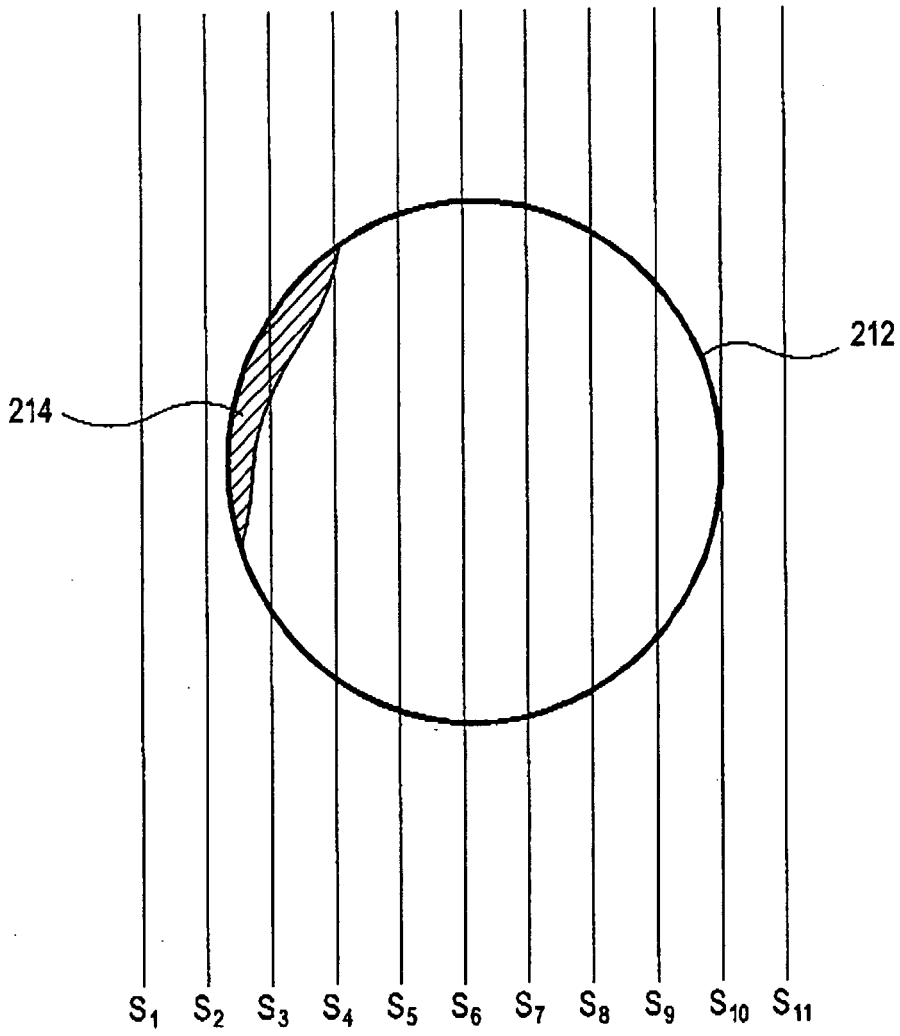


FIG. 3

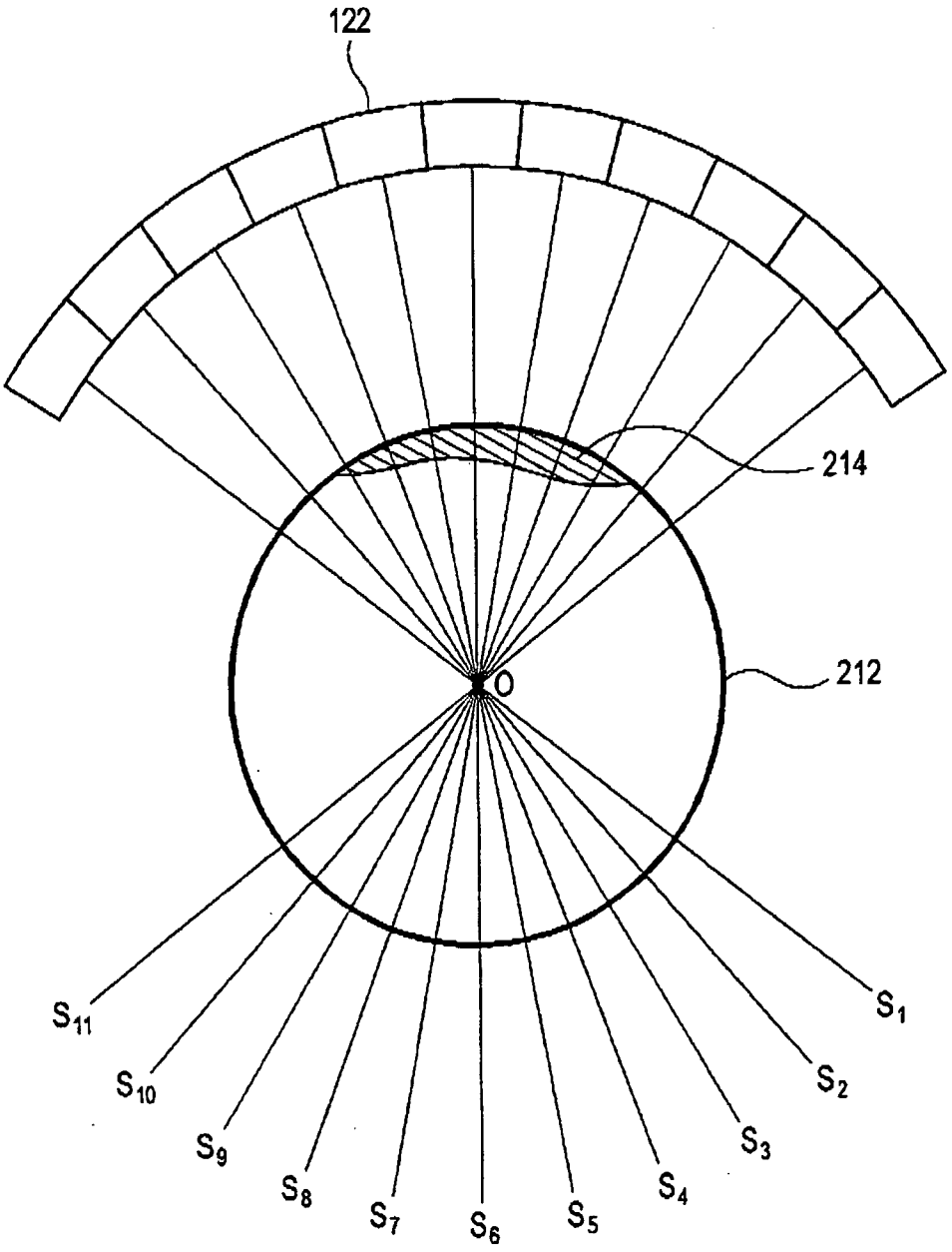


FIG. 4

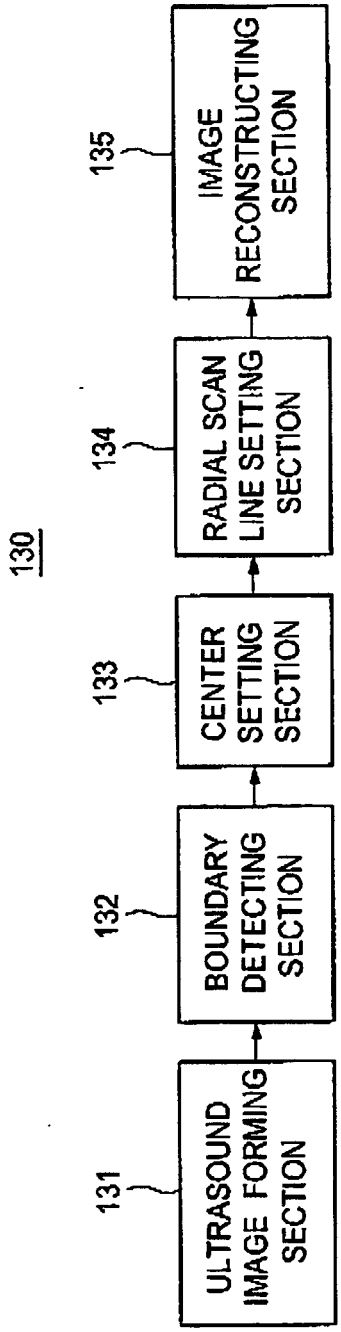

130
131
ULTRASOUND IMAGE FORMING SECTION
132
BOUNDARY DETECTING SECTION
133
CENTER SETTING SECTION
134
RADIAL SCAN LINE SETTING SECTION
135
IMAGE RECONSTRUCTING SECTION

