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(54) **ULTRASONIC DIAGNOSTIC DEVICE AND CONTROL METHOD FOR ULTRASONIC DIAGNOSTIC DEVICE**

ULTRASCHALLDIAGNOSEVORRICHTUNG UND STEUERUNGSVERFAHREN FÜR EINE ULTRASCHALLDIAGNOSEVORRICHTUNG

DISPOSITIF DE DIAGNOSTIC ÉCHOGRAPHIQUE ET PROCÉDÉ DE COMMANDE POUR DISPOSITIF DE DIAGNOSTIC ÉCHOGRAPHIQUE

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(74) Representative: **Klunker IP Patentanwälte PartG mbB Destouchesstraße 68 80796 München (DE)**

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(73) Proprietor: **FUJIFILM Corporation Tokyo 106-8620 (JP)**

(72) Inventor: **IMAI, Yoshiro Ashigara-kami-gun Kanagawa 258-8538 (JP)**

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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 method for controlling the ultrasound diagnostic apparatus, and more particularly, to an ultrasound diagnostic apparatus that determines an imaging part of a subject on the basis of an ultrasound image.

2. Description of the Related Art

[0002] In the related art, an ultrasound diagnostic apparatus using an ultrasound image has been put to practical use in the medical field. In general, in this type of ultrasound diagnostic apparatus, an ultrasound probe provided with an array transducer scans a subject with an ultrasound beam and receives ultrasound echoes from the subject and the received signal is electrically processed to generate an ultrasound image.

[0003] In a case in which the ultrasound diagnostic apparatus is used to diagnose the subject, the user sets imaging conditions according to an imaging part in order to obtain ultrasound images suitable for diagnosis for each examination part. However, in a case in which a plurality of examination parts of the subject are continuously examined, the user needs to reset the imaging conditions according to the examination part whenever the examination part is changed. As a result, there is a concern that it will take a long time for diagnosis. For this reason, JP1992-224738A (JP-H04-224738A) discloses an ultrasound diagnostic apparatus which determines an imaging part from a generated ultrasound image, using collation patterns corresponding to each examination part that is stored in advance, and sets a scanning parameter suitable for the imaging part on the basis of the determination result.

SUMMARY OF THE INVENTION

[0004] However, for example, in a case in which an extended focused assessment with sonography for trauma (eFAST) examination that continuously examines a plurality of examination parts is performed, the number of examination part candidates increases. As such, in a case in which the number of examination part candidates increases, the number of collation patterns used by the ultrasound diagnostic apparatus disclosed in JP1992-224738A (JP-H04-224738A) to determine the imaging part increases in order to respond to these examination part candidates. As a result, there is a concern that it will take a long time until the determination of the imaging part is completed. In addition, in a case in which the ultrasound image of an examination part other than the examination parts corresponding to the collation pat-

terns which have been stored in advance is obtained, it is difficult to determine the imaging part and a part determination process is continuously performed until all of the collation patterns are used. Therefore, there is a concern that it will take a long time until the process proceeds to an operation subsequent to the part determination process. As a result, there is a concern that the setting of the scanning parameter suitable for the imaging part will be delayed, which hinders diagnosis.

[0005] The invention has been made in order to solve the problems of the related art and an object of the invention is to provide an ultrasound diagnostic apparatus and a method for controlling the ultrasound diagnostic apparatus that can prevent the time required to determine an imaging part in an ultrasound image from increasing even in a case in which the number of examination part candidates increases.

[0006] In one aspect, the present invention provides an ultrasound diagnostic apparatus according to claim 1 of the appended claims.

[0007] The determination order decision unit may store content of a plurality of continuous examinations for continuously examining the plurality of examination parts in advance. In a case in which the user inputs a continuous examination selected from the plurality of continuous examinations as the examination type information to the information input unit, the determination order decision unit may decide the determination order of the plurality of examination parts corresponding to the input continuous examination.

[0008] The examination type information may be input as a list of the plurality of examination parts to be continuously examined to the information input unit by the user. The determination order decision unit may decide the determination order of the plurality of examination parts on the basis of the list input from the information input unit.

[0009] The ultrasound diagnostic apparatus may further comprise an imaging condition setting unit that sets imaging conditions corresponding to the imaging part determined by the part determination unit. The imaging unit may generate the ultrasound image according to the imaging conditions set by the imaging condition setting unit.

[0010] In another aspect, the present invention provides a method for controlling an ultrasound diagnostic apparatus, according to claim 6 of the appended claims.

[0011] According to the invention, an ultrasound beam is transmitted and received to and from the subject by the ultrasound probe and the received signal output from the ultrasound probe is converted into an image to generate an ultrasound image of the subject. In a case in which the user inputs the examination type information indicating the content of the examination for continuously examining a plurality of examination parts, the determination order of the plurality of examination parts to be continuously examined is decided on the basis of the input examination type information. Collation patterns corresponding to the examination parts to be continuously examined are read from a plurality of collation patterns,

which correspond to the plurality of examination parts and are stored in advance, according to the decided determination order and the ultrasound image is sequentially collated in the determination order using the read collation patterns to determine the imaging part of the subject. Therefore, it is possible to prevent the time required to determine the imaging part in the ultrasound image from increasing even in a case in which the number of examination part candidates increases.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

Fig. 1 is a block diagram illustrating the configuration of an ultrasound diagnostic apparatus according to Embodiment 1 of the invention.

Fig. 2 is a block diagram illustrating the internal configuration of a receiving unit.

Fig. 3 is a block diagram illustrating the internal configuration of a B-mode processing unit.

Fig. 4 is a flowchart illustrating the operation of Embodiment 1.

Fig. 5 is a flowchart illustrating a part determination process according to Embodiment 1.

Fig. 6 is a flowchart illustrating a part determination process according to Embodiment 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] Hereinafter, embodiments of the invention will be described with reference to the accompanying drawings.

Embodiment 1

[0014] Fig. 1 illustrates the configuration of an ultrasound diagnostic apparatus according to Embodiment 1 of the invention. The ultrasound diagnostic apparatus includes an ultrasound probe 1 provided with an array transducer 1A. An image generation unit 3 is connected to the ultrasound probe 1 through a transmitting/receiving unit 2 and a display unit 5 is connected to the image generation unit 3 through a display control unit 4.

[0015] The transmitting/receiving unit 2 includes a transmitting unit 6 and a receiving unit 7 that are connected to the array transducer 1A of the ultrasound probe 1 and a transmission/reception control unit 8 that is connected to the transmitting unit 6 and the receiving unit 7. The image generation unit 3 includes a brightness-mode (B-mode) processing unit 9 that is connected to the receiving unit 7 of the transmitting/receiving unit 2 and a digital scan converter (DSC) 10 that is connected to the B-mode processing unit 9. The display control unit 4 is connected to the DSC 10. An imaging condition setting unit 11 is connected to the transmission/reception control unit 8 of the transmitting/receiving unit 2 and the B-mode

processing unit 9 and the DSC 10 of the image generation unit 3.

[0016] In addition, a part determination unit 12 is connected to the DSC 10 and a determination order decision unit 13 is connected to of the part determination unit 12.

[0017] An apparatus control unit 14 is connected to the imaging condition setting unit 11, the part determination unit 12, the determination order decision unit 13, and the display control unit 4. In addition, a collation pattern memory 15, an information input unit 16, and a storage unit 17 are connected to the apparatus control unit 14.

