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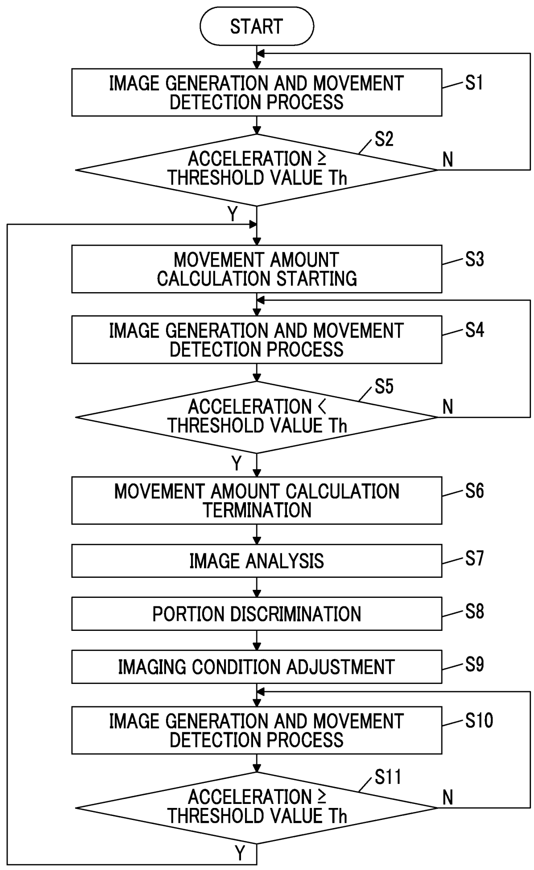
(54) **ULTRASONIC DIAGNOSTIC APPARATUS AND CONTROL METHOD OF ULTRASONIC DIAGNOSTIC APPARATUS**

(57) Provided is an ultrasound diagnostic apparatus including an ultrasound probe; an imaging section that generates an ultrasound image on the basis of a reception signal output from the ultrasound probe; an image analysis section that performs image analysis using the ultrasound image generated by the imaging section; a movement detection sensor that is attached to the ultrasound probe and detects a movement of the ultrasound probe to output the movement as a detection signal; a movement amount calculation section that calculates a movement direction and a movement distance of the ultrasound probe in a case where the ultrasound probe is moved from a first inspection portion where inspection is terminated among the plurality of inspection portions to a second inspection portion that is the next inspection target, using the detection signal output from the movement detection sensor; and a portion discrimination section that discriminates the second inspection portion on the basis of an image analysis result in the image analysis section and the movement direction and the movement distance of the ultrasound probe calculated by the movement amount calculation section.

FIG. 5



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an ultrasound diagnostic apparatus and a control method of the ultrasound diagnostic apparatus, and more particularly, to an ultrasound diagnostic apparatus that discriminates an inspection portion that is currently being imaged.

2. Description of the Related Art

[0002] In the related art, an ultrasound diagnostic apparatus that uses an ultrasound image has been put to practical use in a medical field. Generally, such an ultrasound diagnostic apparatus operates an ultrasound beam into a subject from an ultrasound probe in which an array transducer is provided, receives an ultrasound echo from the subject using the ultrasound probe to output a reception signal, and electrically processes the reception signal to generate an ultrasound image.

[0003] In a case where a plurality of inspection portions of the subject are diagnosed using such an ultrasound image, in order to obtain ultrasound images suitable for diagnosis with respect to the respective inspection portions, it is necessary to set different appropriate imaging conditions in accordance with the inspection portions. In this regard, for example, JP-H4-224738A (JP1992-224738A) discloses an ultrasound diagnostic apparatus that automatically discriminates an inspection portion from a generated ultrasound image through a pattern matching process and sets imaging conditions suitable for the inspection portion on the basis of the discrimination result.

SUMMARY OF THE INVENTION

[0004] However, since an ultrasound image is changed due to various causes such as a difference between shapes of inspection portions and a difference between dynamic ranges or brightnesses due to a difference between passage easinesses of ultrasound for the inspection portions, there is a concern that the inspection portions may be mistakenly discriminated only using the discrimination of the inspection portions based on the ultrasound image. In this case, there is a concern that inappropriate imaging conditions may be set on the basis of the mistaken discrimination result and an ultrasound image with a low image quality may be generated to cause an error in diagnosis.

[0005] The invention has been made in consideration of the problems in the related art, and an object of the invention is to provide an ultrasound diagnostic apparatus and a control method of the ultrasound diagnostic apparatus capable of accurately discriminating an inspection portion.

[0006] According to an aspect of the invention, there is provided an ultrasound diagnostic apparatus that sequentially inspects a plurality of inspection portions of a subject, comprising: an ultrasound probe; an imaging section that performs transmission and reception of an ultrasound beam between the ultrasound probe and the subject and generates an ultrasound image on the basis of a reception signal output from the ultrasound probe; an image analysis section that performs image analysis using the ultrasound image generated by the imaging section; a movement detection sensor that is attached to the ultrasound probe and detects a movement of the ultrasound probe to output the movement as a detection signal; a movement amount calculation section that calculates a movement direction and a movement distance of the ultrasound probe in a case where the ultrasound probe is moved from a first inspection portion where inspection is terminated among the plurality of inspection portions to a second inspection portion that is the next inspection target, using the detection signal output from the movement detection sensor; and a portion discrimination section that discriminates the second inspection portion on the basis of an image analysis result in the image analysis section and the movement direction and the movement distance calculated by the movement amount calculation section.

[0007] The portion discrimination section may integrate the image analysis result in the image analysis section and the movement direction and the movement distance calculated by the movement amount calculation section to discriminate the second inspection portion.

[0008] Further, the portion discrimination section may narrow down the plurality of inspection portions that are targets of the image analysis, on the basis of the movement direction and the movement distance calculated by the movement amount calculation section, and the image analysis section may perform the image analysis with respect to the inspection portions narrowed down by the portion discrimination section, and the portion discrimination section may discriminate the second inspection portion using the image analysis result in the image analysis section.

[0009] Further, the portion discrimination section may determine an analysis order for performing the image analysis with respect to the plurality of inspection portions, on the basis of the movement direction and the movement distance calculated by the movement amount calculation section, the image analysis section may sequentially perform the image analysis with respect to the plurality of inspection portions in accordance with the analysis order determined by the portion discrimination section, and the portion discrimination section may discriminate the second inspection portion using the image analysis result in the image analysis section.

[0010] The ultrasound diagnostic apparatus may further comprise: a movement amount reference value memory in which a plurality of movement amount reference values relating to the movement direction and the movement distance of the ultrasound probe in a case where the ultrasound probe is moved between the plurality of inspection portions are stored in advance. The portion discrimination section may read out the plurality of movement amount reference values from the movement amount reference value memory, compares each of the plurality of read-out movement amount reference values with the movement direction and the movement distance calculated by the movement amount calculation section, and may discriminate the second inspection portion on the basis of the comparison result and the image analysis result in the image analysis section.

[0011] Further, it is preferable that the portion discrimination section corrects the plurality of movement amount reference values in accordance with differences between the movement direction and the movement distance calculated by the movement amount calculation section and used when the second inspection portion is discriminated and the movement amount reference values used when the second inspection portion is discriminated, and uses the plurality of corrected movement amount reference values in discriminating an inspection portion that becomes a next inspection target subsequent to the second inspection portion.

[0012] The ultrasound diagnostic apparatus may further comprise: a subject reference value memory in which a plurality of subject reference values relating to the movement direction and the movement distance in a case where the ultrasound probe is moved between the plurality of inspection portions for each subject are stored in advance. The portion discrimination section may read out the subject reference values corresponding the subject from the subject reference value memory, may compare the read-out subject reference values with the movement direction and the movement distance calculated by the movement amount calculation section, and may discriminate the second inspection portion on the basis of the comparison result and the image analysis result in the image analysis section.

[0013] The movement amount calculation section may detect an acceleration of the ultrasound probe using the detection signal output from the movement detection sensor, and may calculate the movement direction and the movement distance of the ultrasound probe from a time when the detected acceleration becomes equal to or larger than a predetermined threshold value to a time when the detected acceleration becomes smaller than the predetermined threshold value.

[0014] Further, the ultrasound diagnostic apparatus may further comprise: a probe state determination section that determines whether the ultrasound probe is in an air radiation state or in a contact state with respect to the subject. The movement amount calculation section may calculate the movement direction and the movement distance of the ultrasound probe from a time when it is determined by the probe state determination section that the ultrasound probe transitions from the contact state with respect to the subject to the air radiation state to a time when it is determined by the probe state determination section that the ultrasound probe transitions from the air radiation state to the contact state with respect to the subject.

[0015] The ultrasound diagnostic apparatus may further comprise: an imaging condition setting section that sets an imaging condition corresponding to the second inspection portion discriminated by the portion discrimination section, and the imaging section may generate the ultrasound image in accordance with the imaging condition set by the imaging condition setting section.

[0016] It is preferable that the movement detection sensor is formed by an acceleration sensor, a gyro sensor, a magnetic sensor, or a GPS sensor.

[0017] According to an aspect of the invention, there is provided a control method of an ultrasound diagnostic apparatus that sequentially inspects a plurality of inspection portions of a subject, comprising: performing transmission and reception of an ultrasound beam between an ultrasound probe and the subject, and generating an ultrasound image on the basis of a reception signal output from the ultrasound probe; performing image analysis using the generated ultrasound image; detecting a movement of the ultrasound probe to output the movement as a detection signal; calculating a movement direction and a movement distance of the ultrasound probe in a case where the ultrasound probe is moved from a first inspection portion where inspection is terminated among the plurality of inspection portions to a second inspection portion that is the next inspection target, using the output detection signal; and discriminating the second inspection portion on the basis of an image analysis result and the calculated movement direction and movement distance.

