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(54) **Ultrasonic diagnosis apparatus and displaying method**

Ultraschalldiagnosevorrichtung und Anzeigeverfahren

Appareil de diagnostic ultrasonique et procédé d'affichage

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Description

FIELD

[0001] Embodiments described herein relate generally to an ultrasonic diagnosis apparatus and displaying method.

BACKGROUND

[0002] A method for processing real-time contrast enhanced ultrasonic images is disclosed in WO 96/33655. An apparatus for three-dimensional ultrasonic diagnosis is disclosed in US 6,352,509 B1. Image segmentation for displaying myocardial perfusion is disclosed in WO 2005/072617 A1. A method for detecting ultrasound contrast agent in soft tissue is disclosed in US 2001/0056236 A1.

[0003] There have been growing needs for the quantitative evaluation of cardiac wall motion. Recently, a myocardial motion tracking technique (Wall Motion Tracking) using a pattern matching technique has been commercialized, and used clinically. This technique is, however, dependent on the image quality of ultrasonic images. Using a contrast medium will improve the image quality of a cardiac image. Therefore, a contrast medium may be used in combination with tracking processing.

[0004] However, the influence of speckle pattern noise due to a contrast medium will degrade tracking accuracy on the boundary portions between cardiac chambers and cardiac muscle.

[0005] Overcoming the above problems can be provided by the present invention as defined in the independent claims. Further developments of the invention are given in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006]

FIG. 1 is a block diagram showing the arrangement of an ultrasonic diagnosis apparatus according to an embodiment;

FIG. 2 is a flowchart showing a processing procedure by this embodiment;

FIG. 3 is a graph showing an example of an image before the injection of a contrast medium in FIG. 2;

FIG. 4 is a view showing an example of a cardiac chamber ROI and myocardial ROI set in step S12 in FIG. 2;

FIG. 5 is a view for a supplementary explanation of steps S15, S17, and S20 in FIG. 2, showing temporal changes in the average signal / echo intensity of a cardiac chamber ROI and myocardial ROI;

FIG. 6 is a view showing the tracking result obtained by a myocardial tracking processing unit in FIG. 1 without using any contrast medium; and

FIG. 7 is a view showing the tracking result obtained by the myocardial tracking processing unit in FIG. 1 using a contrast medium.

DETAILED DESCRIPTION

[0007] In general, according to one embodiment, an ultrasonic diagnosis apparatus according to claim 1 is provided.

[0008] FIG. 1 is a block diagram showing the arrangement of the ultrasonic diagnosis apparatus according to this embodiment. A multi-channel ultrasonic probe 12 includes a plurality of transducers arranged in an array. Each transducer includes a piezoelectric element, an individual electrode formed on the upper surface of the piezoelectric element, and a common electrode formed on the lower surface of the piezoelectric element. One channel is constituted by one or a plurality of neighboring transducers. An apparatus body 11 housed in a console case is connected to the ultrasonic probe 12.

[0009] The apparatus body 11 includes a transmission unit 21 and reception unit 22 connected to the ultrasonic probe 12. The transmission unit 21 is provided with a pulser 21C connected to each transducer. The pulser 21C applies a driving signal (high-frequency voltage signal) to each corresponding transducer in response to a pulse signal, as a trigger, which is generated from a pulse generator 21A at a predetermined period (the reciprocal of a pulse repetition frequency PRF) and delayed by a transmission delay unit 21B.

[0010] The ultrasonic waves generated by the mechanical vibrations of transducers based on driving signals propagate in an object, are reflected by a discontinuity surface of acoustic impedance along the propagation path, and return as echoes to the ultrasonic probe 12. The echoes mechanically vibrate piezoelectric elements of the ultrasonic probe 12. A preamplifier 22A of the reception unit 22 amplifies the weak electrical signals generated by the vibrations. A reception delay unit 22B then delays the signals. An adder 22C adds the signals (phasing addition processing). This gives directivity to the echo signal. The echo signal obtained by such addition will be referred to as a reception signal hereinafter.

[0011] A B-mode processing unit 23 includes a detection circuit, a logarithmic amplifier, and an analog/digital converter. The detection circuit detects the ultrasonic waves (reception signal) reflected by an acoustic impedance boundary in a living body, and outputs the envelope of the ultrasonic waves. The logarithmic amplifier logarithmically amplifies the output signal from the detection circuit. The analog/digital converter further converts the signal into a digital signal and outputs it as ultrasonic image data.

[0012] The output of the B-mode processing unit 23 is connected to a data/control bus 30. A digital scan converter (DSC) 24 is connected to the data/control bus 30. The digital scan converter 24 superimposes graphics such as a pointer and an ROI mark on the ultrasonic image in an ultrasonic scan scheme, rearranges the in-

formation in accordance with the video scan scheme of a monitor 14, and outputs the resultant information.

[0013] The units connected to the data/control bus 30 include a control unit 31, an image memory 32, an ROI pattern storage unit 33, an ROI setting unit 34, an average luminance calculation unit 35, an average luminance comparison unit 36, a myocardial tracking processing unit 37, an operation unit 38, an indication generating unit 39, and a time register 40. The image memory 32 stores and retains the ultrasonic image data output from the B-mode processing unit 23 in accordance with a control signal for the storage of image data from the control unit 31. When receiving no control signal from the control unit 31, the image memory 32 does not store ultrasonic image data or overwrites the ultrasonic image data but does not retain the data.

[0014] The ROI pattern storage unit 33 stores and holds the data of a plurality of ROI patterns and the data of a plurality of sampled ultrasonic images in advance. The data of each ROI pattern defines the sizes and positions of two, typically circular, ROIs respectively corresponding to a cardiac chamber region and a myocardial region on a long-axis cardiac ultrasonic image. A plurality of sampled ultrasonic images are respectively associated with a plurality of ROI patterns. The two ROIs defined by an ROI pattern are set to sizes and positions suitable for a cardiac chamber region and a myocardial region on a sampled ultrasonic image associated with each ROI pattern.

[0015] The ROI setting unit 34 sets a cardiac chamber ROI and a myocardial ROI on a live ultrasonic image actually acquired from an object, based on a specific ROI pattern selected from the plurality of ROI patterns stored in the ROI pattern storage unit 33. The ROI setting unit 34 selects a sampled ultrasonic image most similar to a live ultrasonic image, and selects an ROI pattern associated with the selected sampled ultrasonic image as a specific ROI pattern. Typically, the ROI setting unit 34 subtracts the live ultrasonic image and each sampled ultrasonic image from each other, and selects a sampled ultrasonic image exhibiting a minimum sum of squares of the difference.

[0016] The average luminance calculation unit 35 calculates, for the live ultrasonic image, the average luminance of the pixels in the set cardiac chamber ROI and the average luminance of the pixels in the set myocardial ROI. The signal intensity or the echo intensity is finally converted into luminance according to the gray scale or color table. Therefore the average luminance can be replaced the average signal / echo intensity.

[0017] The average luminance comparison unit 36 compares the calculated average luminance of the cardiac chamber ROI with the calculated average luminance of the myocardial ROI.

[0018] The control unit 31 controls the indication generating unit 39, in accordance with the comparison result between the average luminance of the cardiac chamber ROI and the average luminance of the myocardial ROI, to generate a preset indication. The control unit 31 also controls the image memory 32 to store the live ultrasonic image data. Typically, an indication is message data using a text representing, for example, that an image suitable for speckle tracking has been acquired. Typically, a message is presented as the text "image suitable for speckle tracking has been acquired". The monitor 14 displays this message after the digital scan converter 24 superimposes it on the live ultrasonic image. The indication may be presented by changing part of an ultrasonic image, typically the color of a boundary frame between cardiac muscle and a cardiac chamber or in another display form. Assume that such an indication is a message in the following description.