FIG. 5

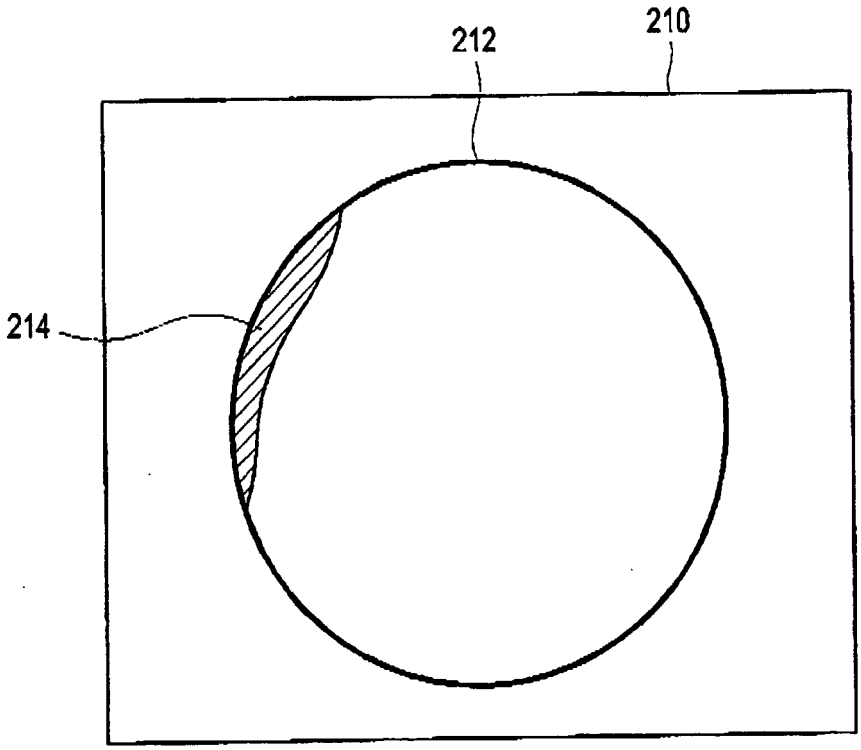


FIG. 6

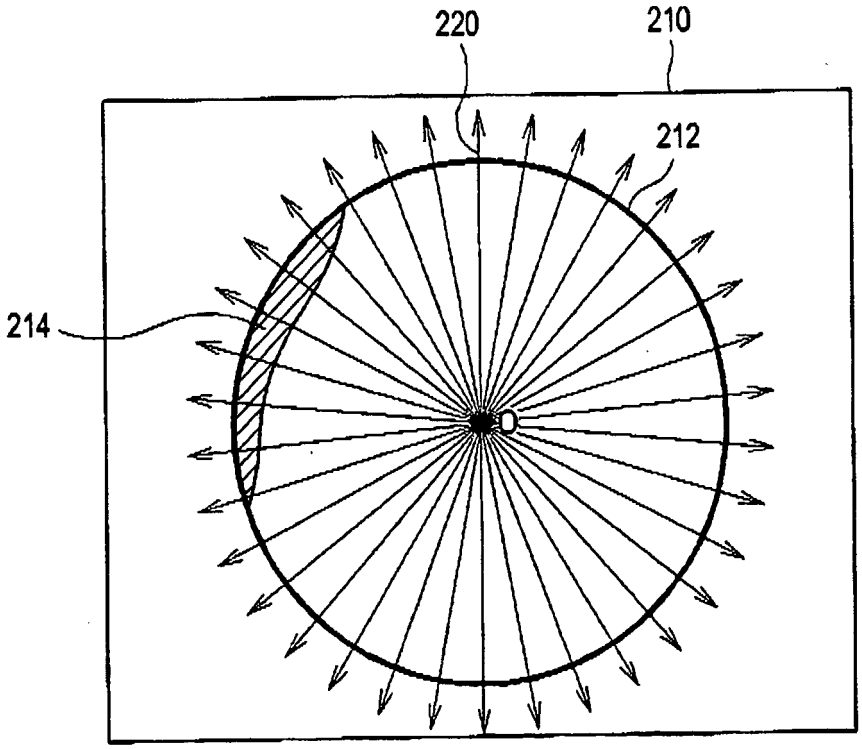


FIG. 7

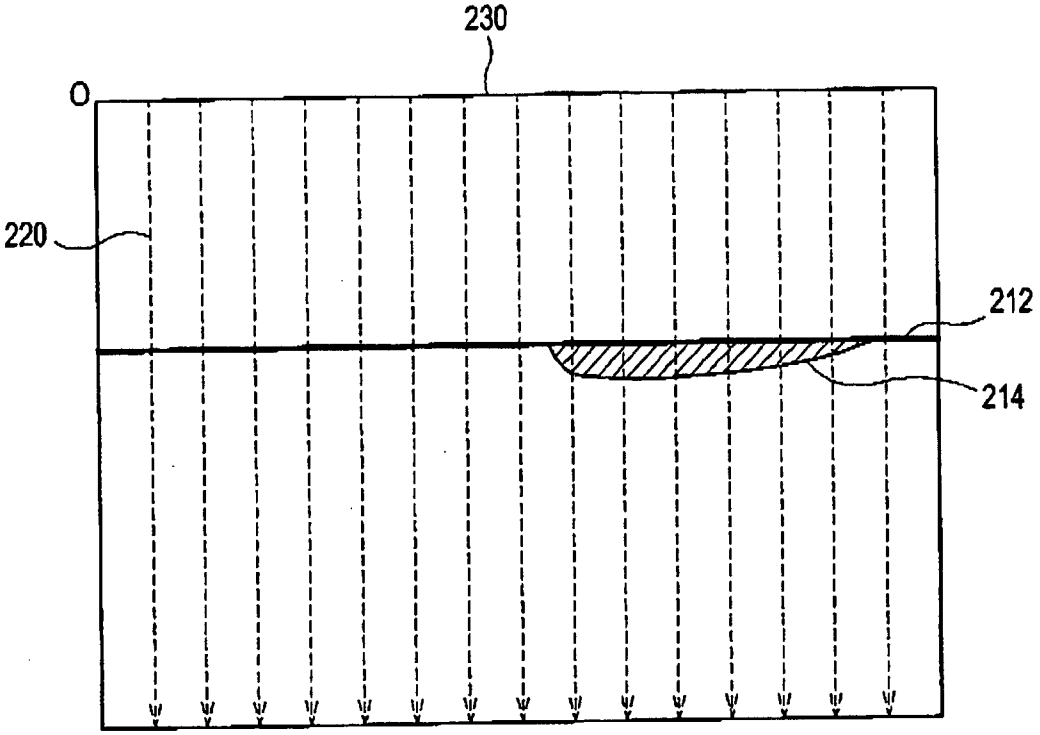


FIG. 8

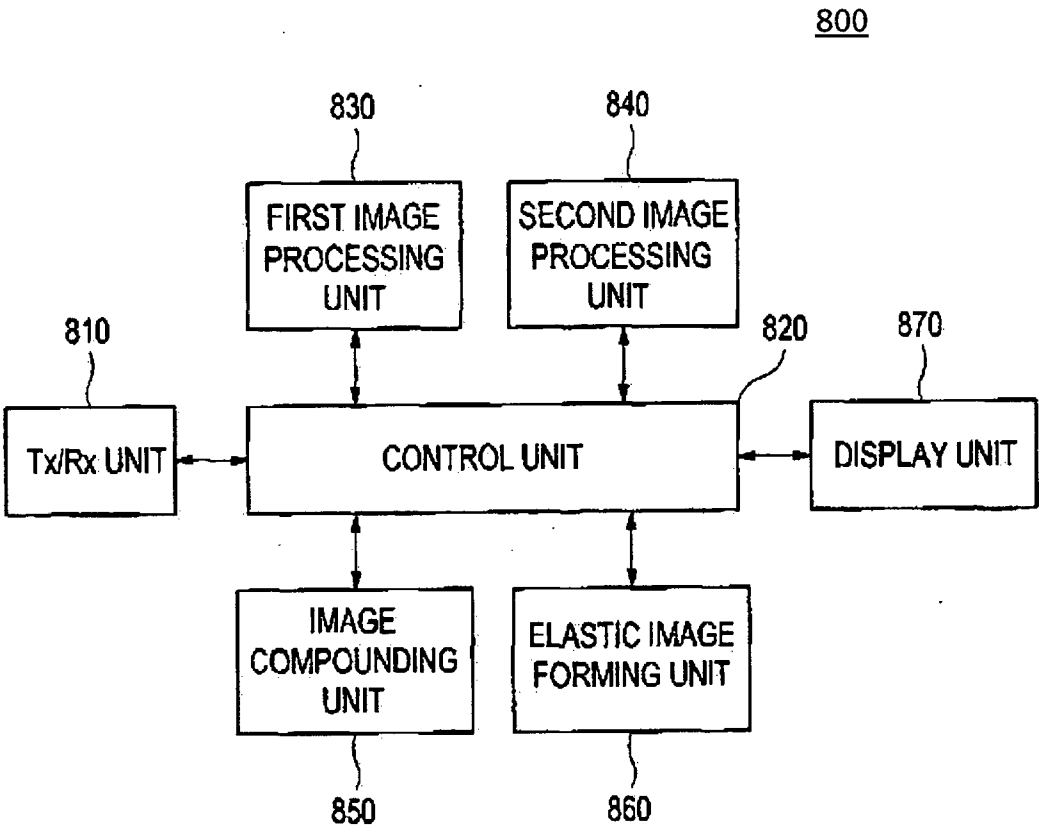

800
830
840
FIRST IMAGE PROCESSING UNIT
SECOND IMAGE PROCESSING UNIT
810
820
870
Tx/Rx UNIT
CONTROL UNIT
DISPLAY UNIT
IMAGE COMPOUNDING UNIT
ELASTIC IMAGE FORMING UNIT
850
860

