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(54) **ULTRASONOGRAPH AND ULTRASONOGRAM CREATING METHOD**

ULTRASONOGRAPH UND VERFAHREN ZUR ERSTELLUNG EINES ULTRASONOGRAMMS
ULTRASONOGRAPHE ET PROCEDE DE CREATION D'ULTRASONOGRAMME

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Description

Technical Field

5 **[0001]** The present invention relates to an ultrasonic diagnostic apparatus and a method of generating an ultrasonic image capable of correcting the blur of an image due to the movement of an object to be examined or the movement of an operator's hand holding an ultrasonic probe.

Background Art

10 **[0002]** In recent years, a 'contrast echo method' of injecting an ultrasonic contrast medium into a vein has been used for ultrasonic diagnosis. The contrast echo method is a method of injecting the ultrasonic contrast medium into the vein, increasing a bloodstream signal, and evaluating the amount of the bloodstream in the heart or the liver. In many cases, minute bubbles of the contrast medium (contrast medium bubbles) serve as a reflective source. From the viewpoint of
15 the property of bubbles, which is a delicate material, bubbles are broken by the mechanical operation of ultrasonic waves having a general diagnostic level, and as a result, the signal intensity from the scanning surface is lowered. Therefore, in order to observe the dynamic aspect of the reflux of the bloodstream in real time, a method of reducing the breaking of bubbles due to scanning, such as a method of forming an image by transmitting low sound pressure ultrasonic waves, is needed.

20 **[0003]** The following method has been developed considering the property of a material, such as the breaking of bubbles. That is, a low sound pressure ultrasonic wave is transmitted to observe the movement of bubbles filled in the scanning surface, a high sound pressure ultrasonic wave is transmitted to the scanning surface (strictly, in an object to be radiated) to break the bubble, and a low sound pressure ultrasonic wave is radiated to the scanning surface to observe the movement of bubbles flowing into the scanning surface. This method is called a 'replenishment method' (for example,
25 see JP-A-11-155858).

30 **[0004]** The contrast medium bubbles are characterized in that it can form an image of a minute bloodstream which cannot be imaged by a color Doppler method. The imaging of the minute bloodstream is abnormal since few bubbles exist in the minute bloodstream. Therefore, a method of superposing the images of the contrast medium bubbles that appear to be abnormal to form a clear image of the structure of a minute blood vessel has been developed. This method is called a 'micro flow imaging (MFI) method' (for example, see JP-A-2004-321688).

35 **[0005]** In the MFI method, it is necessary to superpose ultrasonic images corresponding to a plurality of frames. Therefore, a person to be examined needs to hold his/her breath for a predetermined amount of time, or an operator needs to fix an ultrasonic probe for a predetermined amount of time.

40 **[0006]** However, it is difficult for the person to be examined to hold his/her breath for a predetermined amount of time, and it is not easy for an operator unaccustomed to the MFI method to fix the ultrasonic probe for a predetermined amount of time. Therefore, it is considerably effective to correct the blur of an ultrasonic image, in order to improve the quality of a displayed image in the MFI method.

45 **[0007]** A technique for correcting the blur of a continuous series of frames, such as moving pictures, has been used for video cameras on the market. A method of calculating relative motion vectors between frames of image data is used as a representative example. In this method, image data corresponding to one frame is divided into a plurality of areas, and the motion vector between the frames in each area is calculated on the basis of the correlation between the image data in the areas. When a plurality of motion vectors calculated for each area are used to correct the display position of the image data, it is possible to improve the visibility of a moving picture since the display position of an object does not vary even when a user's hand holding the camera is jiggled more or less.

50 **[0008]** A panoramic imaging technique, which is similar to a technique for correcting the blur of an ultrasonic diagnostic image, has been known. In this technique, ultrasonic images corresponding to a plurality of frames are acquired while moving an ultrasonic probe little by little, and overlapping portions of the ultrasonic images are combined with one another to form a wide still picture, such as a panoramic photograph. In the panoramic imaging technique, since it is necessary to combine overlapping portions of the ultrasonic images corresponding to a plurality of frames, relative motion vectors between frames are needed, similar to the ultrasonic images.

Disclosure of Invention

55 **[0009]** However, it is relatively easy to correct the blur of a general tomographic image, that is, an ultrasonic image generated from an object to be examined not having a contrast medium injected therein. This is because tissue or skeleton, which serves as a mark when a motion vector is detected, is reflected to the general tomographic image.