[0018] According to the invention, since the ultrasound diagnostic apparatus that sequentially inspects a plurality of inspection portions of a subject comprises an ultrasound probe; an imaging section that performs transmission and reception of an ultrasound beam between a subject and the ultrasound probe and generates an ultrasound image on the basis of a reception signal output from the ultrasound probe; an image analysis section that performs image analysis using the ultrasound image generated by the imaging section; a movement detection sensor that is attached to the ultrasound probe and detects a movement of the ultrasound probe to output the movement as a detection signal; a movement amount calculation section that calculates a movement direction and a movement distance of the ultrasound probe in a case where the ultrasound probe is moved from a first inspection portion where inspection is terminated among the plurality of inspection portions to a second inspection portion that is the next inspection target, using the detection signal output from the movement detection sensor; and a portion discrimination section that discriminates the second inspection portion on the basis of an image analysis result in the image analysis section and the movement direction and the movement distance calculated by the movement amount calculation section, it is possible to accurately discriminate an inspection portion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Fig. 1 is a diagram showing a configuration of ultrasound diagnostic apparatus according to Embodiment 1 of the invention.
Fig. 2 is a diagram showing a configuration of a reception section.
Fig. 3 is a diagram showing a configuration of an image processing section.
Fig. 4 is a diagram showing an example of a movement direction and a movement distance of an ultrasound probe.
Fig. 5 is a flowchart showing an operation of Embodiment 1.
Fig. 6 is a flowchart showing operations of an image generation process and a movement detection process.
Fig. 7 is a diagram showing an example of an ultrasound image of a left lung.
Fig. 8 is a diagram showing an example of an ultrasound image of a left abdomen.
Fig. 9 is a diagram showing a configuration of ultrasound diagnosis apparatus according to Embodiment 5.
Fig. 10 is a diagram showing a configuration of ultrasound diagnosis apparatus according to Embodiment 6.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] Hereinafter, embodiments of the invention will be described on the basis of the accompanying drawings.

Embodiment 1

[0021] Fig. 1 shows a configuration of an ultrasound diagnostic apparatus according to Embodiment 1. The ultrasound diagnostic apparatus comprises an ultrasound probe 1 in which an array transducer 1A is provided, an image generation section 3 that is connected to the ultrasound probe 1 through a transmission/reception section 2, and a display section 5 that is connected to the image generation section 3 through a display controller 4.

[0022] The transmission/reception section 2 includes a reception section 6 and a transmission section 7 that are connected to the array transducer 1A, and a transmission/reception controller 8 that is connected to the reception section 6 and the transmission section 7. The image generation section 3 includes an image processing section 9 and a digital scan converter (DSC) 10 that is connected to the image processing section 9. The display controller 4 is connected to the DSC 10. Further, an image analysis section 11 is connected to the DSC 10, and a portion discrimination section 12 is connected to the image analysis section 11.

[0023] An imaging condition setting section 13 is connected to the transmission/reception controller 8 of the transmission/reception section 2, and the image processing section 9 and the DSC 10 of the image generation section 3.

[0024] A movement detection sensor 14 is attached to the ultrasound probe 1, and a movement amount calculation section 15 is connected to the movement detection sensor 14. Further, the portion discrimination section 12 is also connected to the movement amount calculation section 15.

[0025] An apparatus controller 16 is connected to the display controller 4, the image analysis section 11, the portion discrimination section 12, the imaging condition setting section 13, and the movement amount calculation section 15. Further, an operation section 17, a storage section 18, and a movement amount reference value memory 19 are respectively connected to the apparatus controller 16.

[0026] The array transducer 1A of the ultrasound probe 1 includes a plurality of ultrasound transducers that are arranged in one dimension or two dimensions. Each of the ultrasound transducers transmits ultrasound in accordance with a drive signal supplied from the transmission section 7, and receives an ultrasound echo from a subject to output a reception signal. Each ultrasound transducer is formed using a vibrator in which electrodes are formed on opposite ends of a piezoelectric body formed of piezoelectric ceramics represented as lead zirconate titanate (PZT), a high polymer piezoelectric element represented as polyvinylidene fluoride (PVDF), piezoelectric crystals represented as magnesium niobate-lead titanate solute (PMN-PT), or the like.

[0027] In a case where a pulse-shaped voltage or a continuous wave voltage is applied to the electrodes of the vibrator, the piezoelectric body expands and contracts, a pulse-shaped ultrasound or a continuous wave ultrasound is generated from each vibrator, and an ultrasound beam is formed by synthesis of the ultrasounds. Further, each vibrator receives a propagating ultrasound to stretch and compresses to generate an electric signal, and the electric signal is output as an ultrasound reception signal.

[0028] The transmission/reception section 2 performs transmission and reception of an ultrasound beam in accordance with a set ultrasound beam scanning condition, and the image generation section 3 generates an ultrasound image signal in accordance with the set ultrasound image generation condition. The transmission/reception section 2 and the image generation section 3 form an imaging section.

[0029] The reception section 6 of the transmission/reception section 2 has a configuration in which an amplification section 20 and an analogue/digital (A/D) conversion section 21 are sequentially connected in series, as shown in Fig. 2. The reception section 6 amplifies a reception signal transmitted from each ultrasound transducer of the array transducer 1A using the amplification section 20, and performs A/D conversion with respect to the amplified signal using the A/D conversion section 21 to generate digital reception data.

[0030] The transmission/reception controller 8 controls the reception section 6 and the transmission section 7 so that transmission of ultrasound pulses to a subject and reception of ultrasound echoes from the subject are repeated at a pulse repetition frequency (PRF) interval, on the basis of various control signals transmitted from the apparatus controller 16.

[0031] The image processing section 9 of the image generation section 3 has a configuration in which a beam former 22 and a signal processing section 23 are sequentially connected in series, as shown in Fig. 3. The beam former 22 assigns a delay to each piece of reception data output from the reception section 6 of the transmission/reception section 2 in accordance with sound velocities set on the basis of a reception delay pattern selected in accordance with control signals from the imaging condition setting section 13 or a distribution of the sound velocities and adds up the results to perform a reception focus process. Through the reception focus process, a sound ray signal in which focuses of ultrasound echoes after phasing addition are narrowed down is generated.

[0032] The signal processing section 23 corrects attenuation due to a distance in accordance with a depth of a reflecting position of ultrasound with respect to a sound ray signal generated by the beam former 22, and then, performs an envelope detection process and performs a variety of necessary image processing such as a gradation process, to thereby generate an ultrasound image signal that is tomographic image information of a tissue in a subject.

[0033] As the ultrasound image, for example, a brightness mode (B mode) image, a motion mode (M mode) image, a color Doppler imaging, or the like may be used Further, a sound velocity map indicating a distribution of sound velocities, or an elasticity map indicating a distribution of elasticities indicating smoothness or the like of a tissue in a subject may be used as the ultrasound image.

[0034] The DSC 10 of the image generation section 3 converts an ultrasound image signal generated by the signal processing section 23 of the image processing section 9 into an image signal based on a scanning method of a general television signal (raster conversion).

[0035] The display section 5 includes a display device such as a liquid crystal display (LCD), for example, and displays an ultrasound image under the control of the display controller 4.

[0036] The image analysis section 11 performs image analysis using an ultrasound image from the DSC 10, and outputs the image analysis result to the portion discrimination section 12. For example, a feature of the ultrasound image such as a brightness or an edge of the ultrasound image is detected. Further, in a case where a B mode image signal or an M mode image signal is used, the image analysis may be performed on the basis of a known pattern recognition method such as machine learning, template matching, or texture analysis. In addition, in a case where a color Doppler image signal, a sound velocity map or an elasticity map is used, the image analysis may be performed on the basis of a known method such as color information analysis.

[0037] The movement detection sensor 14 is attached to the ultrasound probe 1, and detects a movement of the ultrasound probe 1 in a case where the ultrasound probe 1 is operated by an operator and outputs the movement of the ultrasound probe 1 to the movement amount calculation section 15 as a detection signal. The movement detection sensor 14 is not particularly limited as long as it is possible to detect the movement or position of the ultrasound probe 1, and for example, may be formed by an acceleration sensor, a gyro sensor, a magnetic sensor, a GPS sensor, or other sensors capable of detecting a movement. Further, in order to more accurately detect the movement of the ultrasound probe 1, plural sensors among the above-mentioned sensors may be used in combination.

[0038] As inspection portions of the subject, for example, in a case where an extended focused assessment with sonography for trauma (eFAST) inspection for sequentially inspecting a plurality of inspection portions is considered, the left lung, the right lung, the heart, the left abdomen, the right abdomen, and the bladder, and the like may be used. Portions other than the plurality of inspection portions may be added. Here, among the plurality of inspection portions of the subject, an inspection portion for which inspection is terminated is defined as a first inspection portion. Further, an inspection portion that becomes a next inspection target subsequent to the first inspection portion is defined as a second inspection portion. The ultrasound probe 1 is moved from the first inspection portion for which the inspection is terminated to the second inspection portion that becomes the next inspection target, through an operation of an operator. Further, the second inspection portion is imaged, and an ultrasound image is generated.

[0039] The movement amount calculation section 15 calculates a movement direction and a movement distance of the ultrasound probe 1 in a case where the ultrasound probe 1 is moved from the first inspection portion to the second inspection portion using a detection signal from the movement detection sensor 14, and outputs the result to the portion discrimination section 12. For example, as shown in Fig. 4, it is assumed that the first inspection portion of the subject is the bladder and the second inspection portion that is the next inspection target is the left lung. Here, for ease of description, a direction that is directed from the bladder to the head is defined as an X direction. The movement amount calculation section 15 calculates a movement distance D in a case where the ultrasound probe 1 is moved from the bladder to the left lung, and calculates an angle A in a clockwise direction with reference to the X direction. In this way, the movement direction and the movement distance in a case where the ultrasound probe 1 is moved from the bladder to the left lung are calculated.