FIG. 9

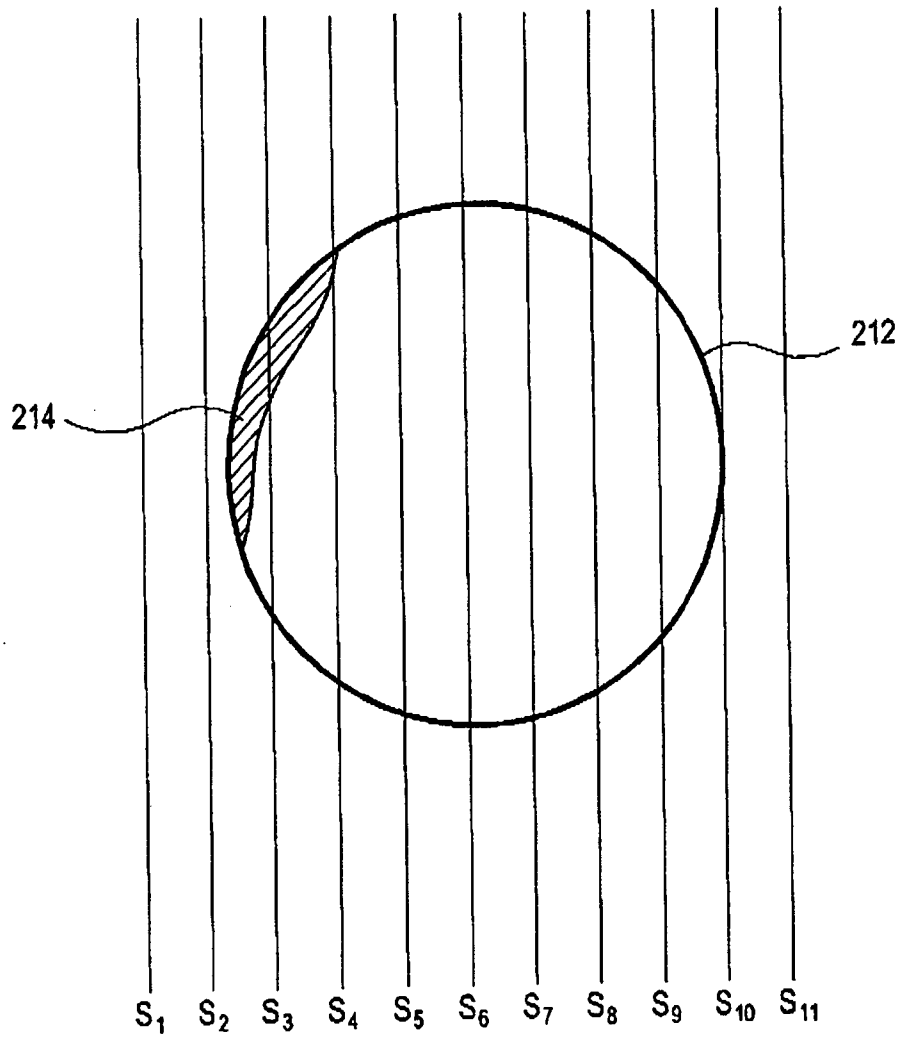


FIG. 10

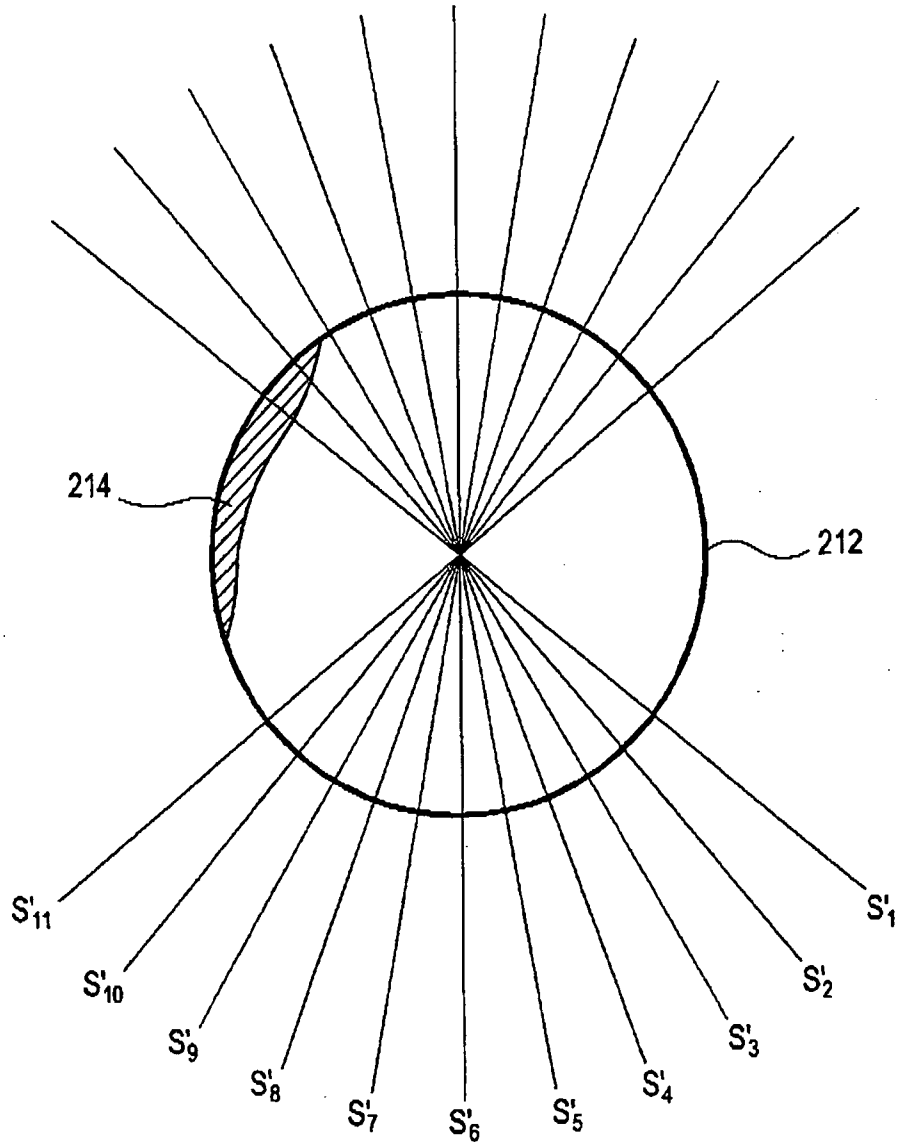


FIG. 11

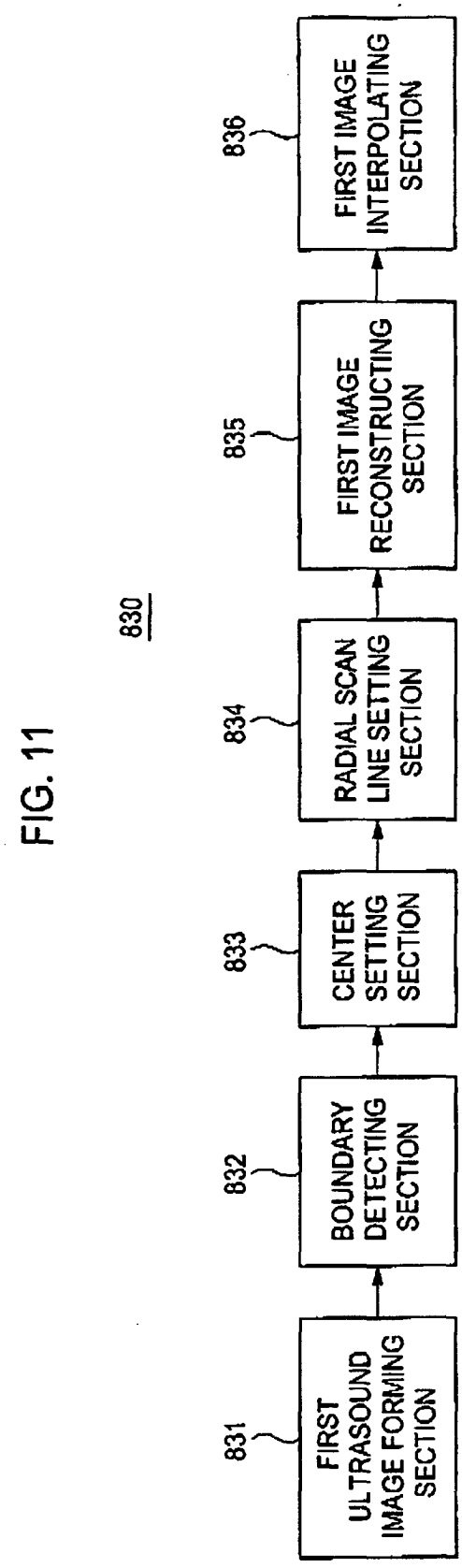

830
831
FIRST ULTRASOUND IMAGE FORMING SECTION
832
BOUNDARY DETECTING SECTION
833
CENTER SETTING SECTION
834
RADIAL SCAN LINE SETTING SECTION
835
FIRST IMAGE RECONSTRUCTING SECTION
836
FIRST IMAGE INTERPOLATING SECTION