[0018] The array transducer 1A of the ultrasound probe 1 includes a plurality of ultrasound transducers that are one-dimensionally or two-dimensionally arranged. Each of the ultrasound transducers transmits ultrasonic waves in response to a driving signal supplied from the transmitting unit 6. In addition, each of the ultrasound transducers receives ultrasound echoes from a subject and outputs a received signal. Each ultrasound transducer is, for example, a transducer in which electrodes are formed at both ends of a piezoelectric body made of piezoelectric ceramic typified by lead zirconate titanate (PZT), a polymer piezoelectric element typified by polyvinylidene difluoride (PVDF), or a piezoelectric crystal typified by lead magnesium niobate-lead titanate (PMN-PT).

[0019] In a case in which a pulsed voltage or a continuous-wave voltage is applied to the electrodes of the transducer, the piezoelectric body is expanded and contracted and pulsed or continuous ultrasonic waves are generated from each transducer. The ultrasonic waves are combined to form an ultrasound beam. In addition, each transducer receives propagated ultrasonic waves, is expanded and contracted, and generates an electric signal. The electric signal is output as a received ultrasound signal.

[0020] The transmitting/receiving unit 2 transmits and receives an ultrasound beam according to the set ultrasound beam scanning conditions and the image generation unit 3 generates a B-mode image signal according to the set ultrasound image generation conditions. Therefore, the transmitting/receiving unit 2 and the image generation unit 3 form an imaging unit. In addition, imaging conditions for the imaging unit are formed by ultrasound beam scanning conditions for the transmitting/receiving unit 2 and ultrasound image generation conditions for the image generation unit 3.

[0021] The transmitting unit 6 of the transmitting/receiving unit 2 includes, for example, a plurality of pulse generators, adjusts the amount of delay of each driving signal such that the ultrasonic waves transmitted from a plurality of ultrasound transducers in the array transducer 1A form an ultrasound beam, on the basis of a transmission delay pattern selected according to a control signal from the transmission/reception control unit 8, and supplies the driving signals to the plurality of ultrasound transducers.

[0022] As illustrated in Fig. 2, the receiving unit 7 has

a configuration in which an amplification unit 18 and an analog/digital (A/D) conversion unit 19 are sequentially connected in series. The receiving unit 7 amplifies the received signals transmitted from each ultrasound transducer of the array transducer 1A with the amplification unit 18 and performs A/D conversion for the received signals with the A/D conversion unit 19 to generate digital received data.

[0023] The transmission/reception control unit 8 controls the transmitting unit 6 and the receiving unit 7 on the basis of various control signals transmitted from the apparatus control unit 14 such that the transmission of an ultrasound pulse to a subject and the reception of an ultrasound echo from the subject are repeated at a pulse repetition frequency (PRF) interval.

[0024] The B-mode processing unit 9 of the image generation unit 3 has a configuration in which a beam former 20 and a signal processing unit 21 are sequentially connected in series, as illustrated in Fig. 3. The beam former 20 applies a delay to each received data item output from the receiving unit 7 of the transmitting/receiving unit 2 according to a sound speed or a sound speed distribution set on the basis of a reception delay pattern selected according to a control signal from the imaging condition setting unit 11 and adds the received data to perform a reception focusing process. A sound ray signal in which the focus of an ultrasound echo subjected to phasing addition is narrowed is generated by the reception focusing process.

[0025] The signal processing unit 21 corrects the attenuation of the sound ray signal generated by the beam former 20 depending on a distance according to the depth of the reflection position of ultrasonic waves and then performs an envelope detection process. In addition, the signal processing unit 21 performs various types of necessary image processing including a gradation process to generate a B-mode image signal which is tomographic image information related to the tissues of the subject.

[0026] The DSC 10 of the image generation unit 3 converts the B-mode image signal generated by the signal processing unit 21 into an image signal based on a general television signal scanning system (raster conversion).

[0027] The display control unit 4 displays a B-mode image on the display unit 5 on the basis of the B-mode image signal generated by the image generation unit 3.

[0028] The display unit 5 includes a display device, such as a liquid crystal display (LCD), and displays the B-mode image under the control of the display control unit 4.

[0029] A plurality of collation patterns corresponding to a plurality of examination parts of the subject are stored in the collation pattern memory 15 in advance.

[0030] The information input unit 16 is used by a user to perform an input operation and may include, for example, a keyboard, a mouse, a trackball, and a touch panel.

[0031] Here, for example, an operation of continuously

examining a plurality of examination parts, such as an eFAST examination, an abdomen routine examination, or a circulatory organ routine examination, is defined as a continuous examination. A continuous examination that is selected from a plurality of continuous examination candidates by the user is input as examination type information to the information input unit 16.

[0032] The determination order decision unit 13 decides a plurality of examination parts to be continuously examined on the basis of the examination type information input to the information input unit 16 and decides a determination order in which the examination parts are determined.

[0033] The part determination unit 12 reads collation patterns corresponding to the examination parts to be continuously examined from the collation pattern memory 15 according to the determination order decided by the determination order decision unit 13 and sequentially collates the B-mode image signal generated by the image generation unit 3 in this determination order, using the read collation patterns, to determine the imaging part of the subject.

[0034] The imaging condition setting unit 11 stores imaging conditions corresponding to a plurality of examination parts in advance and sets the imaging conditions corresponding to the examination part determined by the part determination unit 12.

[0035] The apparatus control unit 14 controls the imaging condition setting unit 11, the display control unit 4, the part determination unit 12, and the determination order decision unit 13 on the basis of commands input from by the information input unit 16 by the user.

[0036] The storage unit 17 stores, for example, an operation program. For example, a recording medium, such as a hard disk, a flexible disk, a magneto-optical disk (MO), a magnetic tape (MT), a random access memory (RAM), a compact disk read only memory (CD-ROM), a digital versatile disk read only memory (DVD-ROM), a secure digital card (SD card), a compact flash card (CF card), or a universal serial bus memory (USB memory), or a server may be used as the storage unit 17.

[0037] In this embodiment, the image generation unit 3, the display control unit 4, the transmission/reception control unit 8 of the transmitting/receiving unit 2, the imaging condition setting unit 11, the part determination unit 12, the determination order decision unit 13, and the apparatus control unit 14 are formed by a central processing unit (CPU) and an operation program that causes the CPU to perform various processes. However, these units may be formed by digital circuits. In addition, some or all of the image generation unit 3, the display control unit 4, the transmission/reception control unit 8, the imaging condition setting unit 11, the part determination unit 12, the determination order decision unit 13, and the apparatus control unit 14 may be integrated into one CPU.

[0038] Next, the operation of Embodiment 1 will be described with reference to a flowchart illustrated in Fig. 4.

[0039] First, in Step S1, the user inputs examination

type information to the information input unit 16. The examination type information indicates the content of an examination that continuously examines a plurality of examination parts in a case in which the subject is diagnosed. For example, in a continuous examination that is generally called an eFAST examination, the right abdomen, the left abdomen, a region around the bladder, an epigastric region, the right lung, and the left lung are continuously examined in this order. In addition, examples of the continuous examination include an abdomen routine examination that continuously examines the liver, the gallbladder, the kidney, the pancreas, and the spleen in this order and a circulatory organ routine examination that continuously examines the long and short axes of the left ventricle, the cardiac apex, the right heart, and an epigastric region in this order. The content and order of the examination parts are illustrative and vary depending on, for example, examination facilities, examiners, and the state of a patient.

[0040] Here, in a case in which the user selects the eFAST examination from the continuous examination candidates, the eFAST examination is input as the examination type information to the information input unit 16.