[0040] Since it is considered that between inspection of the first inspection portion and inspection of the second inspection portion, a gel for filling a gap between the subject and the ultrasound probe 1 is assigned, or the ultrasound probe 1 is once placed, it is preferable that the movement distance D is calculated as a linear distance.

[0041] The movement amount reference value memory 19 stores in advance a plurality of movement amount reference values relating to a movement direction and a movement distance of the ultrasound probe 1 in a case where the ultrasound probe 1 is moved between a plurality of inspection portions. For example, as shown in Table 1, with respect to a subject who has an average body type, a plurality of movement amount reference values relating to a movement direction and a movement distance of the ultrasound probe 1 in a case where the ultrasound probe 1 is moved between a plurality of inspection portions such as the left lung, the right lung, the heart, the left abdomen, the right abdomen, and the bladder are stored.

[Table 1]

First inspection portion \ Second inspection portion		Left lung	Right lung	Heart	Left abdomen	Right abdomen	Bladder
Left lung	Movement distance D Angle A		15 cm 270°	10 cm 225°	20 cm 170°	35 cm 225°	40 cm 190°
Right lung	Movement distance D Angle A	15 cm 90°		10 cm 135°	35 cm 135°	20 cm 190°	40 cm 170°
Heart	Movement distance D Angle A	10 cm 45°	10 cm 315°		25 cm 135°	25 cm 225°	30 cm 180°
Left abdomen	Movement distance D Angle A	20 cm 350°	35 cm 315°	25 cm 315°		30 cm 270°	20 cm 225°
Right abdomen	Movement distance D Angle A	35 cm 45°	20 cm 10°	25 cm 45°	30 cm 90°		20 cm 135°
Bladder	Movement distance D Angle A	40 cm 10°	40 cm 350°	30 cm 0°	20 cm 45°	20 cm 315°	

[0042] The portion discrimination section 12 discriminates the second inspection portion that is currently being imaged, on the basis of the image analysis result in the image analysis section 11 and the movement direction and the movement distance of the ultrasound probe 1 calculated by the movement amount calculation section 15, and outputs the portion discrimination results to the apparatus controller 16.

[0043] Specifically, the portion discrimination section 12 reads out a plurality of movement amount reference values from the movement amount reference value memory 19, and compares the plurality of read-out movement amount reference values with the movement direction and the movement distance of the ultrasound probe 1 calculated by the movement amount calculation section 15, respectively. Further, the portion discrimination section 12 combines the comparison result and the image analysis result in the image analysis section 11 to discriminate the second inspection portion. In order to perform the portion discrimination, for example, a support vector machine (SVM) algorithm, a decision tree algorithm, or other known discrimination algorithms may be used.

[0044] In this way, the portion discrimination section 12 may integrate the image analysis result and the movement direction and the movement distance of the ultrasound probe 1 to perform the portion discrimination.

[0045] The apparatus controller 16 outputs the portion discrimination result output from the portion discrimination section 12 to the imaging condition setting section 13.

[0046] Further, the apparatus controller 16 controls the display controller 4, the image analysis section 11, the portion discrimination section 12, the imaging condition setting section 13, and the movement amount calculation section 15 on the basis of commands input through the operation section 17 from the operator.

[0047] The imaging condition setting section 13 sets imaging conditions suitable for the discriminated second inspection portion with respect to the imaging section formed by the transmission/reception section 2 and the image generation section 3, on the basis of the portion discrimination result input from the apparatus controller 16. The imaging conditions include an ultrasound beam scanning condition for the transmission/reception section 2 and an ultrasound image generation condition for the image generation section 3.

[0048] Among the imaging conditions, as the ultrasound beam scanning condition for the transmission/reception section 2, a transmission frequency of an ultrasound beam, a focal position, a display depth, or the like may be used, and as the ultrasound image generation condition for the image generation section 3, a sound velocity, a wave detection condition, a gain, a dynamic range, a gradation curve, a speckle suppression strength, an edge emphasis degree, or the like may be used.

[0049] The operation section 17 is a unit through which an operator performs an input operation, and may be formed by a keyboard, a mouse, a trackball, a touch panel, or the like.

[0050] The storage section 18 stores an operation program or the like, and may be configured using a recording medium such as a hard disk, a flexible disc, a magneto-optical disc (MO), a magnetic tape (MT), a random access memory (RAM), a compact disc read only memory (CD-ROM), a digital versatile disc read only memory (DVD-ROM), a secure digital card (SD card), a compact flash card (CF card), a universal serial bus memory (USB memory), or a server.

[0051] The transmission/reception controller 8 of the transmission/reception section 2, the image generation section 3, the display controller 4, the image analysis section 11, the portion discrimination section 12, the imaging condition setting section 13, the movement amount calculation section 15, and the apparatus controller 16 are configured by a central processing unit (CPU), and an operation program for causing the CPU to execute various processes, and may be configured by a digital circuit. Further, a configuration in which the transmission/reception controller 8 of the transmission/reception section 2, the image generation section 3, the display controller 4, the image analysis section 11, the portion discrimination section 12, the imaging condition setting section 13, the movement amount calculation section 15, and the apparatus controller 16 are partially or generally integrated into one CPU may be employed.

[0052] Here, a method for discriminating the first inspection portion will be described.

[0053] The first inspection portion is discriminated by the portion discrimination section 12 using an image analysis result. That is, the image analysis section 11 performs image analysis with respect to an ultrasound image signal from the DSC 10, and outputs the image analysis result to the portion discrimination section 12. Further, the portion discrimination section 12 discriminates the first inspection portion using a feature of an ultrasound image such as a brightness or an edge detected by the image analysis.

[0054] Alternatively, the first inspection portion may be discriminated by inputting information indicating which inspection portion the first inspection portion is through the operation section 17 from an operator.

[0055] Next, an operation of Embodiment 1 will be described with reference to a flowchart of Fig. 5.

[0056] First, in step S1, an image generation process and a movement detection process are performed. Specifically, in accordance with a flowchart shown in Fig. 6, an ultrasound image is generated, and a movement of the ultrasound probe 1 is detected. In step S21, transmission and reception and scanning of an ultrasound beam using the plurality of ultrasound transducers of the array transducer 1A of the ultrasound probe 1 are performed by the transmission/reception section 2, a reception signal is output to the reception section 6 from each ultrasound transducer that receives an ultrasound echo from a subject, and is amplified and A/D converted in the reception section 6 to generate reception data.

[0057] Then, in step S22, the reception data is input to the image generation section 3, and is subjected to a reception focus process in the image processing section 9. Then, the data is subjected to image conversion in the DSC 10 to generate an ultrasound image signal. The ultrasound image signal is output to the display controller 4 from the image generation section 3, so that an ultrasound image is displayed on the display section 5. Here, for example, in a case where the first inspection portion is being inspected, the ultrasound image of the first inspection portion is displayed on the display section 5. Further, the ultrasound image signal is also output to the image analysis section 11.

[0058] Further, in step S23, a movement of the ultrasound probe 1 in a case where the ultrasound probe 1 is operated by the operator is detected by the movement detection sensor 14 attached to the ultrasound probe 1, and is output to the movement amount calculation section 15 as a detection signal. For example, in a case where an acceleration sensor is attached as the movement detection sensor 14, an acceleration is output to the movement amount calculation section 15 as a detection signal.

[0059] Further, in step S2 in the flowchart shown in Fig. 5, it is determined by the movement amount calculation section 15 whether the detected acceleration is equal to or greater than a predetermined threshold value Th, and the determination result is output to the apparatus controller 16. In a case where it is determined that the detected acceleration is smaller than the threshold value Th, it is considered that the inspection of the first inspection portion is not terminated, step S1 and step S2 are repeated so that the inspection of the first inspection portion is continued.

[0060] In step S2, in a case where it is determined that the detected acceleration is equal to or greater than the threshold value Th, it is considered that the inspection of the first inspection portion is terminated so that the ultrasound probe 1 begins moving from the first inspection portion to the second inspection portion that is the next inspection target, and then, the procedure proceeds to step S3.

[0061] In the subsequent step S3, calculation of a movement amount of the ultrasound probe 1 is started using the movement amount calculation section 15. Further, in step S4, an ultrasound image is generated in accordance with the flowchart shown in Fig. 6. Then, a movement of the ultrasound probe 1, that is, an acceleration is detected, and the acceleration is used for calculation of a movement direction and a movement distance of the ultrasound probe 1.

[0062] In step S5 of the flowchart shown in Fig. 5, it is determined by the movement amount calculation section 15 whether the detected acceleration is smaller than the threshold value Th used in step S2, and the determination result is output to the apparatus controller 16. In a case where it is determined that the detected acceleration is equal to or greater than the threshold value Th, it is considered that the ultrasound probe 1 is being moved, so that step S4 and step S5 are repeated until the ultrasound probe 1 is in contact with a body surface S, and the calculation of the movement direction and the movement distance of the ultrasound probe 1 is continued.

[0063] In step S5, in a case where it is determined that the detected acceleration is smaller than the threshold value Th, it is considered that the movement of the ultrasound probe 1 is completed and the ultrasound probe 1 is in contact with the body surface S so that the second inspection portion is imaged. Then, the procedure proceeds to step S6.

[0064] In step S6, the calculation of the movement amount of the ultrasound probe 1 is terminated by the movement amount calculation section 15, and calculation results of the movement direction and the movement distance of the ultrasound probe 1 are output to the portion discrimination section 12.

[0065] In the subsequent step S7, image analysis is performed by the image analysis section 11 using the ultrasound image. The image analysis section 11 detects a feature of the ultrasound image such as a brightness or an edge of the ultrasound image output from the image generation section 3, and outputs the image analysis result to the portion discrimination section 12.

[0066] In step S8, the second inspection portion that is currently being imaged is discriminated by the portion discrimination section 12. The portion discrimination section 12 reads out a plurality of movement amount reference values from the movement amount reference value memory 19, and compares the read-out movement amount reference values with the calculation results calculated by the movement amount calculation section 15, respectively. Further, the portion discrimination section 12 integrates the comparison result and the image analysis result output from the image analysis section 11, discriminates the second inspection portion from the plurality of inspection portions, and outputs the portion discrimination result to the apparatus controller 16.