FIG. 12

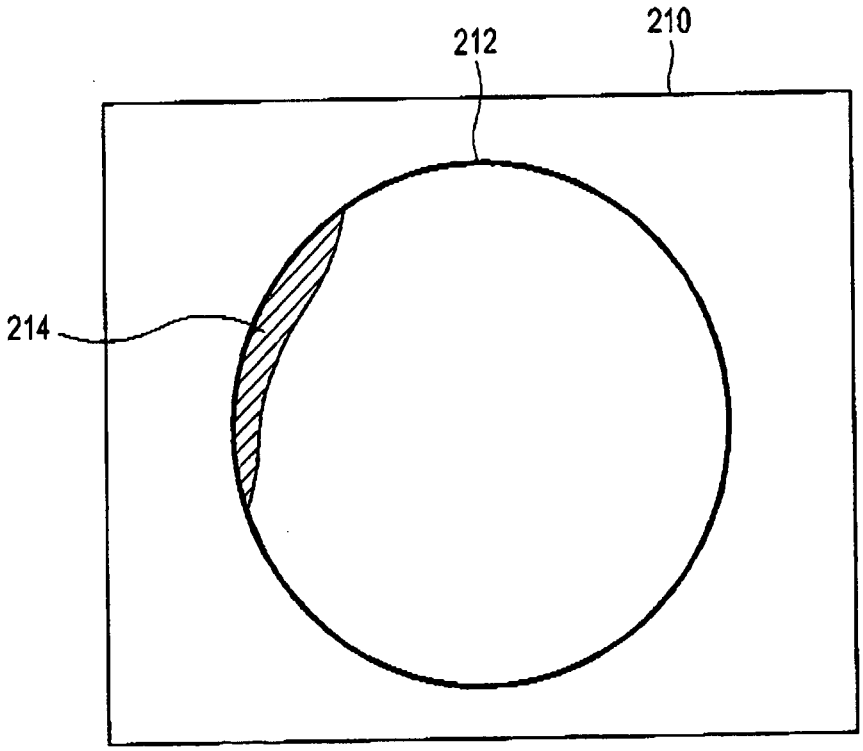
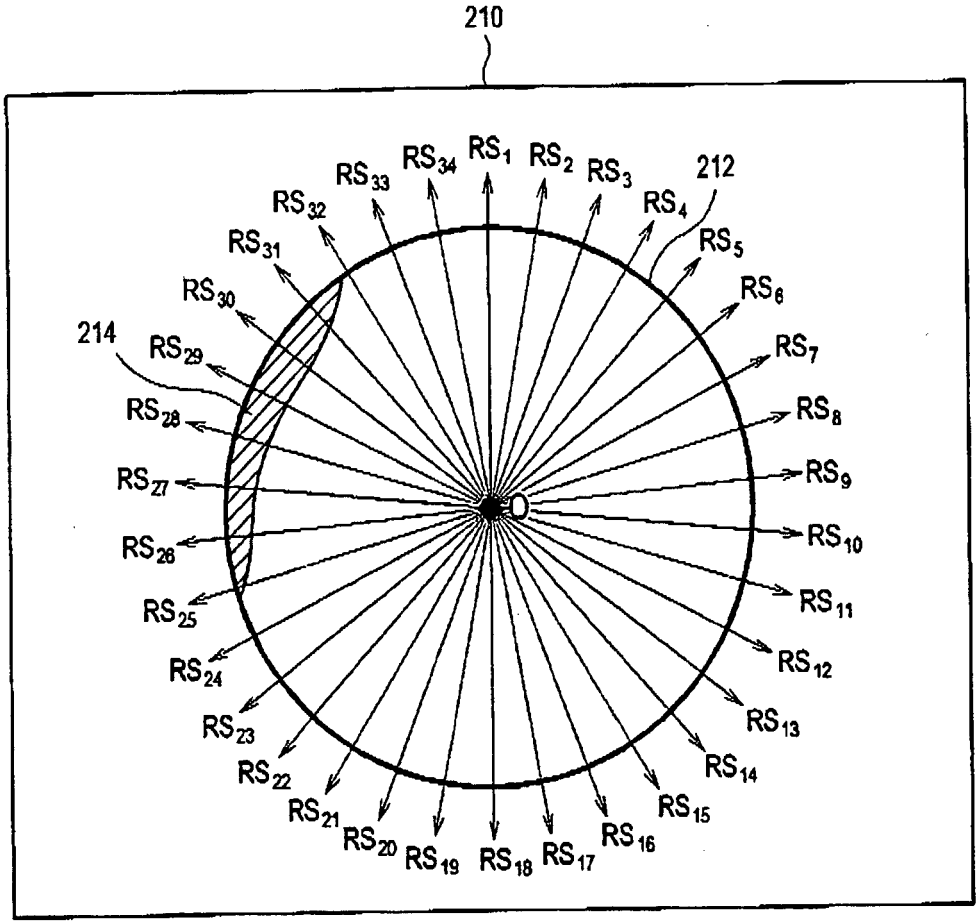


FIG. 13


210
212
214
RS1
RS2
RS3
RS4
RS5
RS6
RS7
RS8
RS9
RS10
RS11
RS12
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RS21
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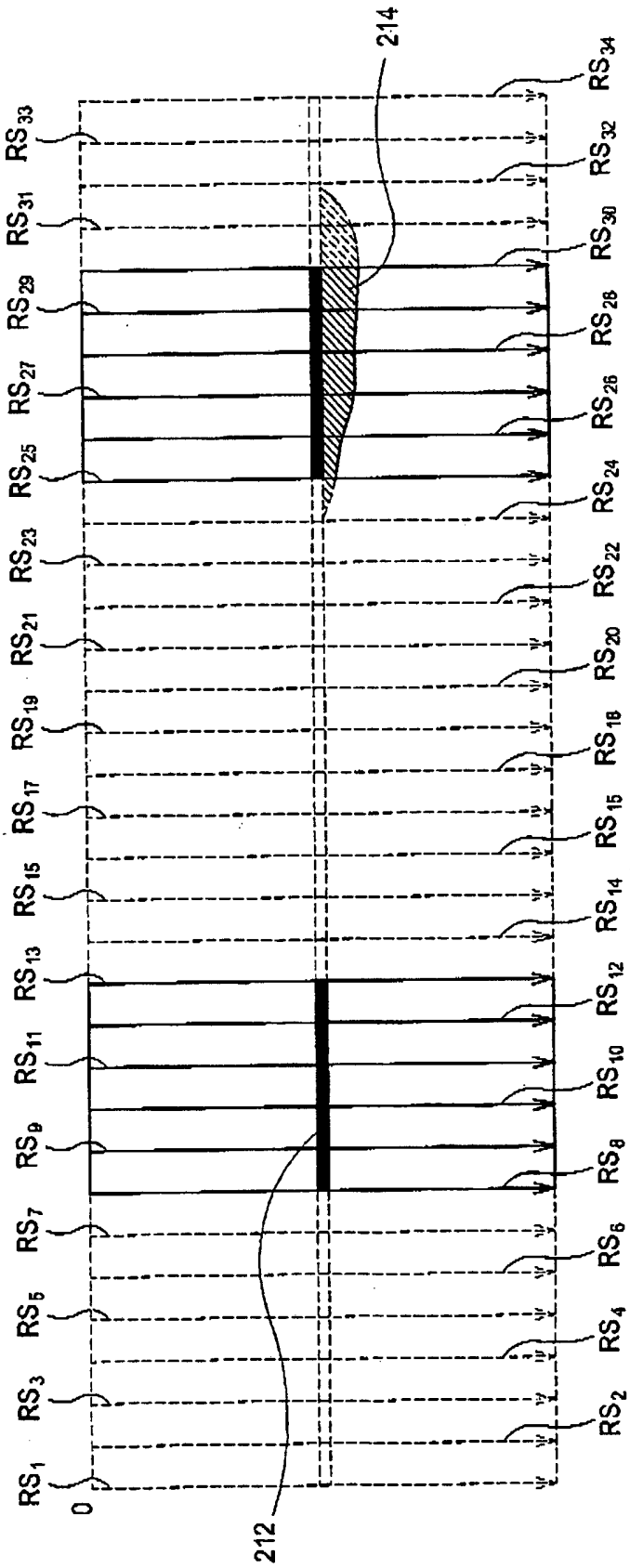
RS32
RS33
RS34

FIG. 14


214
RS34
RS33
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RS30
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RS28
RS27
RS26
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RS24
RS23
RS22
RS21
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RS19
RS18
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RS16
RS15
RS14
RS13
RS12
RS11
RS10
RS9
RS8
RS7
RS6
RS5
RS4
RS3
RS2
RS1
0
212