[0041] Then, in Step S2, the determination order decision unit 13 decides the determination order of a plurality of examination parts to be continuously examined on the basis of the examination type information. The determination order decision unit 13 stores the content of a plurality of continuous examinations in advance and decides a plurality of examination parts to be continuously examined, such as the right abdomen, the left abdomen, the region around the bladder, the epigastric region, the right lung, and the left lung, on the basis of the examination type information such as the eFAST examination input by the user. In addition, the determination order decision unit 13 decides the determination order for determining imaging parts in the order of the right abdomen, the left abdomen, the region around the bladder, the epigastric region, the right lung, and the left lung and outputs the decided determination order to the part determination unit 12.

[0042] In Step S3, the transmitting/receiving unit 2 performs the transmission and reception of an ultrasound beam and scanning, using the plurality of ultrasound transducers in the array transducer 1A of the ultrasound probe 1. A received signal from each ultrasound transducer that has received ultrasound echoes from the subject is output to the receiving unit 7. The receiving unit 7 performs amplification and A/D conversion for the received signal to generate received data.

[0043] In Step S4, the received data is input to the image generation unit 3. The B-mode processing unit 9 performs the reception focusing process for the received data and the DSC 10 converts received data to generate a B-mode image signal. The B-mode image signal is output from the image generation unit 3 to the display control unit 4. The B-mode image is displayed on the display unit

5.

[0044] The B-mode image signal output from the DSC 10 of the image generation unit 3 is input to the part determination unit 12. First, in Step S5, the part determination unit 12 determines whether the imaging part in the B-mode image signal has been changed. For example, in a case in which the examination part is changed from the right abdomen to the left abdomen and the imaging part is changed, it is determined that the imaging part has been changed. Specifically, in general, in a case in which the imaging part is changed, the probe is separated from the surface of the body and emits ultrasonic waves to the air. Therefore, it is possible to determine whether the imaging part has been changed by detecting the aerial emission state (a state in which a reflected signal is not obtained). Alternatively, in a case in which the B-mode image signal is generated first after the determination order is decided in Step S2, the process proceeds to Step S6 in order to determine the imaging part and to set the imaging conditions corresponding to the determination result. Then, in Step S6, the part determination unit 12 determines the imaging part of the subject.

[0045] First, the part determination unit 12 reads the collation patterns corresponding to the examination parts of the eFAST examination from the collation pattern memory 15 according to the determination order decided by the determination order decision unit 13. The collation pattern memory 15 stores collation patterns corresponding to the stomach, the kidney, the liver, and various other imaging parts in order to respond to examination parts other than the examination parts of the eFAST examination. Only six types of collation patterns corresponding to the right abdomen, the left abdomen, the region around the bladder, the epigastric region, the right lung, and the left lung which are the examination parts of the eFAST examination are read from the collation pattern memory 15 storing the various other collation patterns.

[0046] In addition, the part determination unit 12 sequentially collates the B-mode image signal output from the DSC 10 of the image generation unit 3 in the determination order decided by the determination order decision unit 13 using the read collation patterns. That is, as illustrated in the flowchart of Fig. 5, the B-mode image signal is collated in the order of the right abdomen, the left abdomen, the region around the bladder, the epigastric region, the right lung, and the left lung using the collation patterns corresponding to these examination parts.

[0047] For example, in the examination of the right lung, in a case in which it is determined in Step S11 that the imaging part is not the right abdomen, it is determined in Step S12 that the imaging part is not the left abdomen, it is determined in Step S13 that the imaging part is not the region around the bladder, it is determined in Step S14 that the imaging part is not the epigastric region, and it is determined in Step S15 that the imaging part is the right lung, Step S16 is omitted. In Step S18, it is confirmed that the imaging part is the right lung and the determination result is output. Then, the part determination process

ends.

[0048] As such, only six collation patterns corresponding to the examination parts of the eFAST examination are read and collation is performed in Steps S11 to S16. Therefore, even in a case in which collation patterns other than six types of collation patterns corresponding to the examination parts of the eFAST examination are stored in the collation pattern memory 15, it is possible to prevent the time required for the part determination process from increasing.

[0049] In a case in which the imaging part is the liver that is not the examination part of the eFAST examination, in the flowchart illustrated in Fig. 5, Steps S11 to S16 are performed using only the read six types of collation patterns and it is determined in Step S17 that the imaging part is unclear. Therefore, it is possible to prevent the time until the process proceeds to an operation subsequent to the part determination process from increasing.

[0050] In a case in which the eFAST examination starts to examine the right abdomen which is an initial examination part and it is determined in Step S11 that the imaging part is the right abdomen, Steps S12 to S16 are not performed and it is confirmed in Step S18 that the imaging part is the right abdomen. Then, the part determination process is completed. Therefore, the collation of the B-mode image signal in Step S12 and the subsequent steps is omitted and it is possible to reduce the time required for the part determination process.

[0051] A known matching technique can be used to collate the B-mode image signal using the read collation patterns. In addition to the matching technique, for example, machine learning or a general image recognition method maybe used to calculate similarity and the B-mode image signals may be collated on the basis of the calculated similarity.

[0052] In a case in which the part determination unit 12 outputs, for example, the determination result indicating that the imaging part is the right abdomen, the imaging condition setting unit 11 adjusts the imaging conditions in Step S7. The imaging condition setting unit 11 stores a plurality of imaging conditions in advance, selects imaging conditions corresponding to the output determination result, and controls the transmitting/receiving unit 2 and the image generation unit 3 such that imaging is performed for the subsequent frames under the selected imaging conditions.

[0053] Then, returning to Step S3, the transmission/reception control unit 8 of the transmitting/receiving unit 2 is controlled such that an ultrasound beam is transmitted and received according to ultrasound beam scanning conditions included in the imaging conditions selected by the imaging condition setting unit 11. Then, in Step S4, the image generation unit 3 is controlled such that a B-mode image is generated from the received signal according to ultrasound image generation conditions included in the imaging conditions selected by the imaging condition setting unit 11. The B-mode image signal is

output from the image generation unit 3 to the display control unit 4. In this way, the B-mode image suitable for diagnosing the right abdomen can be displayed on the display unit 5.

5 **[0054]** Then, Steps S3 to S5 are repeated until the part determination unit 12 determines that the imaging part has been changed in Step S5 and the right abdomen which is the imaging part is continuously diagnosed.

10 **[0055]** Then, for example, in a case in which the examination part is changed from the right abdomen to the left abdomen, the part determination unit 12 determines that the imaging part has been changed in Step S5. Then, in Step S6, the part determination unit 12 determines that the imaging part is the left abdomen. In Step S7, the
15 imaging condition setting unit 11 selects the imaging conditions corresponding to the determination result and the transmitting/receiving unit 2 and the image generation unit 3 are controlled such that a B-mode image signal suitable for diagnosing the left abdomen which is the imaging part is generated.

20 **[0056]** In the imaging conditions, the ultrasound beam scanning conditions can include, for example, an ultrasound beam transmission frequency, a focal position, and a display depth and the ultrasound image generation
25 conditions can include, for example, a sound speed, detection conditions, a gain, a dynamic range, a gradation curve, speckle reduction strength, and end enhancement.

30 **[0057]** As described above, the content of a plurality of continuous examinations is stored in the determination order decision unit 13 in advance. However, the user may operate the information input unit 16 to edit the stored content of the examinations and to store the edited content of the examinations in the determination order decision unit 13. For example, assuming that the abdomen
35 routine examination which continuously examines the liver, the gallbladder, the kidney, the pancreas, and the spleen in this order is stored in the determination order decision unit 13, the user can change one of a plurality of examination parts from the liver to the stomach and edit the content of the examination such that the stomach,
40 the gallbladder, the kidney, the pancreas, and the spleen are examined in this order. In addition, the examination order may be changed without changing the examination part.