[0067] Further, in step S9, the portion discrimination result in the portion discrimination section 12 is output to the imaging condition setting section 13 through the apparatus controller 16. Further, the imaging condition setting section 13 sets imaging conditions based on the portion discrimination result, and controls the transmission/reception section 2 and the image generation section 3 on the imaging conditions.

[0068] In the next step S10, in accordance with the flowchart shown in Fig. 6, an ultrasound image is generated on the basis of the imaging conditions set by the imaging condition setting section 13, and the movement of the ultrasound probe 1, that is, the acceleration is detected.

[0069] In step S11, it is determined by the movement amount calculation section 15 whether the detected acceleration is equal to or greater than the threshold value Th used in step S2. In a case where it is determined that the detected acceleration is smaller than the threshold value Th, since it is considered that the second inspection portion is being diagnosed, the procedure returns to step S10. Then step S10 and step S11 are repeated, so that the diagnosis is continued.

[0070] On the other hand, in step S11, in a case where it is determined that the detected acceleration is equal to or greater than the threshold value Th, since it is considered that inspection of the left lung that is the second inspection portion is terminated so that the ultrasound probe 1 is moved to an inspection portion that is a next inspection target subsequent to the second inspection portion, the procedure returns to step S3. Then, through steps S3 to S9, the inspection portion that is the next inspection target subsequent to the second inspection portion is discriminated, imaging conditions based on the discriminated inspection portion are set, and step S10 and step S11 are repeated, so that the diagnosis may be continued.

[0071] Next, an example of portion discrimination using the portion discrimination section 12 in a case where it is discriminated that the left lung, the right lung, the heart, the left abdomen, the right abdomen, and the bladder are inspection portions and the first inspection portion is the bladder will be described.

[0072] It is assumed that calculation results of a movement direction and a movement distance of the ultrasound probe 1, of a movement distance D of 35 cm and an angle A of 15° are obtained by the movement amount calculation section

15. When comparing the calculation results of the movement direction and the movement distance of the ultrasound probe 1 with the movement amount reference values written in Table 1, respectively, the calculation results show values close to movement amount reference values between the bladder and the left lung and between the bladder and the heart. On the other hand, the calculation results show values that are quite different from movement amount reference values between the bladder and the right lung, between the bladder and the left abdomen, and between the bladder and the right abdomen. Thus, it is determined that any one of the left lung and the heart is the second inspection portion. However, it is not possible to determine which one of the left lung and the heart is the second inspection portion only using the comparison result.

[0073] On the other hand, since similar structures with respect to the left lung and the left abdomen are shown in a feature of the ultrasound image such as a brightness or an edge obtained by the image analysis section 11, any one of the left lung and the left abdomen is determined as the second inspection portion. For example, an example of an ultrasound image of the left lung shown in Fig. 7 is similar to an example of an ultrasound image of the left abdomen shown in Fig. 8. However, it is not possible to determine which one of the left lung and the left abdomen is the second inspection portion only using the image analysis result.

[0074] Accordingly, by integrating the calculation results of the movement direction and the movement distance of the ultrasound probe 1 and the image analysis result, it is possible to discriminate that the second inspection portion is the left lung.

[0075] In this way, even in a case where it is difficult to perform portion discrimination only using an image analysis result or calculation results of a movement direction and a movement distance of the ultrasound probe 1, it is possible to integrate the calculation results of the movement direction and the movement distance of the ultrasound probe 1 and the image analysis result to thereby accurately discriminate the second inspection portion.

Embodiment 2

[0076] In Embodiment 1, the image analysis result and the movement direction and the movement distance of the ultrasound probe 1 are integrated to discriminate the second inspection portion, but in Embodiment 2, a plurality of inspection portions that are image analysis targets are narrowed down on the basis of the movement direction and the movement distance of the ultrasound probe 1.

[0077] Through steps S1 to S6 in the flowchart shown in Fig. 5, an ultrasound image is generated, and a movement direction and a movement distance of the ultrasound probe 1 in a case where the ultrasound probe 1 is moved from a first inspection portion to a second inspection portion that is the next inspection target are calculated by the movement amount calculation section 15.

[0078] Further, in step S7, in a case where image analysis is performed by the image analysis section 11 using the ultrasound image, a plurality of inspection portions that are targets of the image analysis are narrowed down by the portion discrimination section 12. The portion discrimination section 12 reads out a plurality of movement amount reference values shown in Table 1 from the movement amount reference value memory 19, and sets separation allowances with respect to the plurality of movement amount reference values. Further, in a case where calculation results of the movement direction and the movement distance of the ultrasound probe 1 are within ranges of the separation allowances, a corresponding inspection portion is set as an image analysis target, and in a case where the calculation results are out of the ranges of the separation allowances, the corresponding inspection portion is excluded from the image analysis target. In this way, the plurality of inspection portions that are the image analysis targets are narrowed down, and the narrowing down result is output to the image analysis section 11.

[0079] Further, the image analysis section 11 performs image analysis with respect to the plurality of inspection portions that are narrowed down by the portion discrimination section 12, and outputs the image analysis result to the portion discrimination section 12. Further, in step S8, the portion discrimination section 12 discriminates the second inspection portion using the image analysis result.

[0080] In this way, by narrowing down a plurality of inspection portions that are targets of image analysis on the basis of a movement direction and a movement distance of the ultrasound probe 1, it is possible to reduce the number of image analysis processes for which it is generally considered that a processing load is high, and to effectively reduce the processing load due to the image analysis processes.

[0081] Next, an example of narrowing down of inspection portions in the portion discrimination section 12 in a case where the left lung, the right lung, the heart, the left abdomen, the right abdomen, and the bladder are inspection portions and it is discriminated that the first inspection portion is the bladder will be described.

[0082] It is assumed that calculation results of a movement direction and a movement distance of the ultrasound probe 1, of a movement distance D of 35 cm and an angle A of 15° are obtained by the movement amount calculation section 15. With respect to the plurality of movement amount reference values shown in Table 1, a separation allowance of the movement distance D is set to ±10 cm, and a separation allowance of the angle A is set to ±20°. In a case where the separation allowances are set, different values may be set for each inspection portion.

[0083] For example, in a case where the separation allowance of the movement distance D between the bladder and the left lung is 30 cm to 50 cm and the separation allowance of the angle A is -10° to 30°, the calculation results of the movement direction and the movement distance of the ultrasound probe 1 are within ranges of the separation allowances. Similarly, the calculation results are within ranges of the separation allowances between the bladder and the heart. On the other hand, the calculation results are out of the ranges of the separation allowances between the bladder and the right lung, between the bladder and the left abdomen, and between the bladder and the right abdomen. The image analysis targets are narrowed down to the left lung and the heart on the basis of the comparison results.

[0084] It may be considered that, for each body type of a subject, for example, according to whether the subject is an adult or a child, a direction variation between inspection portions is small and a distance variation between the inspection portions is large. Thus, it may be considered that the variation of the ultrasound probe 1 in the movement direction becomes small and the variation of the ultrasound probe 1 in the movement distance becomes large. Accordingly, it is possible to narrow down the plurality of inspection portions that are targets of image analysis on the basis of only the movement direction of the ultrasound probe 1.

[0085] Further, the portion discrimination section 12 may integrate the image analysis results for the plurality of inspection portions that are narrowed down and the movement direction and the movement distance of the ultrasound probe 1 calculated by the movement amount calculation section 15 to discriminate the second inspection portion. By narrowing down the inspection portions, it is possible to rapidly and accurately discriminate the second inspection portion while reducing a processing load due to the image analysis process.

[0086] Further, in narrowing down the inspection portions, in order to prevent inspection portions from being overlooked, there is a case where the separation allowances are set to large values to some extent, and thus, the inspection portions may not be sufficiently narrowed down. However, even in a case where the inspection portions are not sufficiently narrowed down, it is possible to accurately discriminate the second inspection portion by integrating the image analysis results with the movement direction and the movement distance of the ultrasound probe 1.

Embodiment 3

[0087] In Embodiment 1 and Embodiment 2, an analysis order for performing image analysis with respect to a plurality of inspection portions is not fixed, but in Embodiment 3, the analysis order is determined on the basis of a movement direction and a movement distance of the ultrasound probe 1.

[0088] Through steps S1 to S6 in the flowchart of Fig. 5, an ultrasound image is generated, and a movement direction and a movement distance of the ultrasound probe 1 are calculated in a case where the ultrasound probe 1 is moved from a first inspection portion to a second inspection portion that is the next inspection target by the movement amount calculation section 15.

[0089] In the next step S7, in a case where image analysis is performed by the image analysis section 11 using the ultrasound image, an analysis order for performing the image analysis with respect to a plurality of inspection portions is determined by the portion discrimination section 12. The portion discrimination section 12 reads out a plurality of movement amount reference values shown in Table 1 from the movement amount reference value memory 19, and compares the read-out movement amount reference values with the movement direction and the movement distance of the ultrasound probe 1 calculated by the movement amount calculation section 15, respectively. As the calculation results of the movement direction and the movement distance of the ultrasound probe 1 are respectively closer to the movement amount reference values, the portion discrimination section 12 increases a priority of image analysis with respect to a corresponding inspection portion, and as the calculation results are respectively more distant from the movement amount reference values, the portion discrimination section 12 decreases a priority of image analysis for a corresponding inspection portion. In this way, the analysis order is determined with respect to the plurality of inspection portions.