[0019] In practice, after the injection of a contrast medium, the average luminance of the cardiac chamber ROI increases and exceeds the average luminance of the myocardial ROI. Thereafter, as the contrast medium flows out from the cardiac chamber with the lapse of time, the average luminance of the cardiac chamber ROI changes to become lower than that of the myocardial ROI. At the time of this change (at the start of this change), a message is displayed, and the image memory 32 starts to store live ultrasonic image data. Note that the message may be displayed and the image memory 32 may start to store the live ultrasonic image data at a time point a predetermined time after the change time point as a reference or an estimated time point a predetermined time before the change time point.

[0020] The control unit 31 controls the time register 40 to start measuring an elapsed time at the above change time point. The time register 40 measures an elapsed time from the above change time point. The monitor 14 displays the measured elapsed time.

[0021] The control unit 31 also compares the average luminance of the cardiac chamber ROI with a preset threshold. When the average luminance of the cardiac chamber ROI becomes lower than the threshold, the control unit 31 controls the indication generating unit 39 to generate message data and end the storage of live ultrasonic image data. This message is presented as, for example, the text "acquisition of image suitable for speckle tracking is complete".

[0022] At the same time, the control unit 31 further controls the ultrasonic transmission unit 21 and the ultrasonic reception unit 22 to end ultrasonic scanning.

[0023] Note that the control unit 31 may end ultrasonic scanning at a time point when a predetermined period of time has elapsed since the change time point measured by the time register 40. In accordance with a selection instruction issued by the operator in advance, the control unit 31 selects whether to end ultrasonic scanning at a time point when the average luminance of the cardiac chamber ROI becomes lower than the threshold or at a time point when a predetermined time has elapsed since the change time point measured by the time register 40. When the control unit 31 ends ultrasonic scanning at a time point when a predetermined time has elapsed since

the change time point measured by the time register 40, the monitor 14 displays the remaining time before the end of ultrasonic scanning.

[0024] Note that the operation unit 38 includes operation buttons in the form of real or icon buttons which are manually operated to issue instructions to start and end storing live ultrasonic image data into the image memory 32. The operator can arbitrarily select in advance whether to manually issue instructions to start and end storing live ultrasonic image data into the image memory 32 or to make the control unit 31 automatically control storing operation as described above.

[0025] FIG. 2 shows a processing procedure in this embodiment. First of all, the ultrasonic transmission unit 21 and the ultrasonic reception unit 22 start ultrasonic scanning on a long-axis slice of a cardiac region of an object, as a scan surface, via the ultrasonic probe 12 (S11). Ultrasonic scanning is continuously repeated up to step S21 (to be described later). Concurrently with ultrasonic scanning, the B-mode processing unit 23 instantly generates ultrasonic image data based on a reception signal. This image is displayed as a grayscale image on the monitor 14 via the digital scan converter 24. Although the ultrasonic image data generated by the B-mode processing unit 23 is also supplied to the image memory 32, the data is only overwritten and not stored until a control signal for the start of storage (to be described later) is received from the control unit 31.

[0026] The ROI setting unit 34 reads, from the image memory 32, ultrasonic image data corresponding to a specific cardiac phase which is set in advance, under the control of the control unit 31. The ROI setting unit 34 subtracts the ultrasonic image from each of the plurality of sampled ultrasonic images stored in the ROI pattern storage unit 33, and calculates the sums of squares of the differences. The ROI setting unit 34 selects a sampled ultrasonic image exhibiting a minimum of the calculated sums of squares, and reads out the data of an ROI pattern associated with the selected sampled ultrasonic image from the ROI pattern storage unit 33. With this operation, the ROI setting unit 34 sets a cardiac chamber ROI and a myocardial ROI (S12). The ROI setting unit 34 supplies the data of the ROI pattern to the average luminance calculation unit 35.

[0027] Subsequently, a contrast medium is injected from a contrast medium injector 13 into an object at a proper timing. As a consequence, the contrast medium injector 13 outputs a signal representing the start of the administration of a contrast medium to the control unit 31 (S13). In response to this signal as a trigger, the average luminance calculation unit 35 sequentially receives ultrasonic image data sequentially generated by ultrasonic scanning, via the image memory 32, under the control the control unit 31. The average luminance calculation unit 35 repeatedly calculates an average luminance AVv of the pixels in the cardiac chamber ROI and an average luminance AVm of the pixels in the myocardial ROI, which are based on the ROI pattern exemplified in FIG. 4 (S14).

[0028] FIG. 3 shows temporal changes in the average luminance AVv of the pixels in the cardiac chamber ROI and the average luminance AVm of the pixels in the myocardial ROI. Referring to FIG. 3, time t0 is the time when a contrast medium is administered. In a period before the contrast medium flows into the cardiac chamber, the average luminance AVv of the pixels in the cardiac chamber ROI is lower than the average luminance AVm of the pixels in the myocardial ROI.

[0029] The average luminance comparison unit 36 compares the average luminance AVv of the cardiac chamber ROI with the average luminance AVm of the myocardial ROI, which are calculated by the average luminance calculation unit 35. First, the average luminance comparison unit 36 determines whether the average luminance AVv of the cardiac chamber ROI is higher than the average luminance AVm of the myocardial ROI (S15). The change point at which the average luminance AVv of the cardiac chamber ROI becomes higher than the average luminance AVm of the myocardial ROI indicates that the contrast medium has flowed into the cardiac chamber. This change point corresponds to time t1. The average luminance calculation unit 35 continuously and repeatedly calculates the average luminance AVv of the pixels in the cardiac chamber ROI and the average luminance AVm of the pixels in the myocardial ROI (S16).

[0030] The average luminance comparison unit 36 again compares the average luminance AVv of the cardiac chamber ROI with the average luminance AVm of the myocardial ROI, which are calculated by the average luminance calculation unit 35. This time, the average luminance comparison unit 36 determines whether the average luminance AVv of the cardiac chamber ROI is lower than the average luminance AVm of the myocardial ROI (S17). The time point at which the average luminance AVv of the cardiac chamber ROI changes from a higher value to a lower value than the average luminance AVm of the myocardial ROI indicates that the contrast medium gradually flows out from the cardiac chamber to stabilize the contrast medium density in the cardiac chamber at a proper density in speckle tracking processing including the processing of identifying the interface of the cardiac muscle relative to the cardiac chamber. This time point corresponds to time t2.

[0031] At time t2 when the average luminance AVv of the cardiac chamber ROI has changed from a higher value to a lower value than the average luminance AVm of the myocardial ROI, the indication generating unit 39 generates message data under the control of the control unit 31. The digital scan converter 24 superimposes the message data on a live ultrasonic image. The monitor 14 then displays the resultant image, as exemplified by FIG. 5 (S18). For example, the message "image suitable for speckle tracking has been acquired" is displayed on the screen of the image display 18 upon being superimposed on a live ultrasonic image (S18).

[0032] At the same time, the image memory 32 starts

to store live ultrasonic image data under the control of the control unit 31 (S19). The image memory 32 continuously stores live ultrasonic image data until the control unit 31 determines the end of the processing in step S21.

[0033] Note that when seeing the message, the operator may start storing live ultrasonic image data by issuing an instruction to start the storage of live ultrasonic image data by operating the operation unit 38.

[0034] The average luminance comparison unit 36 compares the average luminance AVv of the cardiac chamber ROI calculated by the average luminance calculation unit 35 with the preset threshold (S20). A change in the average luminance AVv of the cardiac chamber ROI to a value lower than the threshold represents that the effect of the contrast medium in the cardiac chamber has become unsuitable for speckle tracking processing. This time point corresponds to time t3.

[0035] At time t3 when the average luminance AVv of the cardiac chamber ROI has changed to a value lower than the threshold, the monitor 14 stops displaying the message on the screen under the control of the control unit 31. At the same time, the control unit 31 stops ultrasonic scanning and stops storing live ultrasonic image data in the image memory 32 (S21).

[0036] Note that it is possible to stop storing live ultrasonic image data by making the operator operate the operation unit 38 to issue an instruction to end the storage of live ultrasonic image data upon seeing that the message is turned off.