FIG. 15

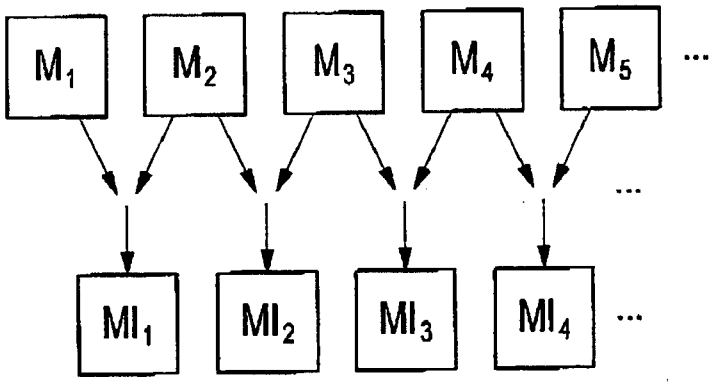


FIG. 16

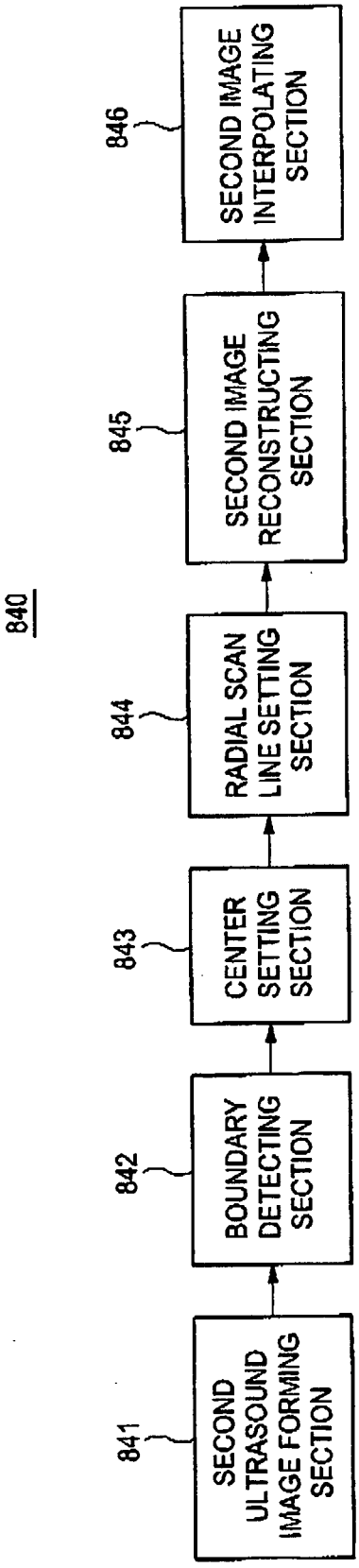

840
841
SECOND ULTRASOUND IMAGE FORMING SECTION
842
BOUNDARY DETECTING SECTION
843
CENTER SETTING SECTION
844
RADIAL SCAN LINE SETTING SECTION
845
SECOND IMAGE RECONSTRUCTING SECTION
846
SECOND IMAGE INTERPOLATING SECTION

FIG. 17

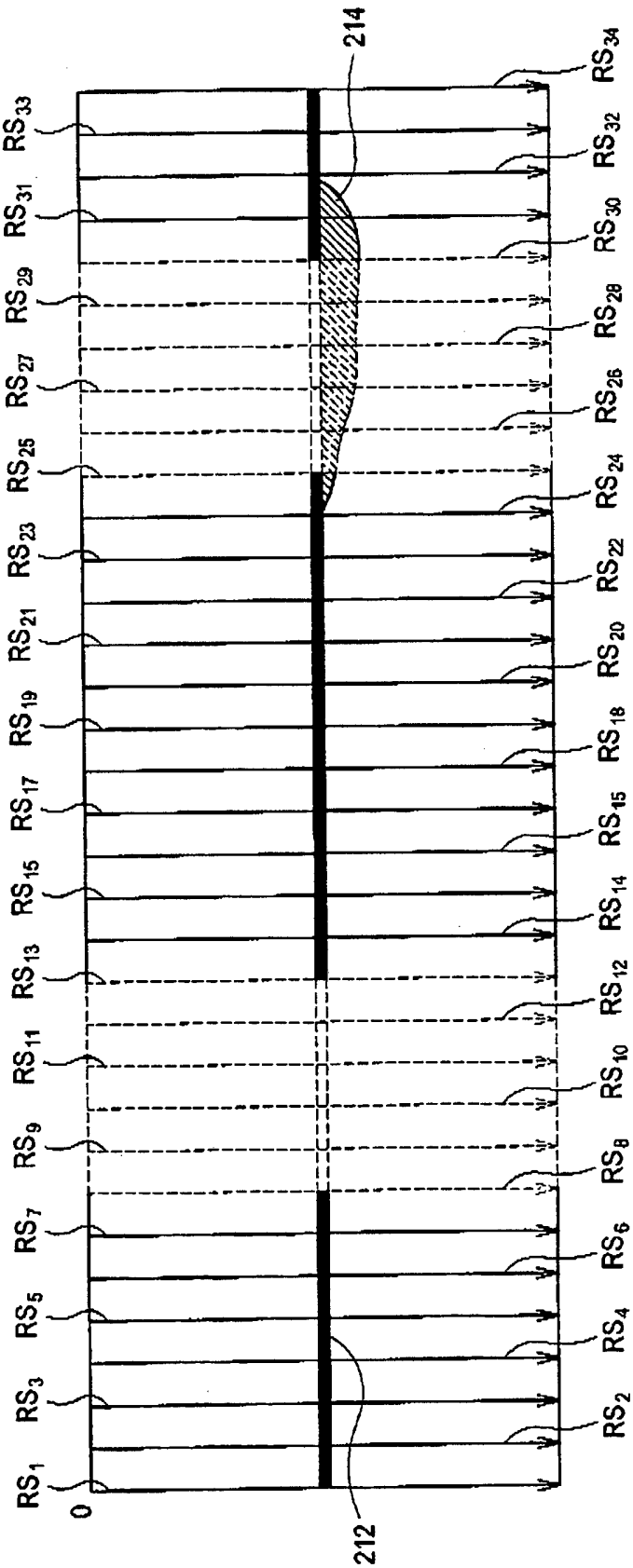

240
214
212
0
RS1
RS2
RS3
RS4
RS5
RS6
RS7
RS8
RS9
RS10
RS11
RS12
RS13
RS14
RS15
RS17
RS18
RS19
RS20
RS21
RS22
RS23
RS24
RS25
RS26
RS27
RS28
RS29
RS30
RS31
RS32
RS33
RS34