[0090] Further, the image analysis section 11 sequentially performs image analysis with respect to the plurality of inspection portions in accordance with the analysis order determined by the portion discrimination section 12, and outputs the image analysis result to the portion discrimination section 12. Further, in step S8, the portion discrimination section 12 discriminates the second inspection portion using the image analysis result. Here, the image analysis is preferentially performed with respect to an inspection portion for which it is determined in advance that there is a high possibility that the inspection portion corresponds to the second inspection portion on the basis of the movement direction and the movement distance of the ultrasound probe 1. Thus, a possibility that it is discriminated that the second inspection portion corresponds to an inspection portion that is a target of preferential image analysis becomes high.

[0091] Next, an example of determination of an analysis order using the portion discrimination section 12 in a case where the left lung, the right lung, the heart, the left abdomen, the right abdomen, and the bladder are inspection portions and it is discriminated that the first inspection portion is the bladder will be described.

[0092] It is assumed that calculation results of a movement direction and a movement distance of the ultrasound probe 1, of a movement distance D of 35 cm and an angle A of 15° are obtained by the movement amount calculation section

15. When comparing the calculation results of the movement direction and the movement distance of the ultrasound probe 1 with the plurality of movement amount reference values written in Table 1, respectively, the calculation results show close values in the order of movement amount reference values between the bladder and the left lung, between the bladder and the heart, between the bladder and the right lung, between the bladder and the left abdomen, and the bladder and the right abdomen,. Through the comparison results, the analysis order is determined so that targets of image analysis are set in the order of the left lung, the heart, the right lung, the left abdomen, and the right abdomen.

[0093] In this way, by determining an analysis order for performing image analysis with respect to a plurality of inspection portions, it is possible to discriminate the second inspection portion in a short time, and thus, it is possible to enhance response performance of the ultrasound diagnostic apparatus according to Embodiment 3.

Embodiment 4

[0094] In Embodiments 1 to 3, movement amount reference values relating to a subject who has an average body type are used in portion discrimination, regardless of the body type of the subject, but it may be considered that variation occurs in a distance between inspection portions due to a difference between body types of subjects. Accordingly, in Embodiment 4, movement amount reference values are corrected in accordance with a body type of a subject, and the corrected movement amount reference values are used in portion discrimination.

[0095] The portion discrimination section 12 corrects a plurality of movement amount reference values in accordance with a difference between calculation results of a movement direction and a movement distance of the ultrasound probe 1 calculated by the movement amount calculation section 15, used in a case where the second inspection portion is discriminated, and movement amount reference values. Further, the plurality of corrected movement amount reference values are used for discrimination of an inspection portion that is a next inspection target subsequent to the second inspection portion.

[0096] For example, it is assumed that it is discriminated that the first inspection portion is the bladder and the second inspection portion is the heart. Further, it is assumed that a calculation result of a movement distance of the ultrasound probe 1, indicating a movement distance D of 20 cm in a case where the second inspection portion is discriminated, and a movement amount reference value of 30 cm between the bladder and the heart written in Table 1 are used. It may be considered that a proportion of the movement amount reference value to the calculation result of the movement distance of the ultrasound probe 1 between the bladder and the heart has the same value as a proportion of a movement amount reference value to a calculation result of a movement distance of the ultrasound probe 1 between different plurality of inspection portions. Thus, the proportion of the movement amount reference value to the calculation result of the movement distance of the ultrasound probe 1 between the bladder and the heart, that is, each movement amount reference value is multiplied by 2/3 for correction.

[0097] In this way, by correcting movement amount reference values in accordance with body types of subjects and using the result for discrimination of an inspection portion that is a next inspection target subsequent to the second inspection portion, it is possible to enhance discrimination accuracy.

Embodiment 5

[0098] In Embodiments 1 to 4, movement amount reference values are used for portion discrimination regardless of subjects, but in Embodiment 5, subject reference values relating to a movement direction and a movement distance of the ultrasound probe 1 for each subject are used for portion discrimination.

[0099] Fig. 9 shows a configuration of an ultrasound diagnostic apparatus according to Embodiment 5. The ultrasound diagnostic apparatus according to Embodiment 5 further comprises a subject reference value memory 31, in the configuration of the ultrasound diagnostic apparatus according to Embodiment 1 shown in Fig. 1, and the subject reference value memory 31 is connected to the apparatus controller 16.

[0100] The subject reference value memory 31 stores in advance subject reference values relating to a movement direction and a movement distance of the ultrasound probe 1 in a case where the ultrasound probe 1 is moved between a plurality of inspection portions for each subject. For example, the subject reference value memory 31 stores movement directions and movement distances of the ultrasound probe 1 in the past inspection for each subject.

[0101] In order to use subject reference values, for example, an operator inputs information on a subject through the operation section 17. On the basis of the input information, the portion discrimination section 12 reads out subject reference values relating to the subject from the subject reference value memory 31. Further, the read-out subject reference values are compared with calculation results of a movement direction and a movement distance of the ultrasound probe 1 calculated by the movement amount calculation section 15. Thus, it is possible to discriminate a second inspection portion in accordance with the subject, and thus, it is possible to enhance the accuracy of portion discrimination.

[0102] In a case where the subject reference values corresponding to the information on the input subject are not stored in the subject reference value memory 31, subject reference values of a different subject that is common in height, weight, gender, and the like may be used. Alternatively, movement amount reference values stored in the movement amount reference value memory 19 may be used.

Embodiment 6

[0103] In Embodiments 1 to 5, start and termination of calculation of a movement amount of the ultrasound probe 1 is determined using an acceleration detected by the movement detection sensor 14, but in Embodiment 6, start and termination of calculation of a movement amount of the ultrasound probe 1 is determined on the basis of a determination result of whether the ultrasound probe 1 is in an air radiation state or a contact state with respect to a subject.

[0104] Fig. 10 shows a configuration of an ultrasound diagnostic apparatus according to Embodiment 6. The ultrasound diagnostic apparatus according to Embodiment 6 further comprises a probe state determination section 41, in the configuration of the ultrasound diagnostic apparatus according to Embodiment 1 shown in Fig. 1, and the probe state determination section 41 is connected to the DSC 10 of the image generation section 3 and is also connected to the movement amount calculation section 15.

[0105] The probe state determination section 41 determines whether the ultrasound probe 1 is in a contact state where the ultrasound probe 1 is in contact with a body surface of a subject to radiate ultrasound into the body of the subject or in an air radiation state where the ultrasound probe 1 is spaced from the body surface of the subject to radiate ultrasound in the air, using an ultrasound image signal output from the DSC 10 of the image generation section 3. Specifically, the probe state determination section 41 determines whether the ultrasound probe 1 is in the contact state with respect to the subject or in the air radiation state according to whether the presence of a structure is detected in the ultrasound image output from the DSC 10 of the image generation section 3. Further, the probe state determination section 41 outputs the determination result to the movement amount calculation section 15.

[0106] In a case where the presence of the structure is not detected in the ultrasound image, the probe state determination section 41 determines that the ultrasound probe 1 transitions from the contact state with respect to the subject to the air radiation state. Further, the probe state determination section 41 considers that the ultrasound probe 1 is spaced from the subject and is being moved from the first inspection portion to the second inspection portion, and outputs the determination result to the movement amount calculation section 15. The movement amount calculation section 15 starts calculation of a movement amount of the ultrasound probe 1, on the basis of the determination result.

[0107] Further, in a case where the presence of the structure is detected in the ultrasound image, the probe state determination section 41 determines that the ultrasound probe 1 transitions from the air radiation state to the contact state with respect to the subject. Further, the probe state determination section 41 considers that the ultrasound probe 1 completes movement and is in contact with the subject, and outputs the determination result to the movement amount calculation section 15. The movement amount calculation section 15 terminates calculation of a movement amount of the ultrasound probe 1, on the basis of the determination result.

[0108] In this way, by determining whether the ultrasound probe 1 is in an air radiation state or in a contact state with respect to a subject, and determining whether the ultrasound probe 1 is being moved between inspection portions, even in a case where a sensor other than an acceleration sensor is attached to the ultrasound probe 1, it is possible to determine start and termination of calculation of a movement amount of the ultrasound probe 1.

Explanation of References

[0109]

1: ultrasound probe
1A: array transducer
2: transmission/reception section
3: image generation section
4: display controller
5: display section
6: reception section
7: transmission section
8: transmission/reception controller
9: image processing section
10: DSC
11: image analysis section
12: portion discrimination section
13: imaging condition setting section
14: movement detection sensor

15: movement amount calculation section
16: apparatus controller
17: operation section
18: storage section
19: movement amount reference value memory
20: amplification section
21: A/D conversion section
22: beam former
23: signal processing section
31: subject reference value memory
41: probe state determination section
X: direction
D: distance
A: angle

Claims

1. An ultrasound diagnostic apparatus that sequentially inspects a plurality of inspection portions of a subject, comprising:

   an ultrasound probe;
   an imaging section that performs transmission and reception of an ultrasound beam between the ultrasound probe and the subject and generates an ultrasound image on the basis of a reception signal output from the ultrasound probe;
   an image analysis section that performs image analysis using the ultrasound image generated by the imaging section;
   a movement detection sensor that is attached to the ultrasound probe and detects a movement of the ultrasound probe to output the movement as a detection signal;
   a movement amount calculation section that calculates a movement direction and a movement distance of the ultrasound probe in a case where the ultrasound probe is moved from a first inspection portion where inspection is terminated among the plurality of inspection portions to a second inspection portion that is the next inspection target, using the detection signal output from the movement detection sensor; and
   a portion discrimination section that discriminates the second inspection portion on the basis of an image analysis result in the image analysis section and the movement direction and the movement distance calculated by the movement amount calculation section.

2. The ultrasound diagnostic apparatus according to claim 1,
   wherein the portion discrimination section integrates the image analysis result in the image analysis section and the movement direction and the movement distance calculated by the movement amount calculation section to discriminate the second inspection portion.

3. The ultrasound diagnostic apparatus according to claim 1,

   wherein the portion discrimination section narrows down the plurality of inspection portions that are targets of the image analysis, on the basis of the movement direction and the movement distance calculated by the movement amount calculation section,
   wherein the image analysis section performs the image analysis with respect to the inspection portions narrowed down by the portion discrimination section, and
   wherein the portion discrimination section discriminates the second inspection portion using the image analysis result in the image analysis section.