[0037] As described above, ultrasonic image data is stored in the period between time t2 when the average luminance AVv of the cardiac chamber ROI has changed from a higher value to a lower value than the average luminance AVm of the myocardial ROI and time 3 when the average luminance AVv of the cardiac chamber ROI has changed to a value lower than the threshold. The myocardial tracking processing unit 37 executes myocardial tracking processing by using a plurality of ultrasonic image data stored in this period. FIGS. 6 and 7 each show a result example display based on a myocardial tracking processing result. Myocardial regions are extracted from a plurality of ultrasonic images. The extracted myocardial regions each are segmented into a plurality of segments. The radial expansion/contraction ratio of each myocardial segment on a reference image relative to the center of the cardiac chamber is calculated. A segment mark is then superimposed and displayed on an ultrasonic image with a hue corresponding to the expansion/contraction ratio. Temporal changes in the radial expansion/contract ratio of each segment are displayed in the form of a graph.

[0038] This embodiment can calculate an accurate speckle tracking processing result by improving degradation in the tracking accuracy of a boundary portion between the cardiac chamber and the cardiac muscle due to the influence of speckle pattern noise caused by a contrast medium and executing speckle tracking processing using an ultrasonic image with suitable image quality.

[0039] According to the above description, the image memory 32 stores a plurality of ultrasonic image data generated in the period between start time point t2 and end time point t3, and myocardial tracking processing is executed for the stored ultrasonic image data. However, it is possible to store, in the image memory 32 in advance, all ultrasonic image data generated after time t0 at which scanning starts or time t1 and execute myocardial tracking processing for a plurality of ultrasonic image data generated in the period between start time t2 and end time t3, which are extracted from the stored ultrasonic image data.

Claims

1. An ultrasonic diagnosis apparatus for generating a plurality of ultrasonic images by repeatedly scanning an interior of an object injected with a contrast medium by using an ultrasonic wave, the apparatus comprising:

   a display unit (14) configured to display the ultrasonic images;
   a comparison unit (36) configured to compare a signal intensity of a cardiac chamber portion of the ultrasonic image with a signal intensity of a myocardial portion concurrently with the scanning; and
   an indication generating unit (39) configured to generate a specific indication at one of a change time point at which a signal intensity of the cardiac chamber portion changes from a higher value to a lower value than a signal intensity of the myocardial portion and another time point with reference to the change time point, wherein the another time point is a time point a predetermined time after the change time point or an estimated time point a predetermined time before the change time point.

2. The apparatus according to claim 1,
   characterized in that the comparison unit (36) is configured to compare an average signal intensity of a cardiac chamber ROI of the ultrasonic image with an average signal intensity of a myocardial ROI.

3. The apparatus according to claim 1 or 2,
   further comprising an ROI setting unit (34) configured to set positions and sizes of the cardiac chamber ROI and myocardial ROI in accordance with a specific ROI pattern selected from a plurality of ROI patterns.

4. The apparatus according to claim 3,
   characterized in that the ROI setting unit (34) is configured to select the specific ROI pattern based

on a correlation between one of the ultrasonic images and a plurality of sampled ultrasonic images respectively corresponding to the plurality of ROI patterns and/or to change the positions and sizes of the cardiac chamber ROI and myocardial ROI in accordance with a cardiac phase.

5. The apparatus according to any one of claims 1 to 4, **characterized in that** the indication generating unit (39) is configured to generate indication data indicating that an image suitable for speckle tracking is acquired, and/or to generate data for causing the display unit to display a message representing that an image suitable for speckle tracking is acquired, and/or to generate data for changing a color of a portion of the displayed ultrasonic image.

6. The apparatus according to any one of claims 1 to 5, further comprising an image storage (32), and
a control unit (31) configured to control the image storage (32) to store at least one of the ultrasonic images generated after one of the change time point and the another time point in the image storage, and/or to control the image storage (32) to store at least one of the ultrasonic images generated in a period between one of the change time point or the another time point and a time point elapsing a predetermined time after the time point.

7. The apparatus according to any one of claims 1 to 6, further comprising a tracking processing unit (37) configured to track a contour of a specific region in the ultrasonic images, and/or to track the contour of the specific region with respect to one of the ultrasonic images generated after one of the change time point and the another time point under the control of the control unit (31), and/or to track the contour of the specific region with respect to one of the ultrasonic images generated in a period between one of the change time point and the another time point and a time point elapsing a predetermined time from one of the change time point and the another time point under the control of the control unit (31).

8. The apparatus according to any one of claims 1 to 7, **characterized in that** the display unit (14) is configured to display an elapsed time from the change time point or the another time point.

9. The apparatus according to any one of claims 1 to 8, configured such that the scanning is stopped at a time point elapsing a predetermined time from one of the change time point and the another time point.

10. The apparatus according to any one of claims 1 to 9, further comprising a time register unit (40) configured to measure an elapsed time from one of the change time point and the another time point.

11. The apparatus according to claim 10, **characterized in that** the display unit (14) is configured to display the measured elapsed time.

12. An ultrasonic diagnosis apparatus for generating a plurality of ultrasonic images by repeatedly scanning an interior of an object injected with a contrast medium by using an ultrasonic wave, the apparatus comprising:

a detection unit (36) configured to detect a specific signal intensity change in the ultrasonic images concurrently with the scanning by comparing a signal intensity of a cardiac chamber portion of the ultrasonic image with a signal intensity of a myocardial portion;
a time register (40) unit configured to measure an elapsed time from one of a change time point at which the specific signal intensity change is detected and another time point with reference to the change time point, wherein the another time point is a time point a predetermined time after the change time point or an estimated time point a predetermined time before the change time point; and
a display unit (14) configured to display the measured elapsed time.

13. A method for displaying ultrasonic images generated by repeatedly scanning, the method comprising:

displaying the ultrasonic images;
comparing (S15) a signal intensity of a cardiac chamber portion of each of the ultrasonic images with a signal intensity of a myocardial portion concurrently with the scanning; and
generating (S18) a specific indication at one of a change time point at which a signal intensity of the cardiac chamber portion changes from a higher value to a lower value than a signal intensity of the myocardial portion and another time point with reference to the change time point, wherein the another time point is a time point a predetermined time after the change time point or an estimated time point a predetermined time before the change time point.

14. The method according to claim 13, **characterized in,that** the indication indicates that an ultrasonic image is suitable for speckle tracking.

15. The method according to claim 13 or 14, **characterized in that** the indication is represented by changing a color of a portion of the displayed ultrasonic image.

Patentansprüche

1. Ultraschalldiagnosevorrichtung zum Erzeugen einer Mehrzahl von Ultraschallbildern durch wiederholtes Scannen eines Innenbereichs eines Objekts, in das ein Kontrastmittel injiziert ist, unter Verwendung von Ultraschallwellen mit
einer zum Darstellen von Ultraschallbildern ausgebildeten Darstelleinheit (14),
einer Vergleichseinheit (36), die dazu ausgebildet ist, eine Signalintensität eines Herzkammerabschnitts des Ultraschallbildes mit einer Signalintensität eines Myokardabschnitts zeitgleich mit dem Scannen zu vergleichen, und
einer Hinweiserzeugungseinheit (39), die dazu ausgebildet ist, einen spezifischen Hinweis zu einem Änderungszeitpunkt, an dem eine Signalintensität des Herzkammerabschnitts sich von einem höheren Wert zu einem niedrigeren Wert als eine Signalintensität des Myokardabschnitts ändert, oder zu einem bezüglich des Änderungszeitpunkts anderen Zeitpunkt zu erzeugen, wobei der andere Zeitpunkt ein Zeitpunkt eine vorbestimmte Zeit nach dem Änderungszeitpunkt oder ein geschätzter Zeitpunkt eine vorbestimmte Zeit vor dem Änderungszeitpunkt ist.

2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Vergleichseinheit (36) dazu ausgebildet ist, eine Durchschnittssignalintensität einer Herzkammer-ROI des Ultraschallbildes mit einer Durchschnittssignalintensität einer Myokard-ROI zu vergleichen.