FIG. 18

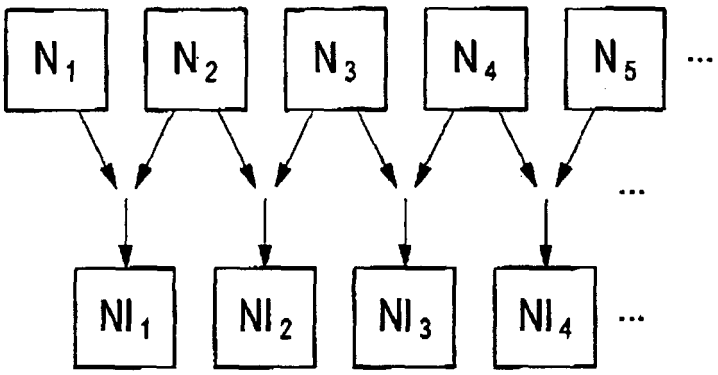


FIG. 19

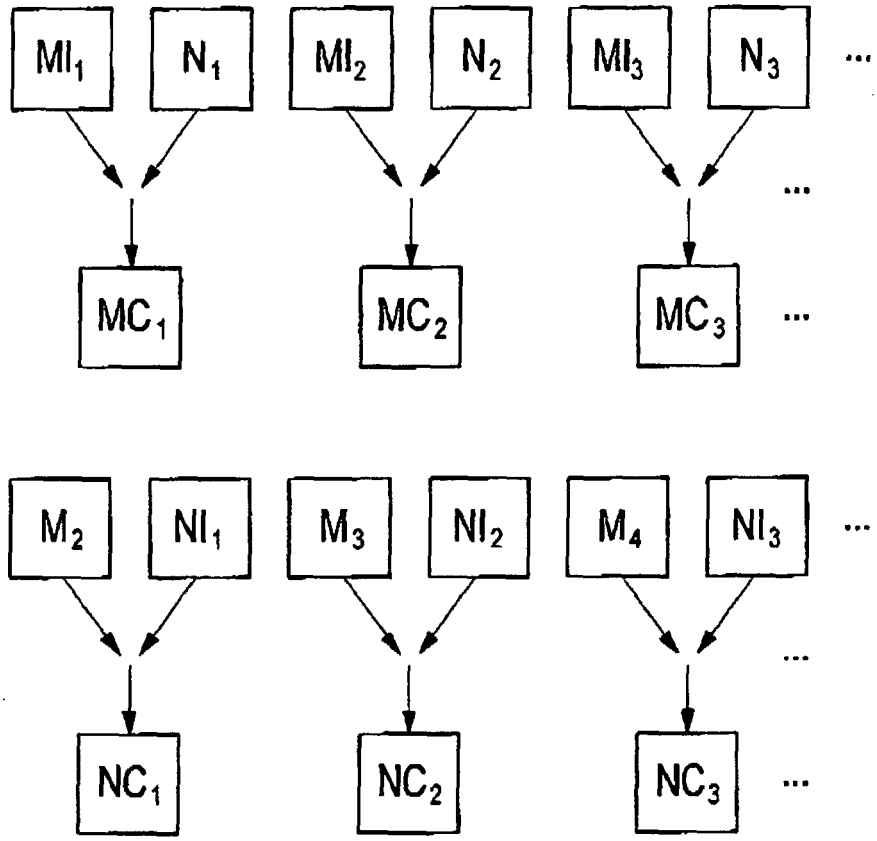


FIG. 20

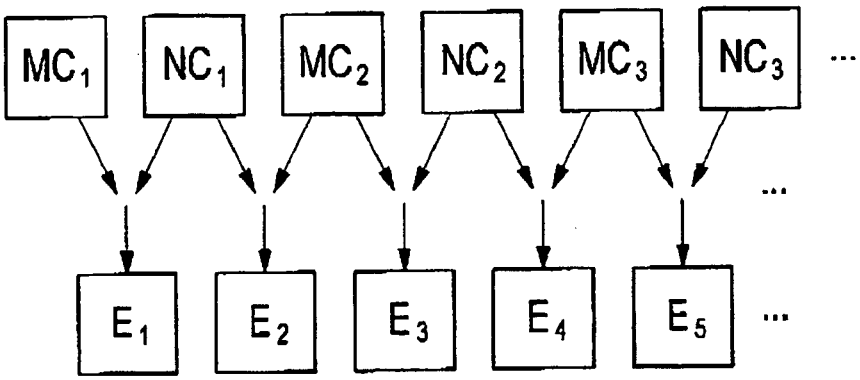

MC1
NC1
MC2
NC2
MC3
NC3
E1
E2
E3
E4
E5

FIG. 21

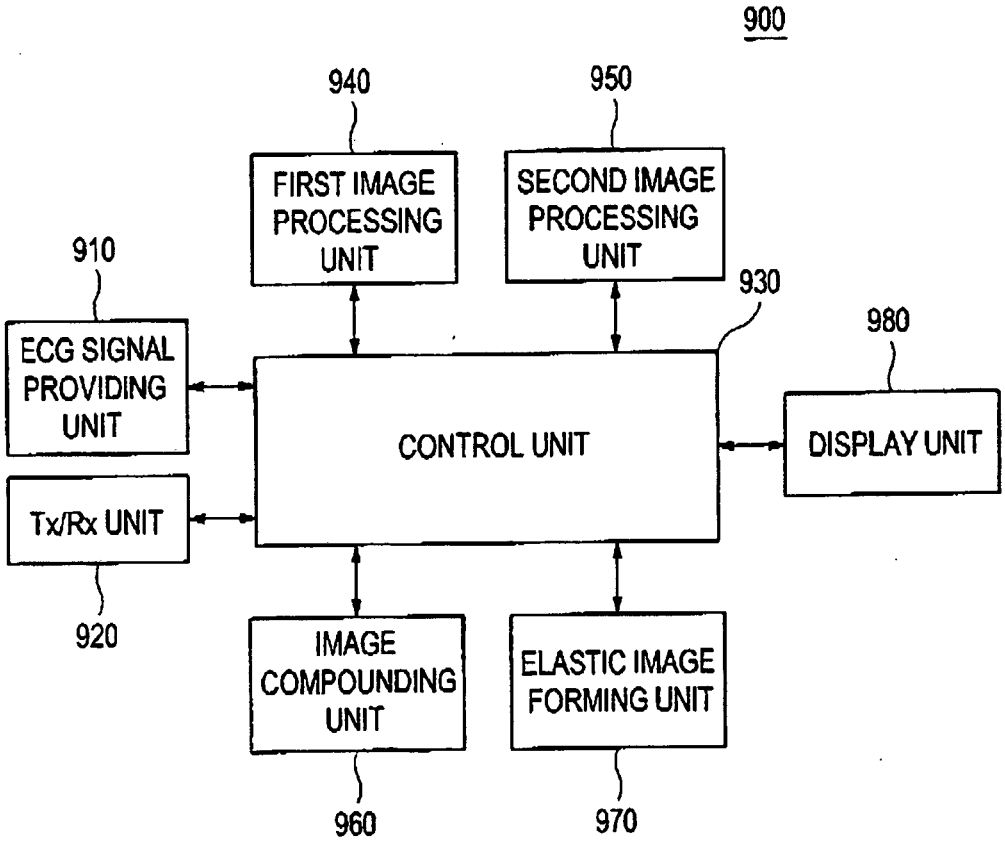

900
940
950
FIRST IMAGE PROCESSING UNIT
SECOND IMAGE PROCESSING UNIT
910
930
980
ECG SIGNAL PROVIDING UNIT