4. The ultrasound diagnostic apparatus according to claim 1 or 3,

   wherein the portion discrimination section determines an analysis order for performing the image analysis with respect to the plurality of inspection portions, on the basis of the movement direction and the movement distance calculated by the movement amount calculation section,
   wherein the image analysis section sequentially performs the image analysis with respect to the plurality of

inspection portions in accordance with the analysis order determined by the portion discrimination section, and wherein the portion discrimination section discriminates the second inspection portion using the image analysis result in the image analysis section.

5. The ultrasound diagnostic apparatus according to any one of claims 1 to 4, further comprising:

a movement amount reference value memory in which a plurality of movement amount reference values relating to the movement direction and the movement distance of the ultrasound probe in a case where the ultrasound probe is moved between the plurality of inspection portions are stored in advance,
wherein the portion discrimination section reads out the plurality of movement amount reference values from the movement amount reference value memory, compares each of the plurality of read-out movement amount reference values with the movement direction and the movement distance calculated by the movement amount calculation section, and discriminates the second inspection portion on the basis of the comparison result and the image analysis result in the image analysis section.

6. The ultrasound diagnostic apparatus according to claim 5,
wherein the portion discrimination section corrects the plurality of movement amount reference values in accordance with differences between the movement direction and the movement distance calculated by the movement amount calculation section and used when the second inspection portion is discriminated and the movement amount reference values used when the second inspection portion is discriminated, and uses the plurality of corrected movement amount reference values in discriminating an inspection portion that becomes a next inspection target subsequent to the second inspection portion.

7. The ultrasound diagnostic apparatus according to any one of claims 1 to 6, further comprising:

a subject reference value memory in which a plurality of subject reference values relating to the movement direction and the movement distance in a case where the ultrasound probe is moved between the plurality of inspection portions for each subject are stored in advance,
wherein the portion discrimination section reads out the subject reference values corresponding the subject from the subject reference value memory, compares the read-out subject reference values with the movement direction and the movement distance calculated by the movement amount calculation section, and discriminates the second inspection portion on the basis of the comparison result and the image analysis result in the image analysis section.

8. The ultrasound diagnostic apparatus according to any one of claims 1 to 7,
wherein the movement amount calculation section detects an acceleration of the ultrasound probe using the detection signal output from the movement detection sensor, and calculates the movement direction and the movement distance of the ultrasound probe from a time when the detected acceleration becomes equal to or larger than a predetermined threshold value to a time when the detected acceleration becomes smaller than the predetermined threshold value.

9. The ultrasound diagnostic apparatus according to any one of claims 1 to 7, further comprising:

a probe state determination section that determines whether the ultrasound probe is in an air radiation state or in a contact state with respect to the subject,
wherein the movement amount calculation section calculates the movement direction and the movement distance of the ultrasound probe from a time when it is determined by the probe state determination section that the ultrasound probe transitions from the contact state with respect to the subject to the air radiation state to a time when it is determined by the probe state determination section that the ultrasound probe transitions from the air radiation state to the contact state with respect to the subject.

10. The ultrasound diagnostic apparatus according to any one of claims 1 to 9, further comprising:

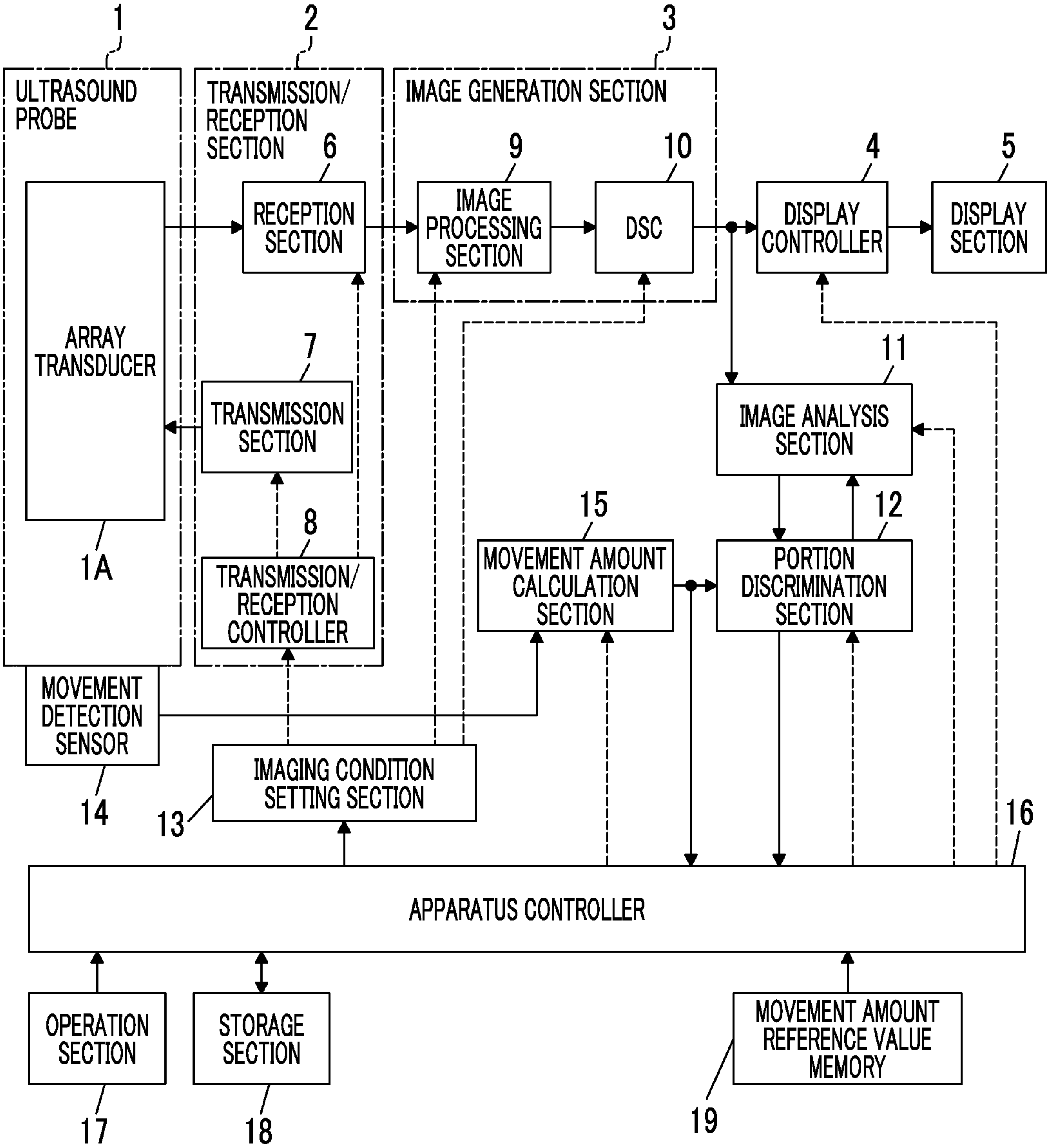
an imaging condition setting section that sets an imaging condition corresponding to the second inspection portion discriminated by the portion discrimination section,
wherein the imaging section generates the ultrasound image in accordance with the imaging condition set by the imaging condition setting section.

11. The ultrasound diagnostic apparatus according to any one of claims 1 to 10, wherein the movement detection sensor is formed by an acceleration sensor, a gyro sensor, a magnetic sensor, or a GPS sensor.

12. A control method of an ultrasound diagnostic apparatus that sequentially inspects a plurality of inspection portions of a subject, comprising:

performing transmission and reception of an ultrasound beam between an ultrasound probe and the subject, and generating an ultrasound image on the basis of a reception signal output from the ultrasound probe;
performing image analysis using the generated ultrasound image;
detecting a movement of the ultrasound probe to output the movement as a detection signal;
calculating a movement direction and a movement distance of the ultrasound probe in a case where the ultrasound probe is moved from a first inspection portion where inspection is terminated among the plurality of inspection portions to a second inspection portion that is the next inspection target, using the output detection signal; and
discriminating the second inspection portion on the basis of an image analysis result and the calculated movement direction and movement distance.

FIG. 1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MOVEMENT AMOUNT CALCULATION SECTION
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FIG. 2