3. Vorrichtung nach Anspruch 1 oder 2, ferner mit
einer ROI-Einstelleinheit (34), die dazu ausgebildet ist, die Positionen und Größen der Herzkammer-ROI und der Myokard-ROI in Übereinstimmung mit einer spezifischen von einer Mehrzahl von ROI-Vorlagen ausgewählten ROI-Vorlage einzustellen.

4. Vorrichtung nach Anspruch 3, **dadurch gekennzeichnet, dass** die ROI-Einstelleinheit (34) dazu ausgebildet ist, die spezifische ROI-Vorlage basierend auf einer Korrelation zwischen einem der Ultraschallbilder und einer Mehrzahl von Beispielultraschallbildern, welche jeweils zu der Mehrzahl von ROI-Vorlagen gehören, auszuwählen und/oder
die Positionen und Größen der Herzkammer-ROI und der Myokard-ROI gemäß einer Herzphase zu verändern.

5. Vorrichtung nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** die Hinweiserzeugungseinheit (39) dazu ausgebildet ist, Hinweisdaten zu erzeugen, die anzeigen, dass ein zur Speckle-Nachverfolgung geeignetes Bild aufgenommen wurde, und/oder Daten zu erzeugen zur Veranlassung der Darstelleinheit zum Darstellen einer Nachricht, dass ein zur Speckle-Nachverfolgung geeignetes Bild aufgenommen wird, und/oder Daten zum Ändern einer Farbe eines Abschnitts des dargestellten Ultraschallbildes zu erzeugen.

6. Vorrichtung nach einem der Ansprüche 1 bis 5, ferner mit einem Bildspeicher (32) und einer Kontrolleinheit (31), die dazu ausgebildet ist, den Bildspeicher (32) zum Speichern von mindestens einem der Ultraschallbilder, die nach dem Änderungszeitpunkt oder dem anderen Zeitpunkt erzeugt wurden in dem Bildspeicher anzusteuern, und/oder den Bildspeicher (32) zum Speichern von mindestens einem der Ultraschallbilder, die in einem Zeitraum zwischen dem Änderungszeitpunkt oder dem anderen Zeitpunkt und einem Zeitpunkt, der eine vorbestimmte Zeit nach dem Zeitpunkt abläuft, anzusteuern.

7. Vorrichtung nach einem der Ansprüche 1 bis 6, ferner mit einer Nachverfolgungsverarbeitungseinheit (37) zum Nachverfolgen einer Kontur einer spezifischen Region in den Ultraschallbildem und/oder zum Nachverfolgen der Kontur der spezifischen Region bezüglich einem der Ultraschallbilder, die nach dem Änderungszeitpunkt oder dem anderen Zeitpunkt unter der Steuerung der Kontrolleinheit (31) erzeugt wurden, und/oder zum Nachverfolgen der Kontur der spezifischen Region mit Bezug zu einem der Ultraschallbilder, die in einem Zeitabschnitt zwischen dem Änderungszeitpunkt oder dem anderen Zeitpunkt und einem Zeitpunkt, der eine vorbestimmte Zeit von dem Änderungszeitpunkt oder dem anderen Zeitpunkt abläuft, unter der Kontrolle der Kontrolleinheit (31), erzeugt wurden.

8. Vorrichtung nach einem der Ansprüche 1 bis 7, **dadurch gekennzeichnet, dass** die Darstelleinheit (14) zum Darstellen einer von dem Änderungszeitpunkt oder dem anderen Zeitpunkt aus abgelaufenen Zeit ausgebildet ist.

9. Vorrichtung nach einem der Ansprüche 1 bis 8, derart ausgebildet, dass das Scannen zu einem Zeitpunkt, der eine vorbestimmte Zeit nach dem Änderungszeitpunkt oder dem anderen Zeitpunkt abläuft, beendet wird.

10. Vorrichtung nach einem der Ansprüche 1 bis 9, ferner mit einer Zeitregistereinheit (40), die zum Messen einer abgelaufenen Zeit von dem Änderungszeitpunkt oder dem anderen Zeitpunkt aus abgelaufenen Zeit ausgebildet ist.

11. Vorrichtung nach Anspruch 10, **dadurch gekennzeichnet, dass** die Darstelleinheit (14) zum Darstellen der gemessenen abgelaufenen Zeit ausgebildet ist.

12. Ultraschalldiagnosevorrichtung zum Erzeugen einer Mehrzahl von Ultraschallbildern durch wiederholtes Scannen eines Innenbereichs eines Objekts, in das ein Kontrastmittel injiziert wurde, durch Verwendung von Ultraschallwellen mit
einer Erkennungseinheit (36), die zum Detektieren einer spezifischen Signalintensitätsänderung in den Ultraschallbildern zeitgleich mit dem Scannen durch Vergleichen einer Signalintensität eines Herzkammerabschnittes des Ultraschallbildes mit einer Signalintensität eines Myokardabschnittes ausgebildet ist,
einer Zeitregistereinheit (40), die zum Messen einer von einem Änderungszeitpunkt, an dem die spezifische Signalintensitätsänderung detektiert wird, oder von einem anderen Zeitpunkt mit Bezug zu dem Änderungszeitpunkt aus abgelaufenen Zeit ausgebildet ist, wobei der andere Zeitpunkt ein Zeitpunkt eine vorbestimmte Zeit nach dem Änderungszeitpunkt oder ein geschätzter Zeitpunkt eine vorbestimmte Zeit vor dem Änderungszeitpunkt ist, und
einer Darstelleinheit (14), die zum Darstellen der gemessenen abgelaufenen Zeit ausgebildet ist.

13. Verfahren zum Darstellen von durch wiederholtes Scannen erzeugten Ultraschallbildern mit
Darstellen der Ultraschallbilder,
Vergleichen (S15) einer Signalintensität eines Herzkammerabschnittes eines jeden der Ultraschallbilder mit einer Signalintensität eines Myokardabschnittes zeitgleich mit dem Scannen, und
Erzeugen (S 18) eines spezifischen Hinweises zu einem Änderungszeitpunkt, an dem sich eine Signalintensität des Herzkammerabschnittes von einem höheren Wert zu einem niedrigeren Wert als eine Signalintensität des Myokardabschnitts verändert, oder zu einem anderen Zeitpunkt mit Bezug zu dem Änderungszeitpunkt, wobei der andere Zeitpunkt ein Zeitpunkt eine vorbestimmte Zeit nach dem Änderungszeitpunkt oder ein geschätzter Zeitpunkt eine vorbestimmte Zeit vor dem Änderungszeitpunkt ist.

14. Verfahren nach Anspruch 13, **dadurch gekennzeichnet, dass** der Hinweis anzeigt, dass ein Ultraschallbild zur Speckle-Nachverfolgung geeignet ist.

15. Verfahren nach Anspruch 13 oder 14, **dadurch gekennzeichnet, dass** der Hinweis durch Ändern einer Farbe eines Abschnitts des dargestellten Ultraschallbildes dargestellt wird.

Revendications

1. Appareil de diagnostic ultrasonique pour générer une pluralité d'images ultrasoniques en balayant à répétition un intérieur d'un objet injecté avec un produit de contraste en utilisant une onde ultrasonique, l'appareil comprenant :

une unité d'affichage (14) agencée pour afficher les images ultrasoniques ;
une unité de comparaison (36) agencée pour comparer une intensité de signal d'une partie de ventricule cardiaque d'une image ultrasonique avec une intensité de signal d'une partie de myocarde en même temps avec le balayage ; et
une unité génératrice d'indications (39) agencée pour générer une indication spécifique à un point de variation dans le temps auquel une intensité de signal de la partie de ventricule cardiaque change d'une valeur plus élevée à une valeur moins élevée qu'une intensité de signal de la partie de myocarde et un autre point dans le temps avec référence au point de variation dans le temps, où l'autre point dans le temps est un point dans le temps qui est un temps prédéterminé après le point de variation dans le temps ou un temps prédéterminé d'un point estimé dans le temps avant le point de variation dans le temps.

2. Appareil selon la revendication 1, **caractérisé en ce que** l'unité de comparaison (36) est agencée pour comparer un signal d'intensité moyen d'un ventricule cardiaque ROI de l'image ultrasonique avec un signal d'intensité moyen d'un myocarde ROI.