45 **[0058]** As described above, in the part determination process for the imaging part in the B-mode image signal, a plurality of collation patterns which have been read according to the determination order are used one by one
50 and the imaging part is confirmed at the time when the imaging part in the B-mode image signal is determined to the examination part corresponding to the collation pattern used for collation. However, the invention is not limited thereto. For example, for the imaging part in the
55 B-mode image signal, similarities to the collation patterns corresponding to the right abdomen, the left abdomen, the region around the bladder, the epigastric region, the right lung, and the left lung may be calculated and the

examination part corresponding to a collation pattern with the highest similarity may be confirmed as the imaging part.

[0059] In a case in which the similarity is calculated as described above, only six types of collation patterns corresponding to the examination parts, such as the right abdomen, the left abdomen, the region around the bladder, the epigastric region, the right lung, and the left lung decided by the determination order decision unit 13, are used. Therefore, it is possible to prevent the time required for the part determination process from increasing.

Embodiment 2

[0060] In Embodiment 1, the part determination unit 12 reads the collation patterns from the collation pattern memory 15 according to the determination order decided by the determination order decision unit 13 and determines the imaging part in the B-mode image signal using only the read collation patterns. However, the invention is not limited thereto. In Embodiment 2, a collation pattern corresponding to an examination part which is located in the vicinity of the examination part corresponding to the collation pattern read by the part determination unit 12 is stored in the collation pattern memory 15 in advance. Then, the collation pattern corresponding to the examination part which is located in the vicinity of the examination part corresponding to the read collation pattern is read from the collation pattern memory 15 so as to be added to the collation patterns read by the part determination unit 12. Then, the imaging part can be determined.

[0061] In a case in which the user inputs the eFAST examination as the examination type information to the information input unit 16, first, the determination order decision unit 13 decides a plurality of examination parts to be continuously examined such as the right abdomen, the left abdomen, a region around the bladder, an epigastric region, the right lung, and the left lung. In addition, the determination order decision unit 13 decides a determination order for determining an imaging part in the order of the right abdomen, the left abdomen, the region around the bladder, the epigastric region, the right lung, and the left lung and outputs the decided determination order to the part determination unit 12. The part determination unit 12 reads collation patterns corresponding to the right abdomen, the left abdomen, the region around the bladder, the epigastric region, the right lung, and the left lung from the collation pattern memory 15 according to the decided determination order.

[0062] Here, the collation patterns corresponding to examination parts which are located in the vicinity of the examination part of the eFAST examination, for example, the cardiac apex and a parasternal region which are located in the vicinity of the epigastric region are also stored in the collation pattern memory 15 in advance. In addition, the examination parts which are located in the vicinity of the examination part of the eFAST examination are stored in the part determination unit 12 in advance. The

collation patterns corresponding to the cardiac apex and the parasternal region which are located in the vicinity of the epigastric region are also read from the collation pattern memory 15.

[0063] As illustrated in the flowchart of Fig. 6, the collation patterns corresponding to the examination parts, such as the right abdomen, the left abdomen, the region around the bladder, the epigastric region, the right lung, the left lung, the cardiac apex, and the parasternal region, are used in this order and the B-mode image signal output from the DSC 10 of the image generation unit 3 is collated.

[0064] For example, in a case in which the parasternal region located in the vicinity of the epigastric region is examined, it is impossible to determine the imaging parts in Steps S11 to S16 corresponding to the right abdomen, the left abdomen, the region around the bladder, the epigastric region, the right lung, and the left lung which are the content of the eFAST examination. It is determined in Step S21 that the imaging part is not the cardiac apex. Then, it is determined in Step S22 that the imaging part is the parasternal region. It is confirmed in Step S18 that the imaging part is the parasternal region.

[0065] As such, for example, in the eFAST examination, in a case in which the examination part that is anomalously located in the vicinity of the epigastric region needs to be examined, the part determination unit 12 can read the collation patterns corresponding to the parasternal region and the cardiac apex located in the vicinity of the epigastric region to determine the imaging part.

[0066] The part determination unit 12 may read the collation pattern corresponding to the examination part of the eFAST examination and the collation patterns corresponding to the examination parts located in the vicinity of the examination part of the eFAST examination at the time when the determination order decided by the determination order decision unit 13 is input. In addition, in the flowchart illustrated in Fig. 5 in Embodiment 1, at the time when the imaging part is determined not to be the left lung in Step S16, the part determination unit 12 may read the collation patterns corresponding to the examination parts located in the vicinity of the examination part of the eFAST examination and may collate the B-mode image signal using the read collation patterns.

Embodiment 3

[0067] In Embodiment 1 and Embodiment 2, the examination type information is selected from a plurality of continuous examination candidates by the user and is then input to the information input unit 16. However, in Embodiment 3, the examination type information is input as a list of a plurality of examination parts selected by the user to the information input unit 16.

[0068] The user selects, for example, the liver, the gallbladder, the kidney, the pancreas, and the spleen from various examination part candidates and inputs a list of examination type information indicating the content of the examination that continuously examines the exami-

nation parts to the information input unit 16. Then, the determination order decision unit 13 decides the determination order of the liver, the gallbladder, the kidney, the pancreas, and the spleen on the basis of the input examination type information and outputs the determination order to the part determination unit 12. The part determination unit 12 performs the part determination process which reads the collation patterns corresponding to the examination parts from the collation pattern memory 15 according to the determination order decided by the determination order decision unit 13, collates the B-mode image signal output from the DSC 10 of the image generation unit 3 in the order of the liver, the gallbladder, the kidney, the pancreas, and the spleen, using the collation patterns corresponding to the examination parts, and determines the imaging part.

[0069] As such, the user can arbitrarily select a plurality of examination parts and input a list of examination type information.

Explanation of References

[0070]

- 1: ultrasound probe
- 1A: array transducer
- 2: transmitting/receiving unit
- 3: image generation unit
- 4: display control unit
- 5: display unit
- 6: transmitting unit
- 7: receiving unit
- 8: transmission/reception control unit
- 9: B-mode processing unit
- 10: DSC
- 11: imaging condition setting unit
- 12: part determination unit
- 13: determination order decision unit
- 14: apparatus control unit
- 15: collation pattern memory
- 16: information input unit
- 17: storage unit
- 18: amplification unit
- 19: A/D conversion unit
- 20: beam former
- 21: signal processing unit

Claims

1. An ultrasound diagnostic apparatus comprising:

an ultrasound probe (1);
 an imaging unit (3) that is configured to transmit and receive an ultrasound beam to and from a subject using the ultrasound probe (1) and convert a received signal output from the ultrasound probe into an image to generate an ultrasound

image of the subject;
 a collation pattern memory (15) that is configured to store a plurality of collation patterns corresponding to a plurality of examination parts of the subject in advance;
 an information input unit (16) that is usable by a user to input examination type information indicating content of an examination for continuously examining the plurality of examination parts;
 a determination order decision unit (13) that is configured to decide a determination order of the plurality of examination parts to be continuously examined, on the basis of the examination type information input to the information input unit (16); and
 a part determination unit (12) that is configured to read the collation patterns corresponding to the examination parts to be continuously examined from the collation pattern memory (15) according to the determination order decided by the determination order decision unit (13) and sequentially collate the ultrasound image generated by the imaging unit (3) in the determination order using the read collation patterns to determine an imaging part of the subject;
 wherein the part determination unit (12) is configured to read a collation pattern corresponding to an examination part which is located in the vicinity of the examination part corresponding to the read collation pattern from the collation pattern memory (15), in addition to the collation patterns read from the collation pattern memory according to the determination order, and determine the imaging part.