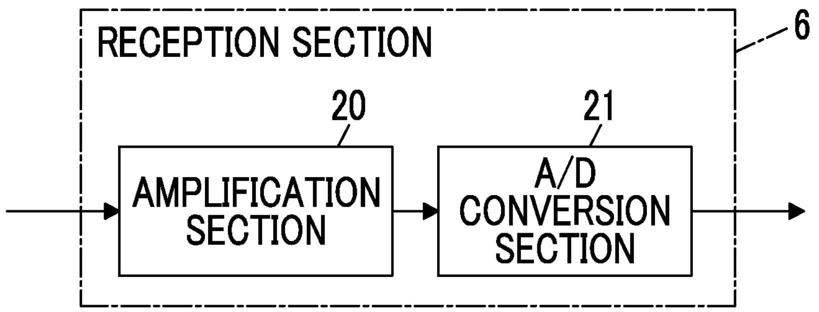

FIG. 3

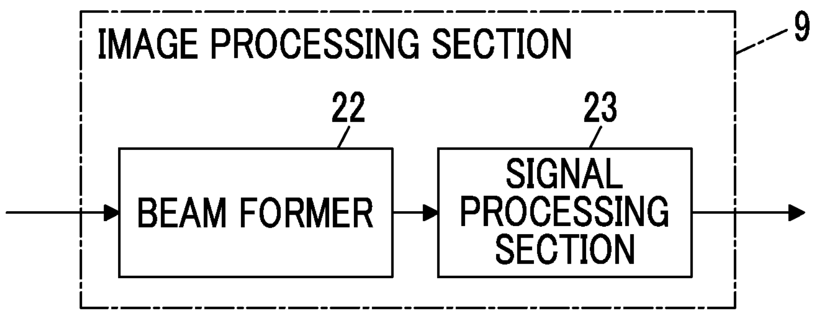

FIG. 4

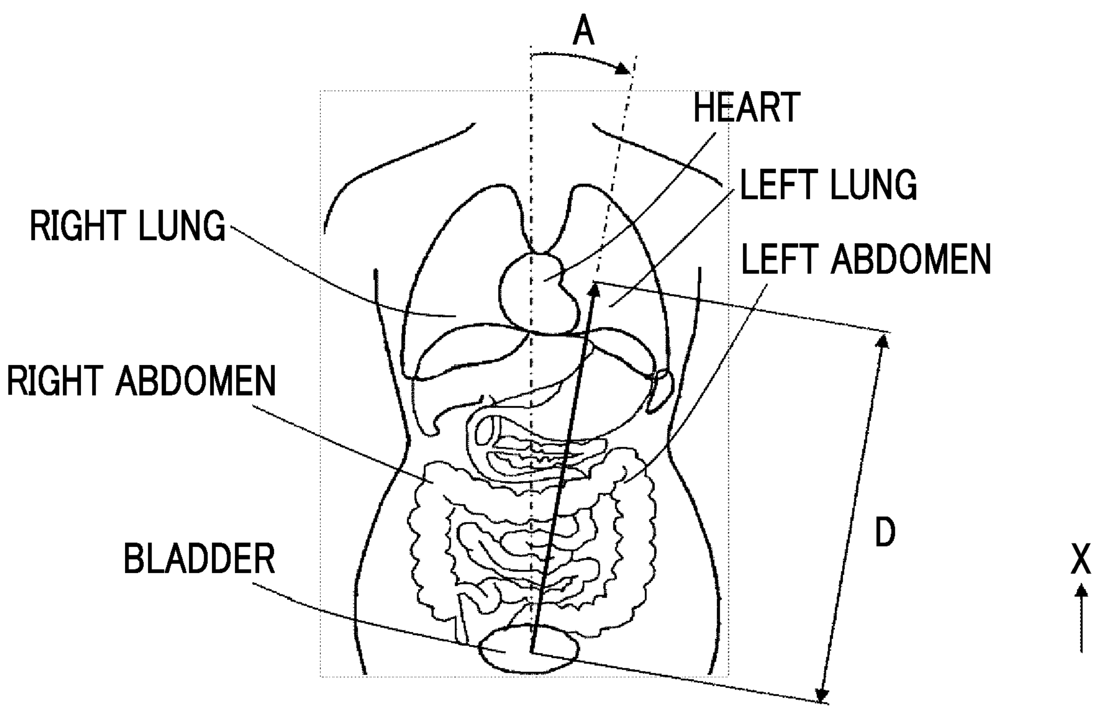

FIG. 5

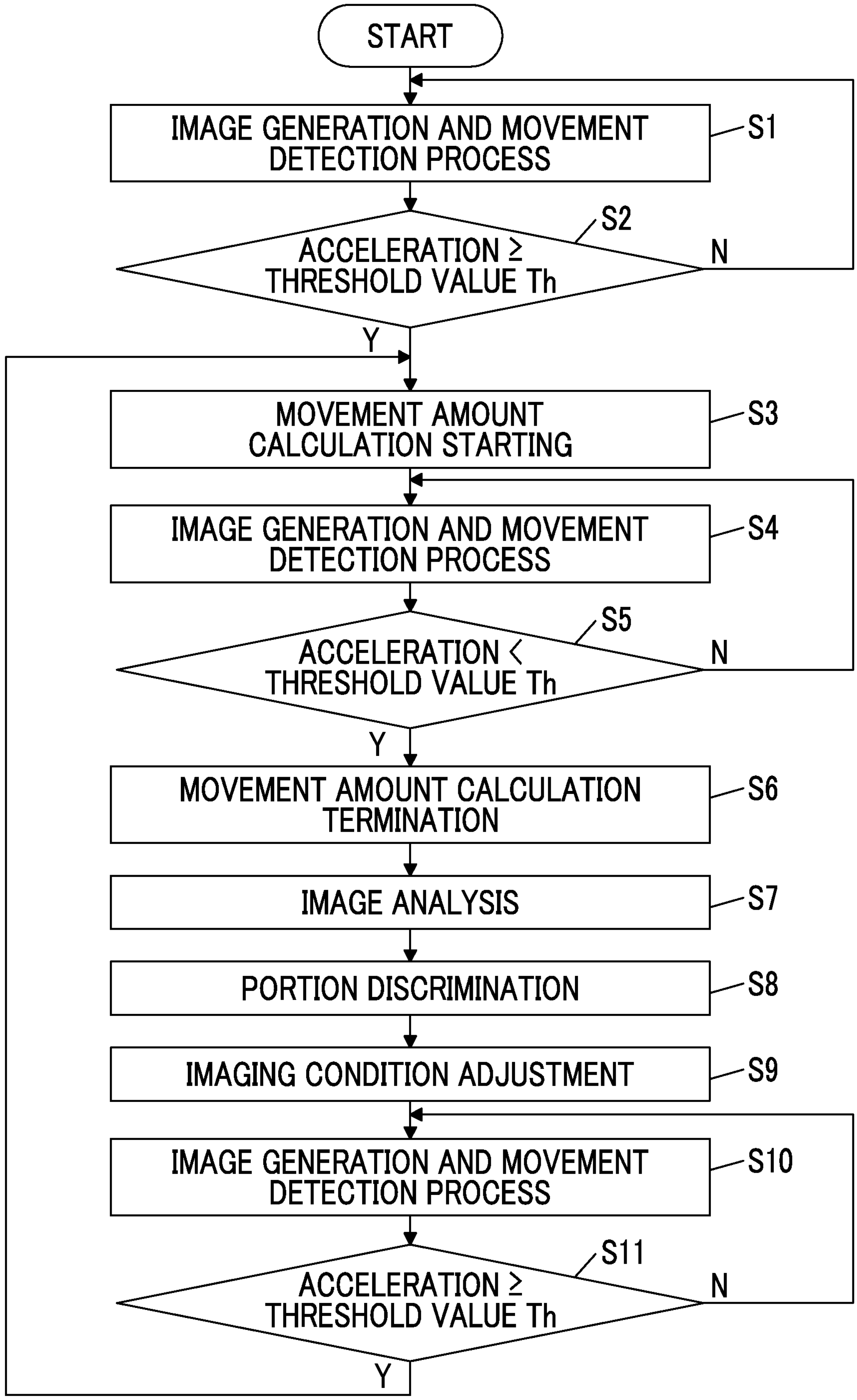
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FIG. 6