3. Appareil selon la revendication 1 ou 2, comprenant en outre une unité de réglage ROI (34) agencée pour définir des positions et des tailles du ventricule cardiaque ROI et du myocarde ROI selon un modèle spécifique ROI sélectionné parmi un pluralité de modèles ROI.

4. Appareil selon la revendication 3, **caractérisé en ce que** l'unité de réglage ROI (34) est configurée pour sélectionner le modèle spécifique ROI sur base d'une corrélation entre l'une des images ultrasonique et une pluralité d'images ultrasoniques échantillonnées correspondant respectivement à la pluralité de modèles ROI et/ou pour modifier les positions et les tailles du ventricule cardiaque ROI et du myocarde ROI selon une phase cardiaque.

5. Appareil selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** l'unité génératrice d'indications (39) est agencée pour générer des données d'indication indiquant qu'une image acceptable pour un suivi de pixel est acquise, et/ou pour générer des données pour inciter l'unité d'affichage à afficher un message représentant qu'une image acceptable pour un suivi de pixel est acquise, et/ou pour générer des données pour changer une couleur d'une partie de l'image ultrasonique affichée.

6. Appareil selon l'une quelconque des revendications 1 à 5, comprenant en outre une mémoire pour les images (32), et
une unité de contrôle (31) agencée pour contrôler la mémoire pour les images (32) pour stocker au moins une des images ultrasoniques générées après l'un des points de variation dans le temps et l'autre point dans le temps dans la mémoire pour les images, et/ou pour contrôler la mémoire pour les images (32) pour stocker au moins une des images ultrasoniques générées dans une période entre l'un des points de variation dans le temps ou l'autre point dans le temps et un point dans le temps s'écoulant dans un temps prédéterminé après le point dans le temps.

7. Appareil selon d'une quelconque des revendications 1 à 6, comprenant en outre une unité de traitement de suivi (37) agencée pour suivre un contour d'une région spécifique dans les images ultrasoniques, et/ou pour suivre le contour de la région spécifique en ce qui concerne l'une des images ultrasoniques générées après l'un des points de variation dans le temps et l'autre point dans le temps sous le contrôle de l'unité de contrôle (31), et/ou pour suivre le contour de la région spécifique en ce qui concerne l'une des images ultrasoniques générées dans une période entre l'un des points de variation dans le temps et l'autre point dans le temps et un point dans le temps s'écoulant dans un temps prédéterminé depuis l'un des points de variation dans le temps et l'autre point dans le temps sous le contrôle de l'unité de contrôle (31).

8. Appareil selon l'une quelconque des revendications 1 à 7, **caractérisé en ce que** l'unité d'affichage (14) est agencée pour afficher un temps écoulé depuis le point de variation dans le temps ou l'autre point dans le temps.

9. Appareil selon l'une quelconque des revendications 1 à 8, agencée de telle façon que le balayage est arrêté à un point dans le temps s'écoulant dans un temps prédéterminé depuis l'un des points de variation dans le temps et l'autre point dans le temps.

10. Appareil selon l'une quelconque des revendications 1 à 9, comprenant en outre une unité d'enregistrement de temps (40) agencée pour mesurer un temps écoulé depuis l'un des points de variation dans le temps et l'autre point dans le temps.

11. Appareil selon la revendication 10, **caractérisé en ce que** l'unité d'affichage (14) est agencée pour afficher le temps écoulé mesuré.

12. Appareil de diagnostique ultrasonique pour générer une pluralité d'images ultrasoniques en balayant à répétition un intérieur d'un objet injecté avec un produit de contraste en utilisant une onde ultrasonique, l'appareil comprenant :

une unité de détection (36) agencée pour détecter une modification spécifique d'intensité de signal dans les images ultrasoniques en même temps que le balayage en comparant une intensité de signal d'une partie de ventricule cardiaque de l'image ultrasonique avec une intensité de signal d'une partie de myocarde ;
une unité d'enregistrement (40) de temps agencée pour mesurer un temps écoulé depuis l'un des points de variation dans le temps auquel la modification spécifique d'intensité de signal est détectée et un autre point dans le temps avec référence au point de variation dans le temps, où l'autre point dans le temps est un point dans le temps qui est un temps prédéterminé après le point de variation dans le temps ou un temps prédéterminé d'un point estimé dans le temps avant le point de variation dans le temps et ;
une unité d'affichage (14) agencée pour afficher le temps écoulé mesuré.

13. Méthode pour afficher des images ultrasoniques générées par balayage à répétition, la méthode comprenant :

affichage d'images ultrasoniques ;
comparaison (S15) d'une intensité de signal d'une partie de ventricule cardiaque de chaque image ultrasonique avec une intensité de signal d'une partie de myocarde en même temps que le balayage ; et
génération (S18) d'une indication spécifique à l'un des points de variation dans le temps auquel une intensité de signal de la partie de ventricule cardiaque change d'une valeur plus élevée à une valeur moins élevée qu'une intensité de signal de la partie de myocarde et un autre point dans le temps avec référence ou point de variation dans le temps, où l'autre point dans le temps est un point dans le temps qui est un temps prédéterminé après le point de variation dans le temps ou un temps prédéterminé d'un point estimé dans le temps avant le point de variation dans le temps.

14. Méthode selon la revendication 13, **caractérisée en ce que** l'indication indique qu'une image ultrasonique est acceptable pour un suivi de pixel.

15. Méthode selon la revendication 13 à 14, **caractérisée en ce que** l'indication est représentée par un changement de couleur d'une partie de l'image ultrasonique affichée.