2. The ultrasound diagnostic apparatus according to claim 1, wherein the determination order decision unit (13) is configured to store content of a plurality of continuous examinations for continuously examining the plurality of examination parts in advance, and
 in a case in which the user inputs a continuous examination selected from the plurality of continuous examinations as the examination type information to the information input unit (16), the determination order decision unit (13) is configured to decide the determination order of the plurality of examination parts corresponding to the input continuous examination.

3. The ultrasound diagnostic apparatus according to claim 1, wherein the examination type information is to be input as a list of the plurality of examination parts to be continuously examined to the information input unit (16) by the user, and the determination order decision unit (13) is configured to decide the determination order of the plurality of examination parts on the basis of the list input from the information input unit (16).

4. The ultrasound diagnostic apparatus according to any one of claims 1 to 3, further comprising:

an imaging condition setting unit (11) that is configured to set imaging conditions corresponding to the imaging part determined by the part determination unit (12),
 wherein the imaging unit (3) is configured to generate the ultrasound image according to the imaging conditions set by the imaging condition setting unit (11).

5. A method for controlling an ultrasound diagnostic apparatus, the method comprising:

a step of transmitting and receiving (S3) an ultrasound beam to and from a subject using an ultrasound probe and converting a received signal output from the ultrasound probe into an image to generate an ultrasound image of the subject;
 a step of allowing (S1) a user to input examination type information indicating content of an examination for continuously examining a plurality of examination parts;
 a step of deciding (S2) a determination order of the plurality of examination parts to be continuously examined, on the basis of the input examination type information; and
 a step of reading (S6) collation patterns corresponding to the examination parts to be continuously examined from a plurality of collation patterns, which correspond to the plurality of examination parts and are stored in advance, according to the decided determination order and sequentially collating the ultrasound image in the determination order using the read collation patterns to determine (S18) an imaging part of the subject;
 wherein the step of reading (S6) collation patterns comprises reading a collation pattern corresponding to an examination part which is located in the vicinity of the examination part corresponding to the read collation pattern, in addition to the collation patterns read according to the determination order.

Patentansprüche

1. Ultraschalldiagnosevorrichtung, umfassend:

eine Ultraschallsonde (1);
 eine Bildgebungseinheit (3), ausgebildet zum Senden und zum Empfangen eines Ultraschallstrahls zu bzw. von einem Subjekt unter Verwendung der Ultraschallsonde (1) und zum Umwandeln eines empfangenen Signals, das von

der Ultraschallsonde ausgegeben wurde, in ein Bild, um ein Ultraschallbild eines Bildgebungsteils des Subjekts zu erzeugen;
 einen Kollationsmusterspeicher (15), konfiguriert zum Vorab-Speichern mehrerer Kollationsmuster entsprechend mehreren Untersuchungsteilen des Subjekts;
 eine Informationseingabeeinheit (16), die verwendbar ist von einem Benutzer zum Eingeben von Untersuchungstypinformation, die den Inhalt einer Untersuchung für eine kontinuierliche Untersuchung der mehreren Untersuchungsteile angibt;
 eine Bestimmungsreihenfolgen-Entscheidungseinheit (13), konfiguriert zum Entscheiden einer Bestimmungsreihenfolge der mehreren Untersuchungsteile für die kontinuierliche Untersuchung auf der Grundlage der Untersuchungstypinformation, die in die Informationseingabeeinheit (16) eingegeben wurde; und
 eine Teilebestimmungseinheit (12), konfiguriert zum Lesen der Kollationsmuster entsprechend den kontinuierlich zu untersuchenden Untersuchungsteilen aus dem Kollationsmusterspeicher (15) gemäß der Bestimmungsreihenfolge, die von der Bestimmungsreihenfolgen-Entscheidungseinheit (13) entschieden wurde, und zum sequentiellen Zuordnen des von der Bildgebungseinheit (3) erzeugten Ultraschallbilds in der Bestimmungsreihenfolge unter Verwendung der gelesenen Kollationsmuster, um einen Bildgebungsteil des Subjekts zu bestimmen; wobei die Teilebestimmungseinheit (12) konfiguriert ist zum Lesen eines Kollationsmusters entsprechend einem Untersuchungsteil, das sich in der Nähe des Untersuchungsteils entsprechend dem gelesenen Kollationsmuster befindet, aus dem Kollationsmusterspeicher (15), zusätzlich zu den Kollationsmustern, die aus dem Kollationsmusterspeicher gemäß der Bestimmungsreihenfolge gelesen werden, und zum Bestimmen des Bildgebungsteils.

2. Vorrichtung nach Anspruch 1,

bei der die Bestimmungsreihenfolgen-Entscheidungseinheit (13) konfiguriert ist zum Vorab-Speichern des Inhalts mehrerer kontinuierlicher Untersuchungen zum kontinuierlichen Untersuchen der mehreren Untersuchungsteile, und für den Fall, dass der Benutzer eine aus den mehreren kontinuierlichen Untersuchungen ausgewählte kontinuierliche Untersuchung als die Untersuchungstypinformation in die Informationseingabeeinheit (16) eingegeben hat, die Bestimmungsreihenfolgen-Entscheidungseinheit (13) konfiguriert ist zum Entscheiden der Bestimmungsreihenfolge der mehreren Unter-

suchungsteile entsprechend der eingegebenen kontinuierlichen Untersuchung.

3. Vorrichtung nach Anspruch 1,

bei der die Untersuchungstyp-Information eingegeben ist als eine Liste der mehreren Untersuchungsteile für die kontinuierliche Untersuchung über die Informationseingabeeinheit (16) seitens des Benutzers, und die Bestimmungsreihenfolgen-Entscheidungseinheit (13) konfiguriert ist zum Entscheiden der Bestimmungsreihenfolge der mehreren Untersuchungsteile auf der Grundlage der über die Informationseingabeeinheit (16) eingegebenen Liste.

4. Vorrichtung nach einem der Ansprüche 1 bis 3, weiterhin umfassend:

eine Bildgebungsbedingungs-Einstelleinheit (11), konfiguriert zum Einstellen von Bildgebungsbedingungen entsprechend dem von der Teilebestimmungseinheit (12) bestimmten Bildgebungsteil, wobei die Bildgebungseinheit (3) konfiguriert ist zum Erzeugen des Ultraschallbilds gemäß den von der Bildgebungsbedingungs-Einstelleinheit (11) eingestellten Bildgebungsbedingungen.

5. Verfahren zum Steuern einer Ultraschalldiagnosevorrichtung, umfassend:

einen Schritt des Sendens und des Empfangens (S3) eines Ultraschallstrahls zu und von einem Subjekt unter Verwendung einer Ultraschallsonde, und des Umwandelns eines empfangenen Signals, welches von der Ultraschallsonde ausgegeben wird, in ein Bild, um ein Ultraschallbild des Subjekts zu erzeugen;

einen Schritt, der es einem Benutzer erlaubt (S1), Untersuchungstyp-Information einzugeben, welche den Inhalt einer Untersuchung für eine kontinuierliche Untersuchung mehrerer Untersuchungsteile angibt;

einen Schritt des Entscheidens (S2) einer Bestimmungsreihenfolge der mehreren Untersuchungsteile für die kontinuierliche Untersuchung auf der Grundlage der eingegebenen Untersuchungstypinformation; und

einen Schritt des Lesens (S6) von Kollationsmustern entsprechend den Untersuchungsteilen für die kontinuierliche Untersuchung aus einer Mehrzahl von Kollationsmustern, die den mehreren Untersuchungsteilen entsprechen und vorab gespeichert wurden, nach Maßgabe der entschiedenen Bestimmungsreihenfolge, und des sequentiellen Zuordnens des Ultra-

schallbilds in die Bestimmungsreihenfolge unter Verwendung der gelesenen Kollationsmuster, um einen Bildgebungsteil des Subjekts zu bestimmen (S18);

wobei der Schritt des Lesens (S6) von Kollationsmustern das Lesen eines Kollationsmusters umfasst, das einem Untersuchungsteil entspricht, welches sich in der Nähe desjenigen Untersuchungsteils befindet, das dem gelesenen Kollationsmuster entspricht, zusätzlich zu den gemäß der Bestimmungsreihenfolge gelesenen Kollationsmustern.