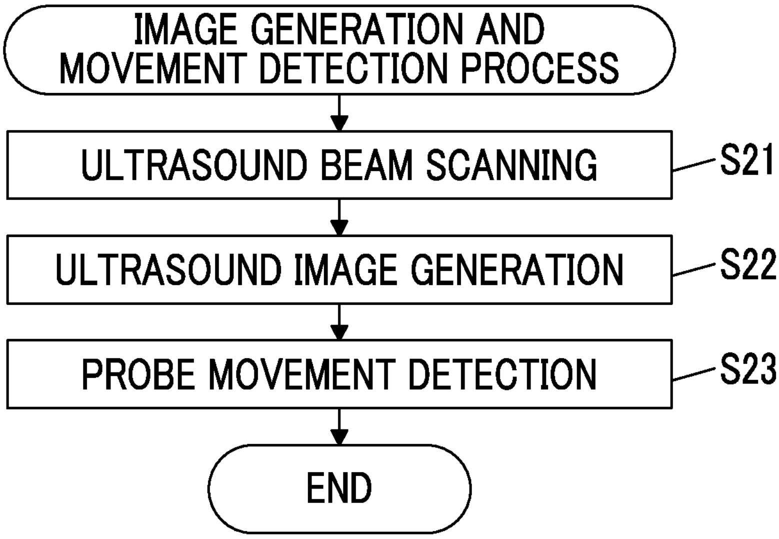

FIG. 7

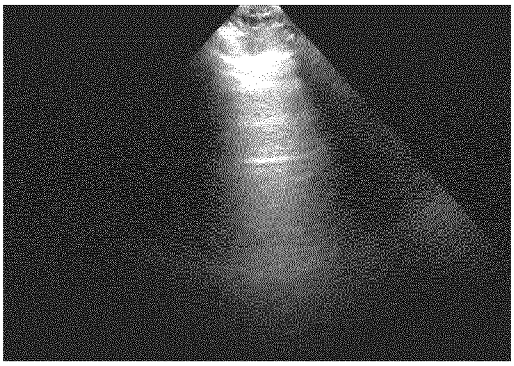

FIG. 8

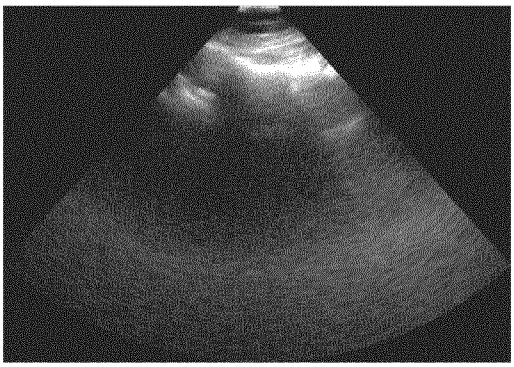

FIG. 9

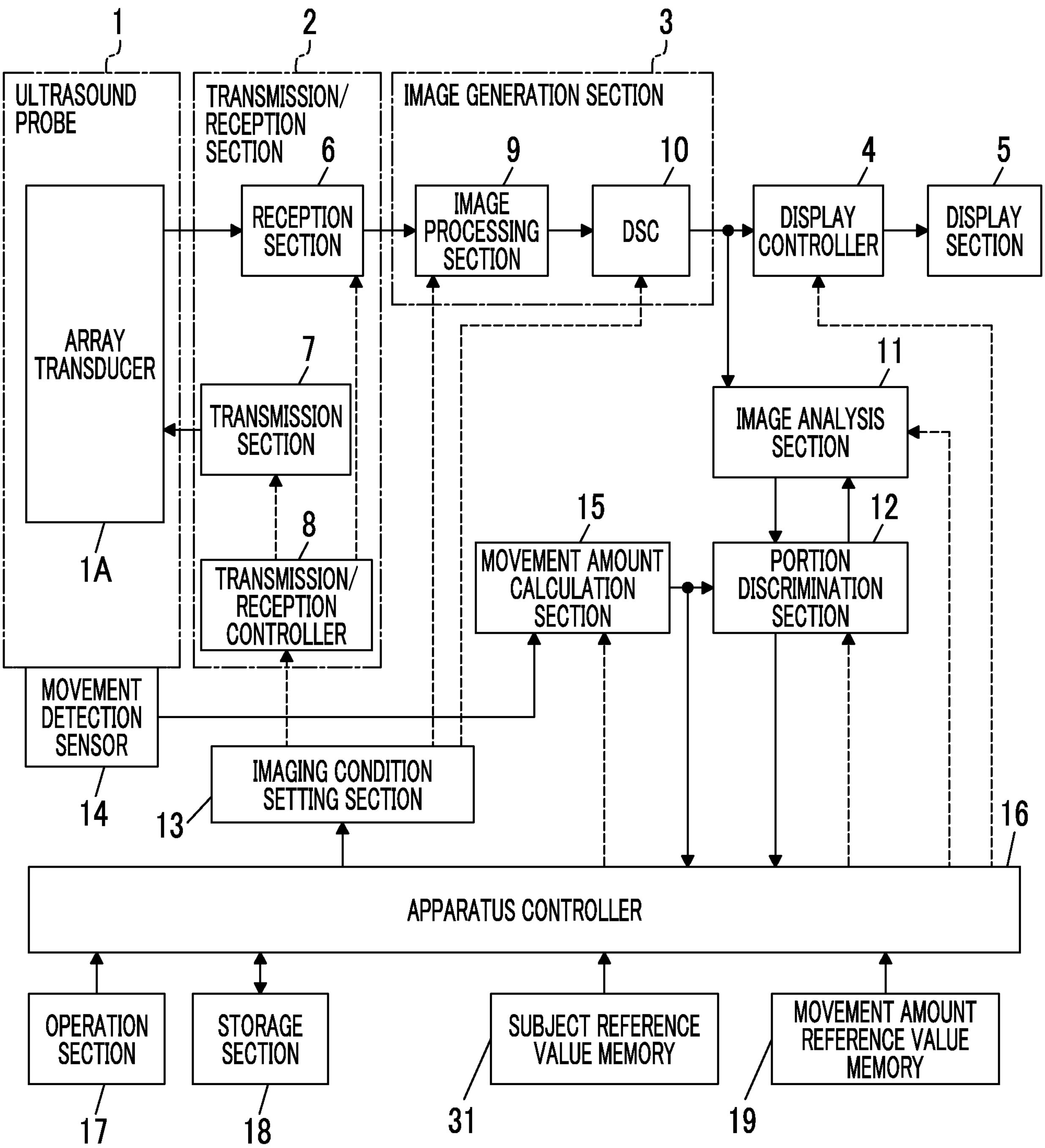
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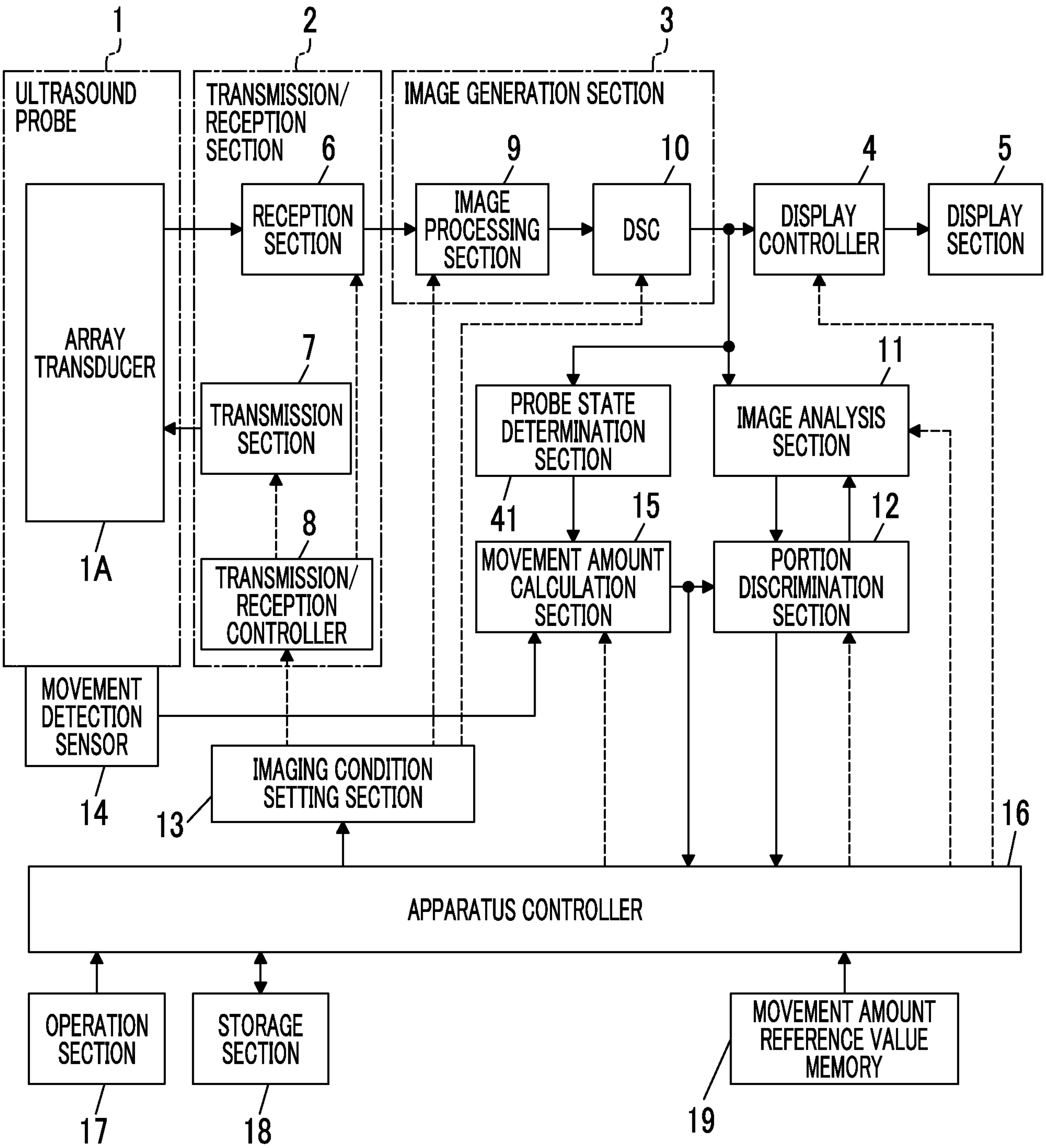
FIG. 10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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/015263

A. CLASSIFICATION OF SUBJECT MATTER
A61B8/14(2006.01)i

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)
A61B8/14

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2017
Kokai Jitsuyo Shinan Koho	1971-2017	Toroku Jitsuyo Shinan Koho	1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2013-111309 A (GE Medical Systems Global Technology Co., L.L.C.), 10 June 2013 (10.06.2013), claims 1 to 9; paragraphs [0009] to [0060]; fig. 1 to 5 (Family: none)	1-12
A	JP 2010-259662 A (Shimadzu Corp.), 18 November 2010 (18.11.2010), claims 1 to 4; paragraphs [0023] to [0055]; fig. 1 to 4 (Family: none)	1-12

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
27 April 2017 (27.04.17)	16 May 2017 (16.05.17)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/015263

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2007-167116 A (Matsushita Electric Industrial Co., Ltd.), 05 July 2007 (05.07.2007), claims 1 to 3; paragraphs [0013] to [0027]; fig. 1 to 6 (Family: none)	1-12
A	JP 4-224738 A (Yokogawa Medical Systems, Ltd.), 14 August 1992 (14.08.1992), paragraphs [0009] to [0026]; fig. 1 to 3 (Family: none)	1-12

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H4224738 A **[0003]**
- JP 4224738 A **[0003]**

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专利名称(译)	超声波诊断装置及超声波诊断装置的控制方法		
公开(公告)号	EP3517046A4	公开(公告)日	2019-10-23
申请号	EP2017852600	申请日	2017-04-14
[标]申请(专利权)人(译)	富士胶片株式会社		
申请(专利权)人(译)	富士胶片株式会社		
当前申请(专利权)人(译)	富士胶片株式会社		
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发明人	EBATA, TETSUROU		
IPC分类号	A61B8/14		
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优先权	2016187535 2016-09-26 JP		
其他公开文献	EP3517046A1		
外部链接	Espacenet		

摘要(译)

提供一种超声波诊断装置，其包括超声波探头。成像部基于从超声波探头输出的接收信号生成超声波图像。图像分析部，其使用由摄像部生成的超声波图像进行图像分析。移动检测传感器，其附接到超声探头并检测超声探头的运动，以将该运动作为检测信号输出；移动量计算部分，其在超声波探头从多个检查部分中终止检查的第一检查部分移动到作为第二检查部分的第二检查部分的情况下，计算超声波探头的移动方向和移动距离。使用从运动检测传感器输出的检测信号的下一个检查对象；根据该图像分析部中的图像分析结果以及由移动量计算部计算出的超声波探头的移动方向和移动距离，来区分第二检查部位的部位区分部。