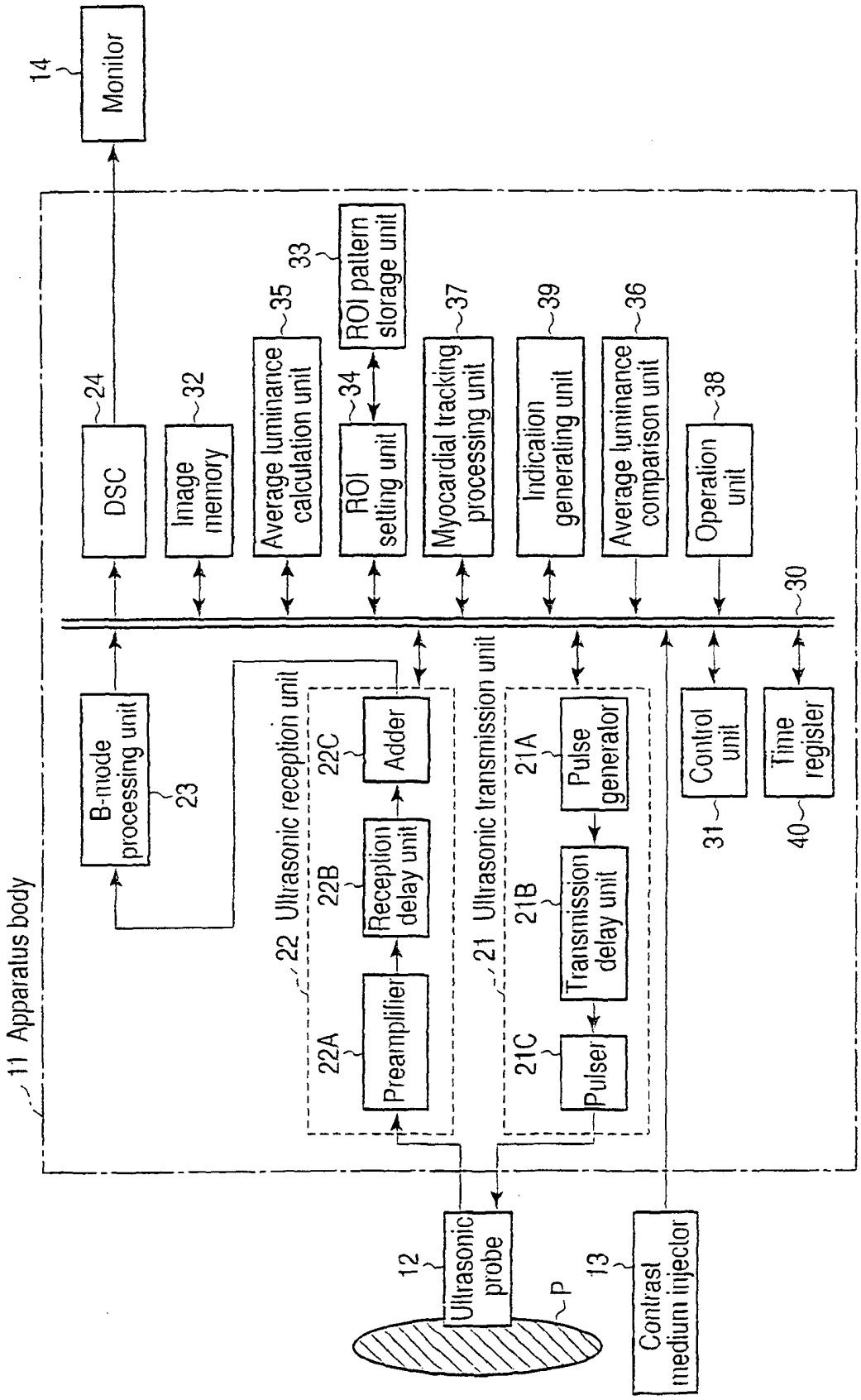

14
Monitor
24
DSC
32
Image memory
35
Average luminance calculation unit
33
ROI pattern storage unit
34
ROI setting unit
37
Myocardial tracking processing unit
39
Indication generating unit
36
Average luminance comparison unit
38
Operation unit
30
11 Apparatus body
B-mode processing unit
23
22 Ultrasonic reception unit
22C
Adder
22B
Reception delay unit
22A
Preamplifier
21 Ultrasonic transmission unit
21A
Pulse generator
21B
Transmission delay unit
21C
Pulser
Control unit
31
Time register
40
12
Ultrasonic probe
P
13
Contrast medium injector

FIG. 1

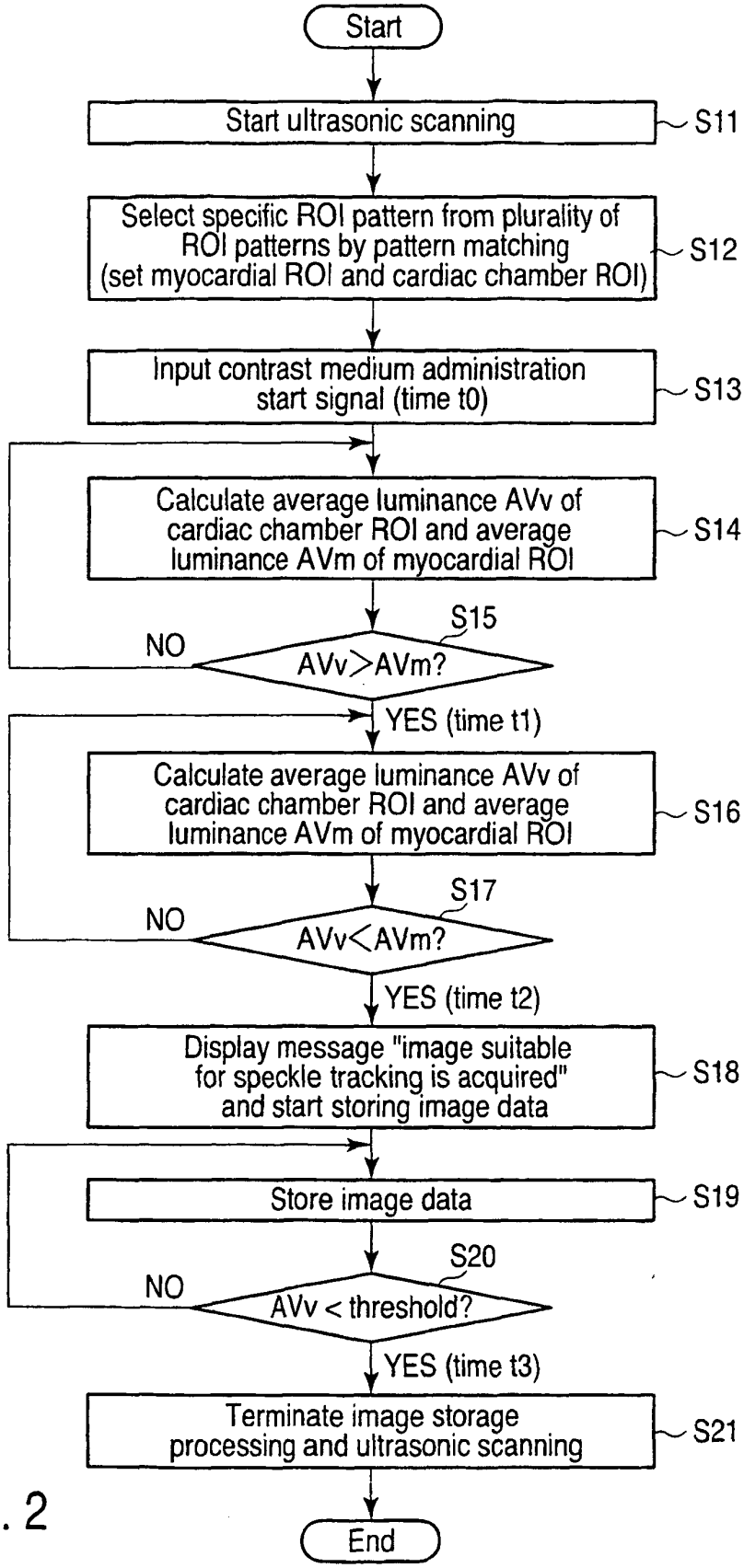
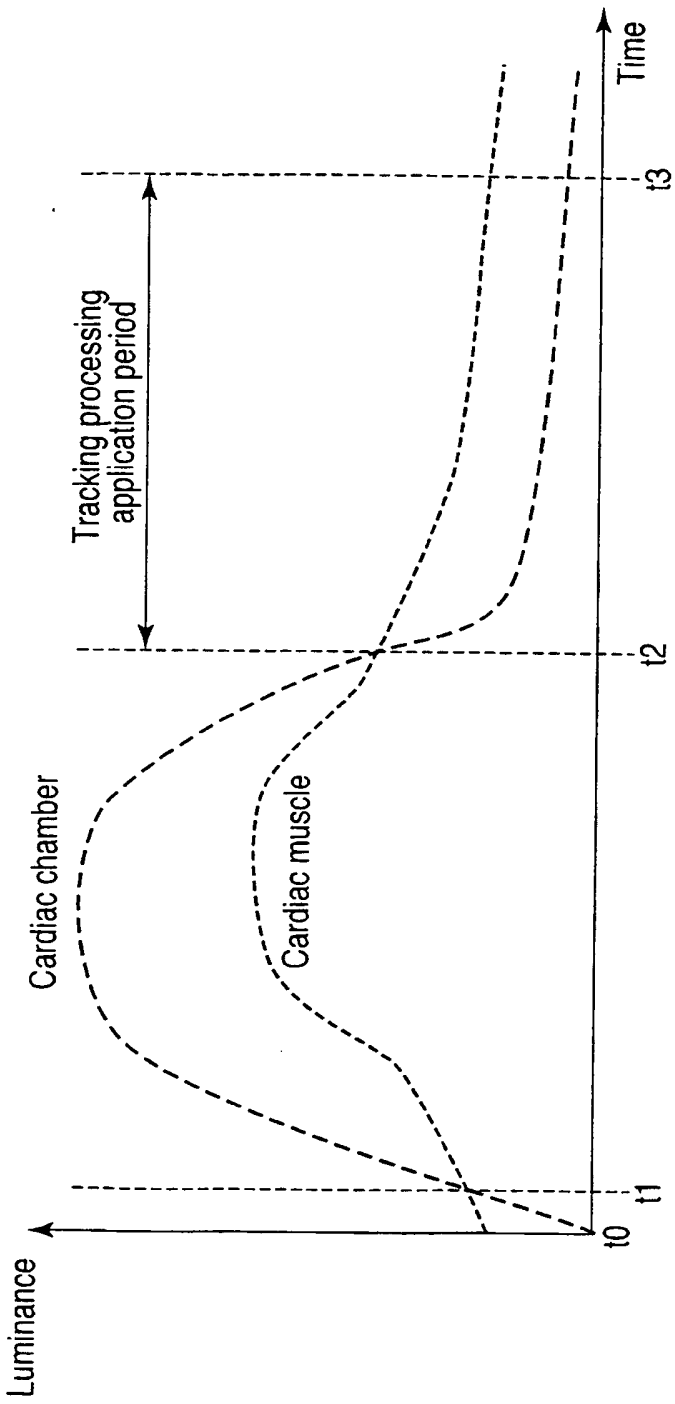