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Revendications

1. Appareil de diagnostic à ultrasons, comprenant :

une sonde à ultrasons (1) ;

une unité d'imagerie (3), laquelle est configurée pour transmettre et recevoir un faisceau ultrasonore en direction et en provenance d'un sujet à l'aide de la sonde à ultrasons (1), et pour convertir un signal reçu produit à partir de la sonde à ultrasons en une image afin de générer une image ultrasonore du sujet ;

une mémoire de motifs de collationnement (15), laquelle est configurée pour stocker au préalable une pluralité de motifs de collationnement correspondant à une pluralité de parties d'examen du sujet ;

une unité d'entrée d'informations (16), laquelle peut être utilisée par un utilisateur pour entrer des informations de type d'examen indiquant un contenu d'un examen pour examiner en continu la pluralité de parties d'examen ;

une unité de décision d'ordre de détermination (13), laquelle est configurée pour décider d'un ordre de détermination de la pluralité de parties d'examen à examiner en continu, sur la base des informations de type d'examen entrées dans l'unité d'entrée d'informations (16), et

une unité de détermination de partie (12), laquelle est configurée pour lire les motifs de collationnement correspondant aux parties d'examen à examiner en continu à partir de la mémoire de motifs de collationnement (15) conformément à l'ordre de détermination décidé par l'unité de décision d'ordre de détermination (13), et pour collationner de manière séquentielle l'image ultrasonore générée par l'unité d'imagerie (3) dans l'ordre de détermination à l'aide des motifs de collationnement lus, afin de déterminer une partie d'imagerie du sujet ;

dans lequel l'unité de détermination de partie (12) est configurée pour lire un motif de collationnement correspondant à une partie d'examen située dans le voisinage de la partie d'exa-

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- men correspondant au motif de collationnement lu à partir de la mémoire de motifs de collationnement (15), outre les motifs de collationnement lus à partir de la mémoire de motifs de collationnement conformément à l'ordre de détermination, et pour déterminer la partie d'imagerie. 5
2. Appareil de diagnostic à ultrasons selon la revendication 1, dans lequel l'unité de décision d'ordre de détermination (13) est configurée pour stocker au préalable le contenu d'une pluralité d'examens continus pour examiner en continu la pluralité de parties d'examen, et 10
- dans un cas où l'utilisateur entre un examen continu sélectionné parmi la pluralité d'examens continus comme informations de type d'examen dans l'unité d'entrée d'informations (16), l'unité de décision d'ordre de détermination (13) est configurée pour décider de l'ordre de détermination de la pluralité de parties d'examen correspondant à l'examen continu d'entrée. 15
3. Appareil de diagnostic à ultrasons selon la revendication 1, dans lequel les informations de type d'examen doivent être entrées sous la forme d'une liste de la pluralité de parties d'examen à examiner en continu dans l'unité d'entrée d'informations (16) par l'utilisateur, et 20
- l'unité de décision d'ordre de détermination (13) est configurée pour décider de l'ordre de détermination de la pluralité de parties d'examen sur la base de la liste entrée à partir de l'unité d'entrée d'informations (16). 25
4. Appareil de diagnostic à ultrasons selon l'une quelconque des revendications 1 à 3, comprenant en outre : 30
- une unité de réglage de condition d'imagerie (11), laquelle est configurée pour régler des conditions d'imagerie correspondant à la partie d'imagerie déterminée par l'unité de détermination de partie (12), et 35
- dans lequel l'unité d'imagerie (3) est configurée pour générer l'image ultrasonore conformément aux conditions d'imagerie réglées par l'unité de réglage de condition d'imagerie (11). 40
5. Procédé destiné à commander un appareil de diagnostic à ultrasons, comprenant les étapes suivantes :
- une étape pour transmettre et recevoir (S3) un faisceau ultrasonore en direction et en provenance d'un sujet à l'aide d'une sonde à ultrasons, et pour convertir un signal reçu produit à 45
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partir de la sonde à ultrasons en une image afin de générer une image ultrasonore du sujet ; une étape pour permettre (S1) à un utilisateur d'entrer des informations de type d'examen indiquant un contenu d'un examen pour examiner en continu une pluralité de parties d'examen ; une étape pour décider (S2) d'un ordre de détermination de la pluralité de parties d'examen à examiner en continu, sur la base des informations de type d'examen entrées, et une étape pour lire (S6) des motifs de collationnement correspondant aux parties d'examen à examiner en continu à partir d'une pluralité de motifs de collationnement, lesquels correspondent à la pluralité de parties d'examen et sont stockés au préalable, conformément à l'ordre de détermination décidé, et pour collationner de manière séquentielle l'image ultrasonore dans l'ordre de détermination à l'aide des motifs de collationnement lus, afin de déterminer (S18) une partie d'imagerie du sujet ; dans lequel l'étape pour lire (S6) les motifs de collationnement comprend l'étape pour lire un motif de collationnement correspondant à une partie d'examen située dans le voisinage de la partie d'examen correspondant au motif de collationnement lu, outre les motifs de collationnement lus conformément à l'ordre de détermination.