CONTROL UNIT
DISPLAY UNIT
Tx/Rx UNIT
920
IMAGE COMPOUNDING UNIT
ELASTIC IMAGE FORMING UNIT
960
970

FIG. 22

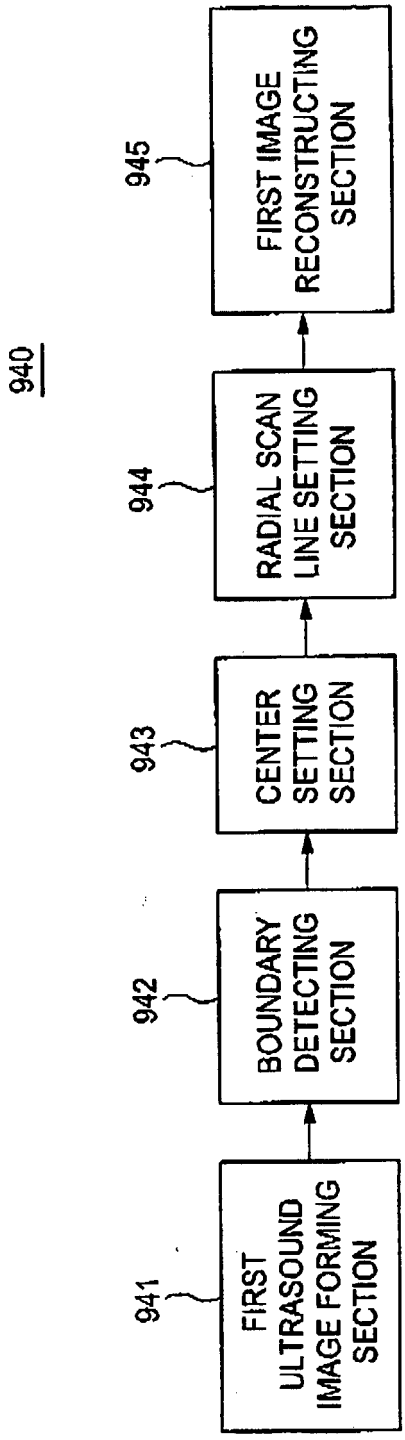

940
941
FIRST ULTRASOUND IMAGE FORMING SECTION
942
BOUNDARY DETECTING SECTION
943
CENTER SETTING SECTION
944
RADIAL SCAN LINE SETTING SECTION
945
FIRST IMAGE RECONSTRUCTING SECTION