Start
Start ultrasonic scanning
S11
Select specific ROI pattern from plurality of ROI patterns by pattern matching (set myocardial ROI and cardiac chamber ROI)
S12
Input contrast medium administration start signal (time t0)
S13
Calculate average luminance AVv of cardiac chamber ROI and average luminance AVm of myocardial ROI
S14
S15
NO
AVv>AVm?
YES (time t1)
Calculate average luminance AVv of cardiac chamber ROI and average luminance AVm of myocardial ROI
S16
S17
NO
AVv<AVm?
YES (time t2)
Display message "image suitable for speckle tracking is acquired" and start storing image data
S18
Store image data
S19
S20
NO
AVv < threshold?
YES (time t3)
Terminate image storage processing and ultrasonic scanning
S21
End

FIG. 2



t0 : Contrast medium administration start time
t1 : Time when luminance of cardiac chamber has become higher than luminance of cardiac muscle as contrast medium flowed in
t2 : Time when luminance of cardiac chamber has become lower than luminance of cardiac muscle after t1 (display of image data storage start message/storage of image data)
t3 : Time when luminance of cardiac chamber has become lower than threshold as contrast medium flowed out (end of ultrasonic scanning/end of image data storage)

FIG. 3

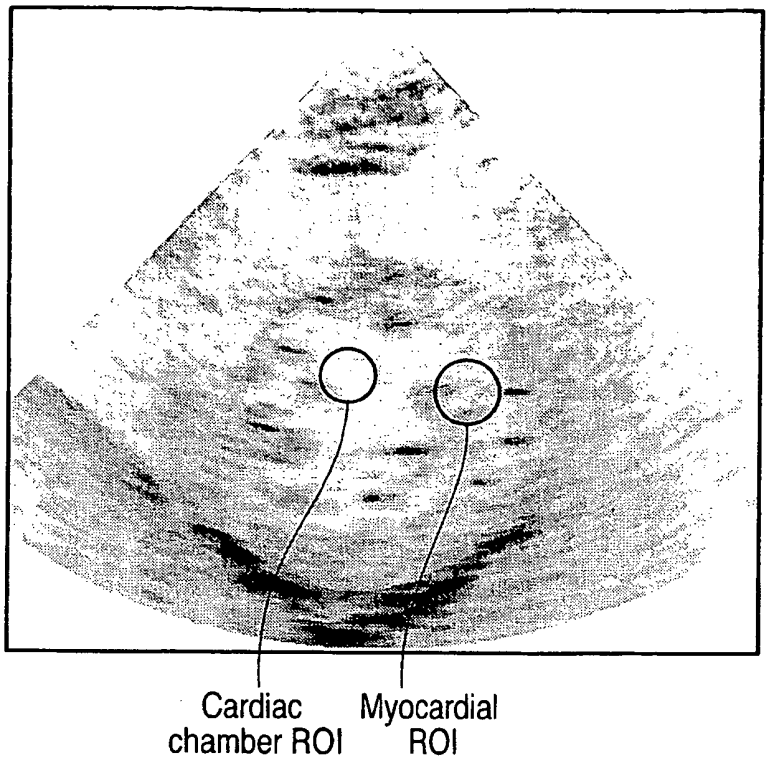