FIG. 1

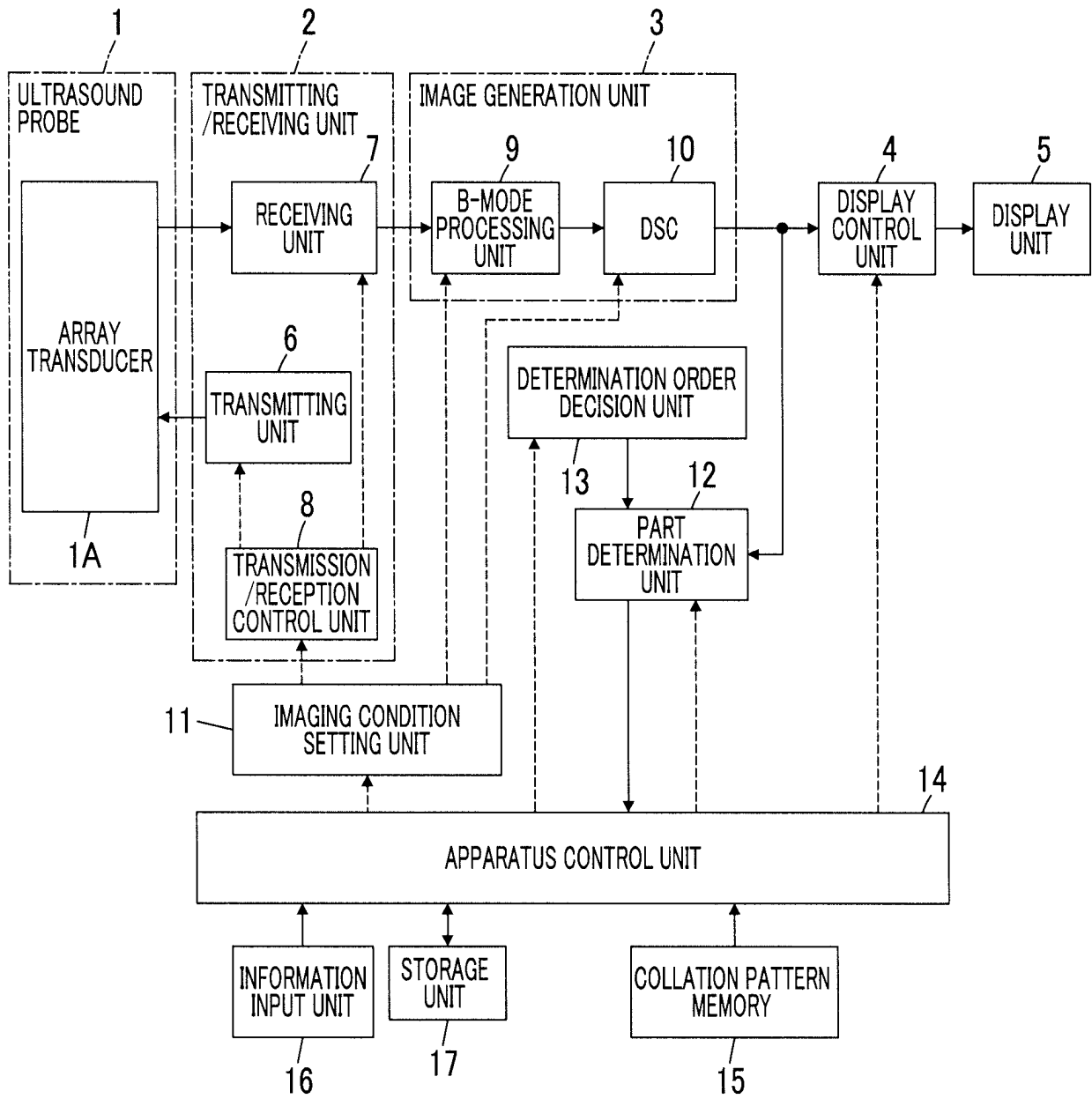


FIG. 2

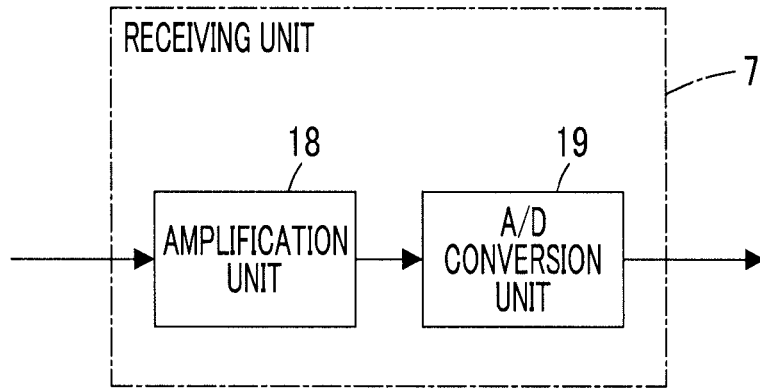


FIG. 3

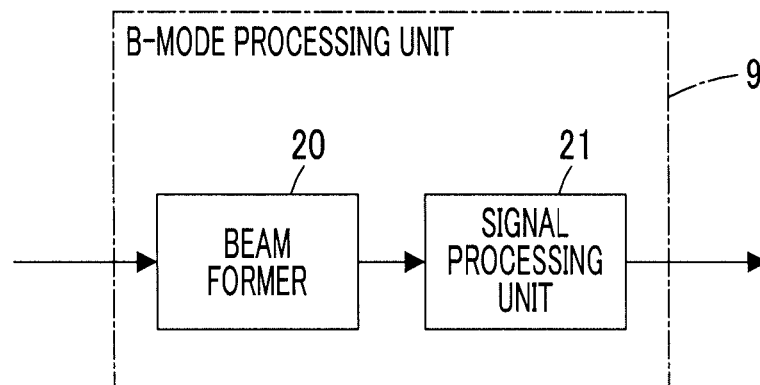


FIG. 4

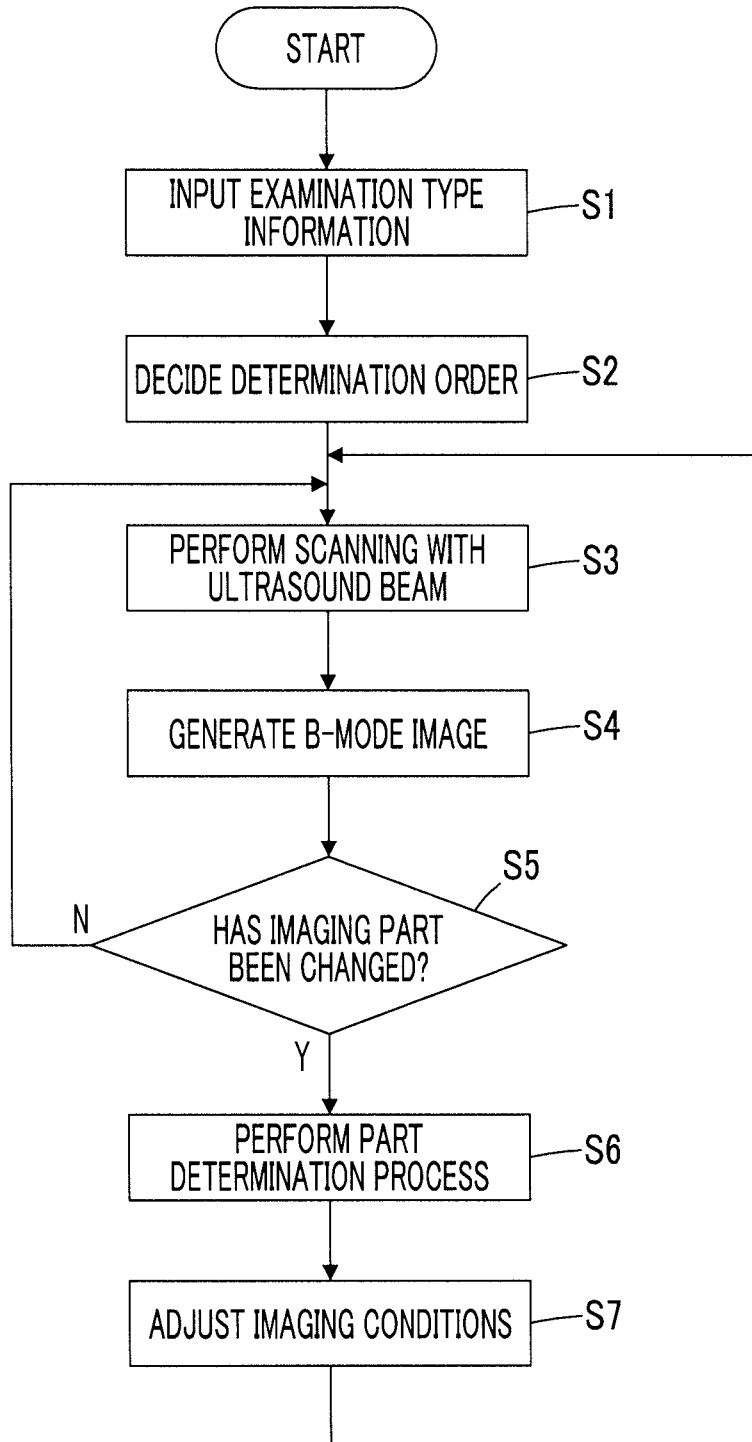