FIG. 23

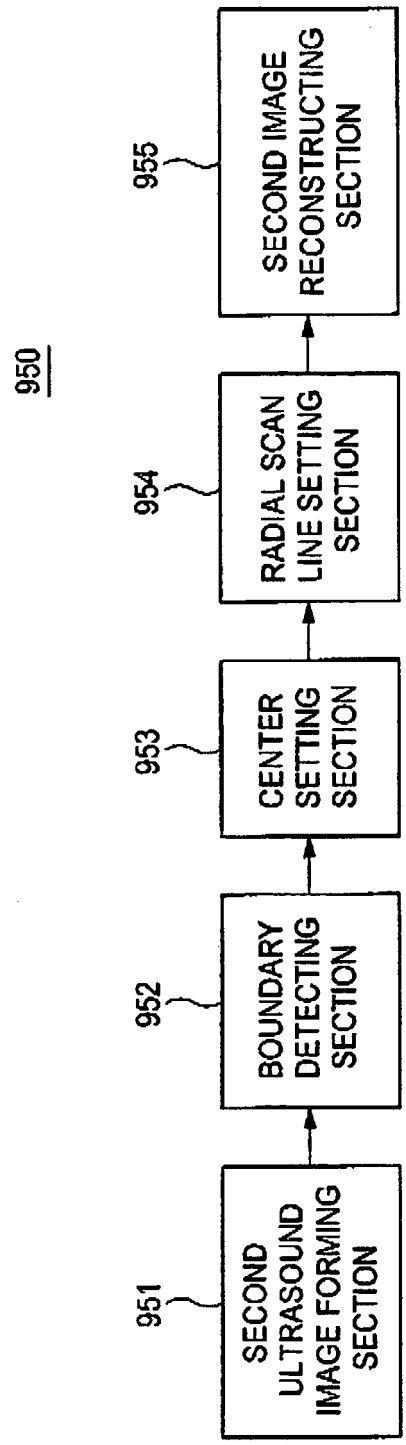
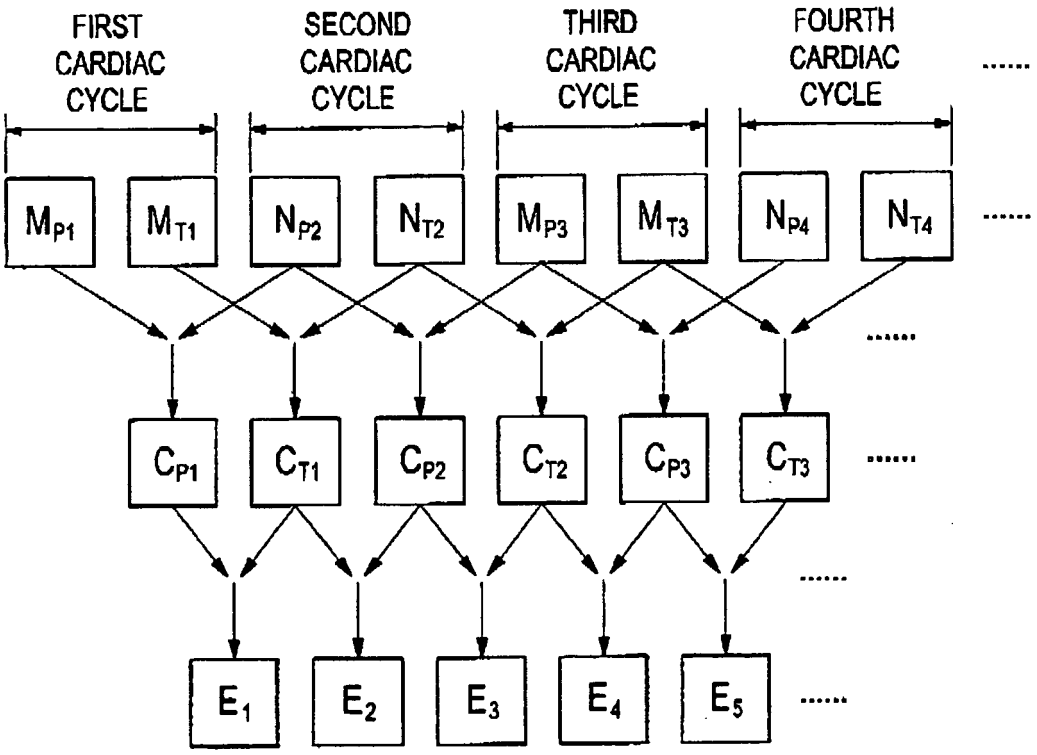

950
951
SECOND ULTRASOUND IMAGE FORMING SECTION
952
BOUNDARY DETECTING SECTION
953
CENTER SETTING SECTION
954
RADIAL SCAN LINE SETTING SECTION
955
SECOND IMAGE RECONSTRUCTING SECTION

FIG. 24


FIRST CARDIAC CYCLE
SECOND CARDIAC CYCLE
THIRD CARDIAC CYCLE
FOURTH CARDIAC CYCLE
.....
$M_{P1}$
$M_{T1}$
$N_{P2}$
$N_{T2}$
$M_{P3}$
$M_{T3}$
$N_{P4}$
$N_{T4}$
$C_{P1}$
$C_{T1}$
$C_{P2}$
$C_{T2}$
$C_{P3}$
$C_{T3}$
$E_1$
$E_2$
$E_3$
$E_4$
$E_5$

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


- US 5615680 A **[0005]**
- WO 9917660 A1 **[0006]**

| | | | |
|---|---|---|---|
| 专利名称(译) | 在超声系统中形成弹性图像 | | |
| 公开(公告)号 | EP2107389B1 | 公开(公告)日 | 2014-05-14 |
| 申请号 | EP2009004659 | 申请日 | 2009-03-31 |
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| IPC分类号 | A61B5/02 G01S7/52 A61B8/08 | | |
| CPC分类号 | G01S7/52046 A61B5/02007 A61B8/0833 A61B8/0858 A61B8/485 A61B8/543 G01S7/52034 G01S7/52042 G01S7/52085 | | |
| 代理机构(译) | LORENZ，MARKUS | | |
| 优先权 | 1020080030913 2008-04-02 KR<br>1020080030921 2008-04-02 KR<br>1020080030918 2008-04-02 KR | | |
| 其他公开文献 | EP2107389A3<br>EP2107389A2 | | |
| 外部链接 | Espacenet | | |


摘要(译)

公开了用于在超声系统中形成弹性图像的实施例。在一个实施例中，Tx / Rx单元沿着目标对象中的扫描线重复地发送/接收超声波束，以输出接收信号。图像处理单元基于接收信号形成多个连续的超声图像，并且在每个超声图像上设置目标对象的中心。图像处理单元还在每个超声图像上相对于中心在径向方向上设置径向扫描线，并重建超声图像，使得径向扫描线彼此平行以形成重建图像。弹性图像形成单元基于重建图像形成弹性图像。


FIG. 1