Cardiac chamber ROI
Myocardial ROI

FIG. 4

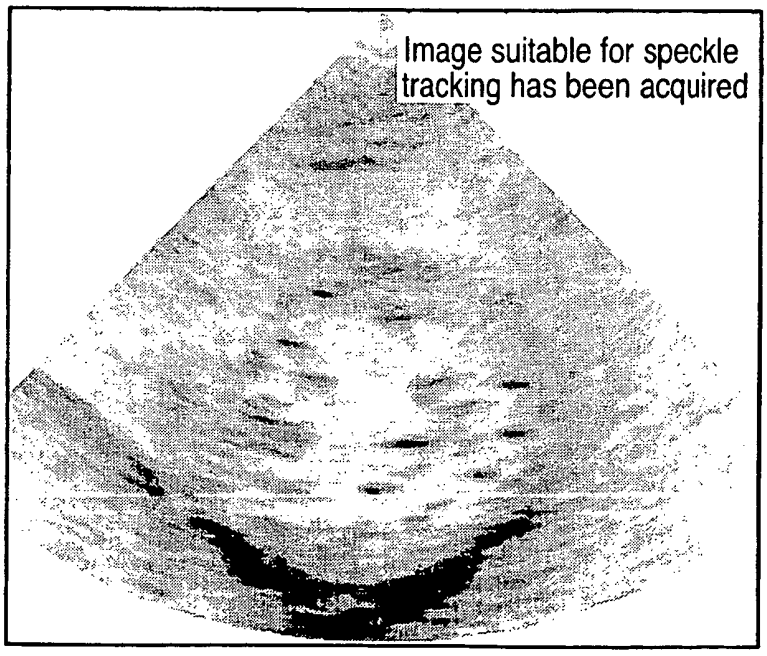


Image suitable for speckle tracking has been acquired

FIG. 5

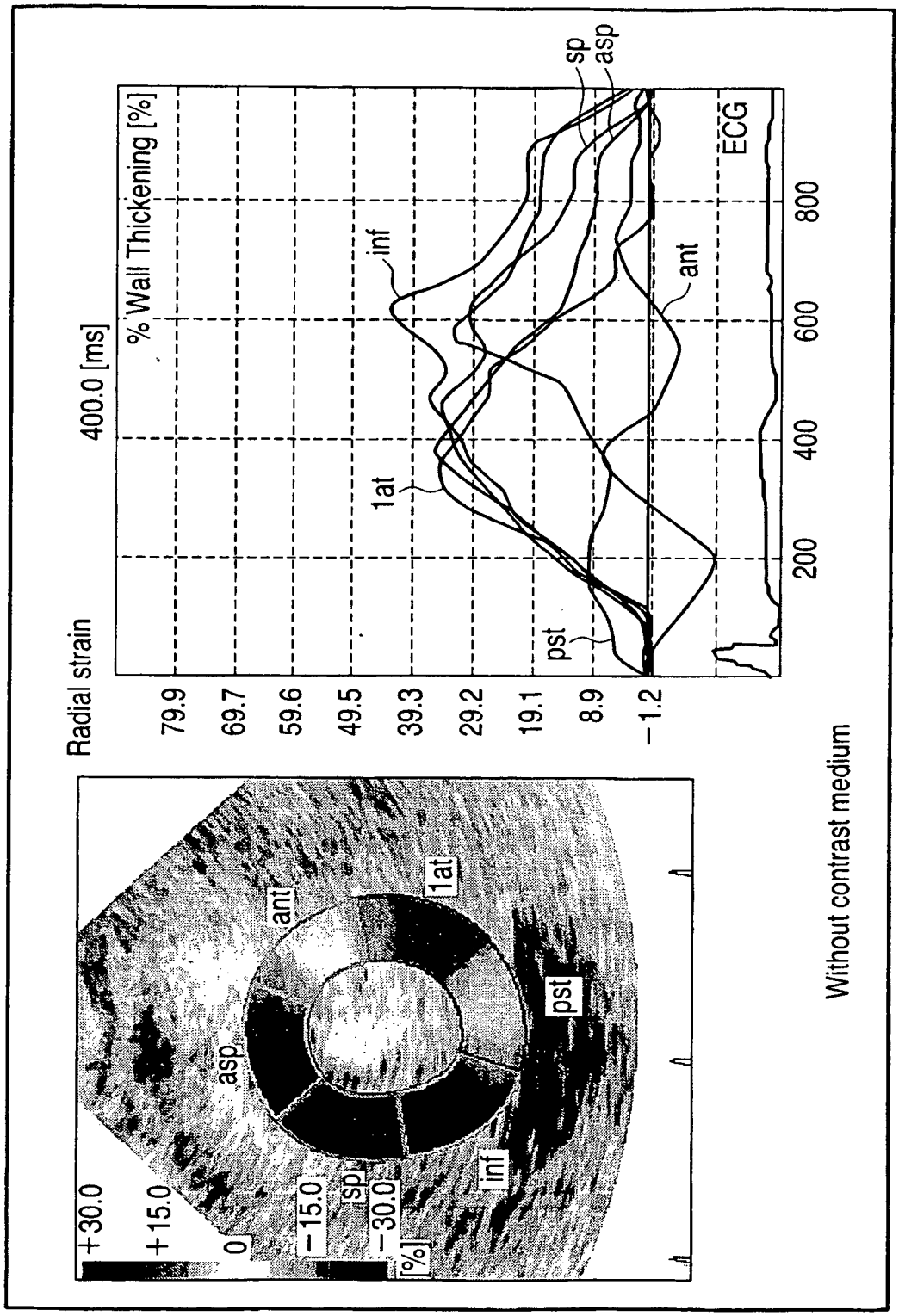

Radial strain
400.0 [ms]
% Wall Thickening [%]
79.9
69.7
59.6
49.5
39.3
29.2
19.1
8.9
−1.2
200
400
600
800
ECG
sp
asp
inf
1at
ant
pst
+30.0
+15.0
0
−15.0
−30.0
[%]
Without contrast medium

FIG. 6

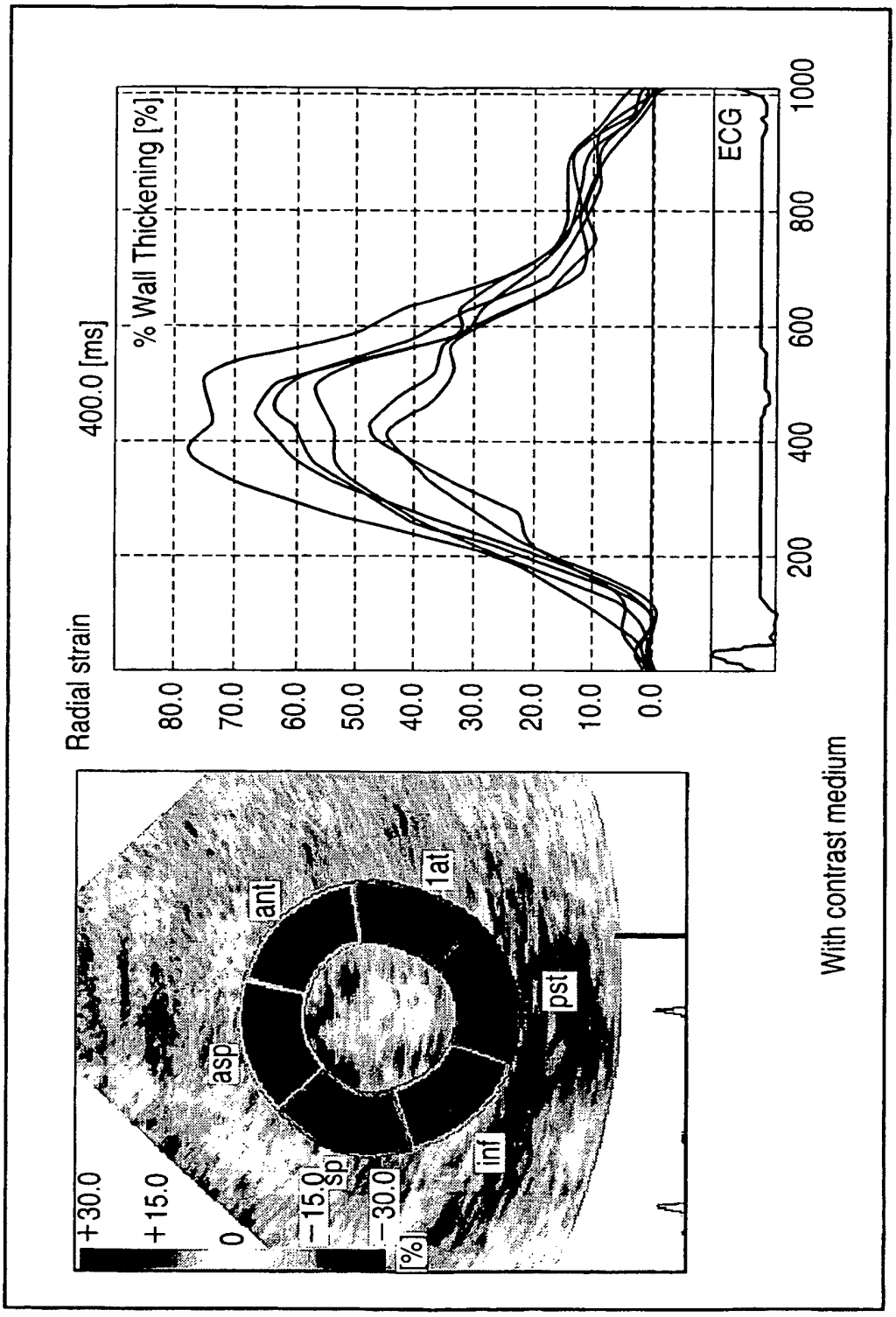

Radial strain
400.0 [ms]
% Wall Thickening [%]
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
200
400
600
800
1000
ECG
+30.0
+15.0
0
−15.0
−30.0
[%]
ant
lat
asp
sp
inf
pst
With contrast medium

FIG. 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 9633655 A **[0002]**
- US 6352509 B1 **[0002]**
- WO 2005072617 A1 **[0002]**
- US 20010056236 A1 **[0002]**

专利名称(译)	超声波诊断装置和显示方法		
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[标]申请(专利权)人(译)	东芝医疗系统株式会社		
申请(专利权)人(译)	东芝医疗系统公司 关西电力CO.，INC.		
当前申请(专利权)人(译)	东芝医疗系统公司 关西电力CO.，INC.		
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摘要(译)

根据一个实施例，超声诊断设备包括显示超声图像的显示单元（14），比较单元（36），用于比较超声图像的心腔部分的信号/回波强度与信号/回波强度图像的心肌部分，以及指示产生单元（39），用于在心室部分的信号/回声强度从较高值变为较低值而不是信号/回声的时间点产生特定指示心肌部分的强度或在参考时间点的另一时间点。

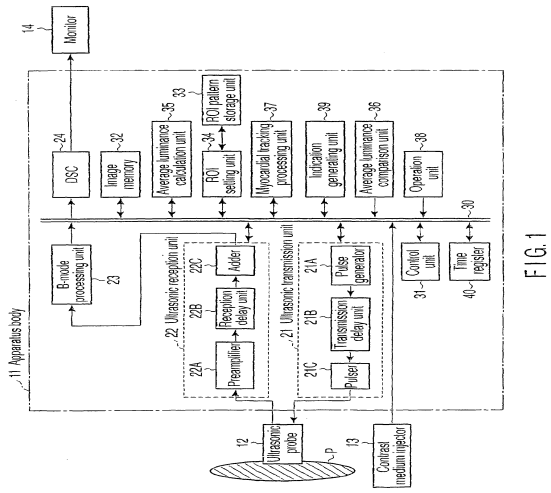

FIG. 1