FIG. 5

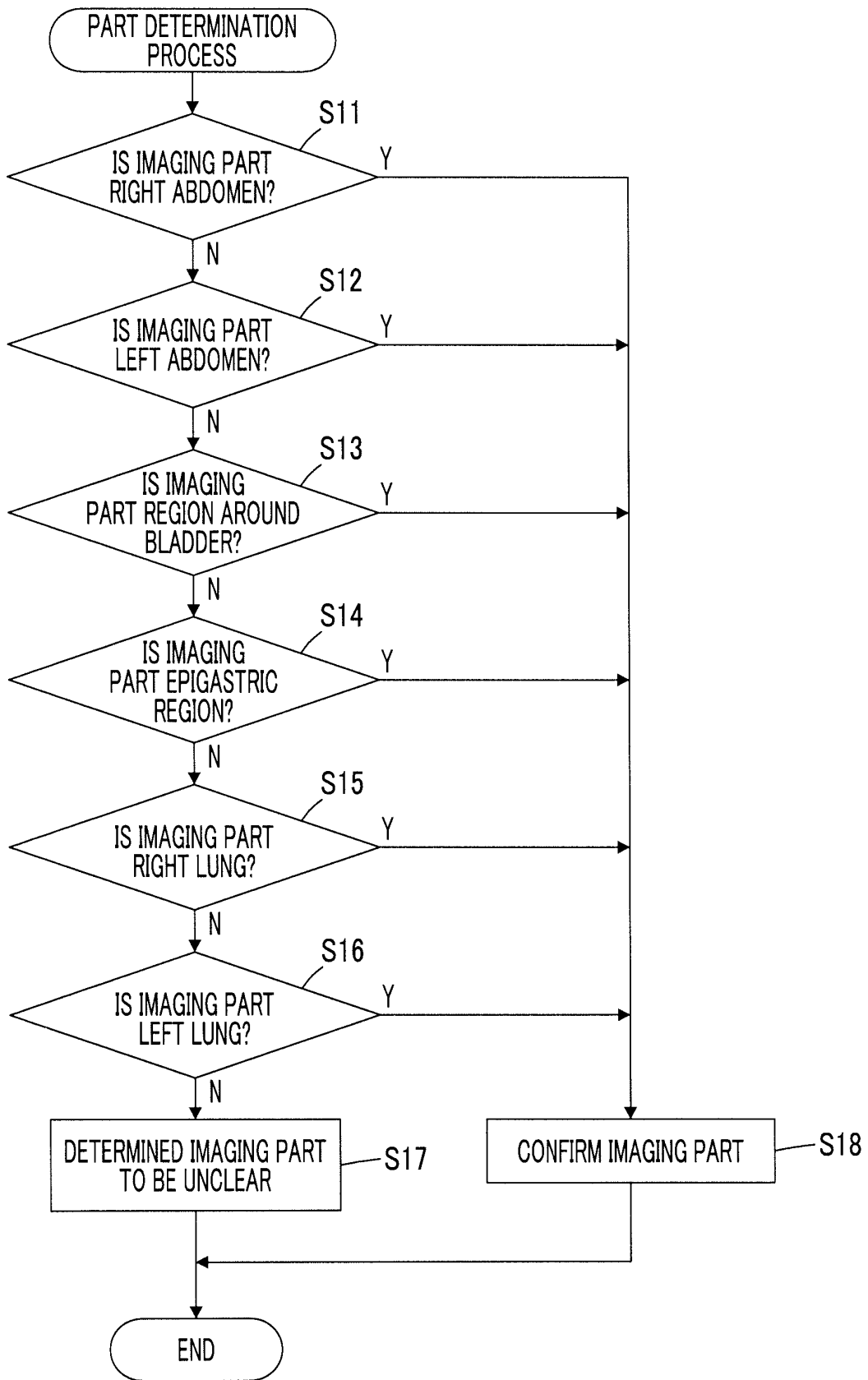
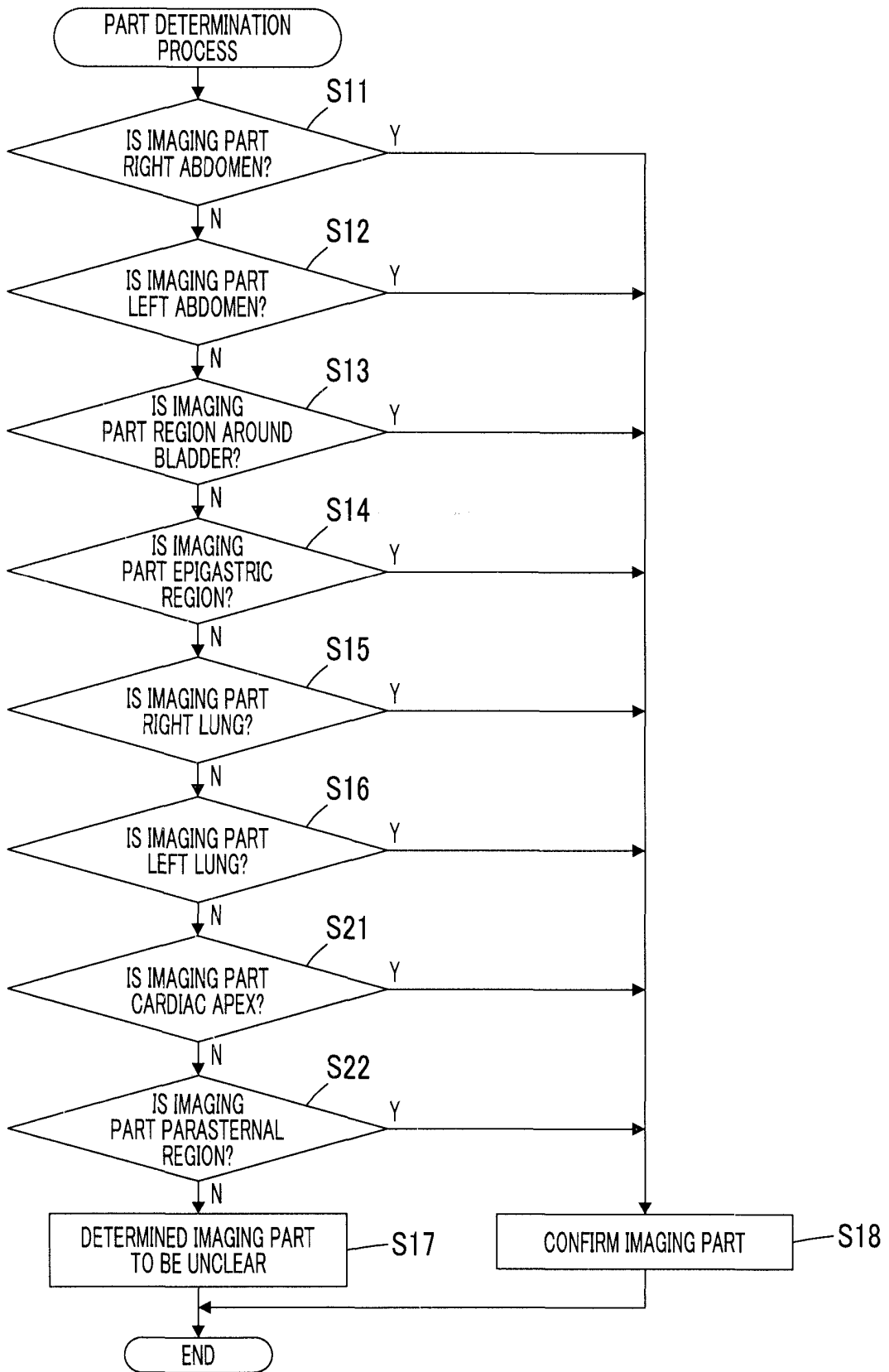


FIG. 6



REFERENCES CITED IN THE DESCRIPTION

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