60 **[0010]** However, since bubbles are abnormally dyed, a blur correcting technique used for a general ultrasonic image cannot be applied to angiography, that is, an ultrasonic image of an object to be examined having a contrast medium

injected thereto. In particular, in the MFI method, a high sound pressure ultrasonic wave is used to sweep away bubbles. Therefore, in order to form an image of replenishment, few marks for blur correction exist in the image generated immediately after the bubbles are swept away. Further, in the image generated immediately after the bubbles are swept away, the shapes of the imaged bubbles vary every moment, which makes it difficult to extract motion vectors.

[0011] US 2005/0033123 A1 relates to a system for ultrasound imaging capable of performing motion correction on ultrasound images that are automatically selected from a plurality of ultrasound images associated with the same phase of the heart cycled.

[0012] US 2004/0120559 A1 relates to a method and apparatus for contrast agent time intensity curve analysis, including inter alia a comparison of frames on a pixel by pixel basis.

[0013] Accordingly, it is an object of the present invention to provide an ultrasonic diagnostic apparatus and a method of generating an ultrasonic image capable of preventing a reduction in the quality of a diagnostic image even when an object to be examined or an ultrasonic probe moves more or less.

[0014] This is achieved by the ultrasonic diagnostic apparatus according to claim 1 and the method according to claim 41. Further advantageous embodiments are defined in the dependent claims.

Brief Description of Drawings

[0015]

FIG. 1 is a block diagram illustrating an ultrasonic diagnostic apparatus according to a first embodiment of the invention;

FIG. 2 is a diagram schematically illustrating various types of track balls according to the first embodiment of the invention;

FIG. 3 is a diagram schematically illustrating various buttons according to the first embodiment of the invention;

FIG. 4 is a flow chart illustrating a process performed by the ultrasonic diagnostic apparatus according to the first embodiment of the invention;

FIG. 5 is a diagram schematically illustrating a diagnostic image having an ROI mark superposed thereon according to the first embodiment of the invention;

FIG. 6A is a diagram schematically illustrating five frames of diagnostic images generated after flash according to the first embodiment of the invention;

FIG. 6B is a diagram schematically illustrating five frames of diagnostic images generated after flash according to the first embodiment of the invention;

FIG. 6C is a diagram schematically illustrating five frames of diagnostic images generated after flash according to the first embodiment of the invention;

FIG. 6D is a diagram schematically illustrating five frames of diagnostic images generated after flash according to the first embodiment of the invention;

FIG. 6E is a diagram schematically illustrating five frames of diagnostic images generated after flash according to the first embodiment of the invention;

FIG. 7 is a diagram schematically illustrating a diagnostic image having an ROI mark superposed thereon according to a modification of the first embodiment of the invention;

FIG. 8A is a diagram schematically illustrating five frames of diagnostic images generated after flash according to a third embodiment of the invention;

FIG. 8B is a diagram schematically illustrating five frames of diagnostic images generated after flash according to the third embodiment of the invention;

FIG. 8C is a diagram schematically illustrating five frames of diagnostic images generated after flash according to the third embodiment of the invention;

FIG. 8D is a diagram schematically illustrating five frames of diagnostic images generated after flash according to the third embodiment of the invention;

FIG. 8E is a diagram schematically illustrating five frames of diagnostic images generated after flash according to the third embodiment of the invention;

FIG. 9 is a flow chart illustrating the flow of an MFI process including blur correction according to a fourth embodiment of the invention; and

FIG. 10 is a diagram illustrating the blur correction according to the fourth embodiment of the invention.

FIG. 11 is a diagram schematically illustrating a diagnostic image having an ROI mark superposed thereon according to a fifth embodiment of the invention;

FIG. 12 is a diagram illustrating a method of calculating a correlation amount according to the fifth embodiment of the invention;

FIG. 13 is a diagram schematically illustrating a diagnostic image having ROI marks superposed thereon according

to a sixth embodiment of the invention;

FIG. 14 is a diagram schematically illustrating an example of the correction result of image data superposed on a diagnostic image according to an eleventh embodiment of the invention;

FIG. 15 is a diagram schematically illustrating an example of the correction result of image data superposed on a diagnostic image according to the eleventh embodiment of the invention;

FIG. 16 is a diagram schematically illustrating an example of the correction result of image data superposed on a diagnostic image according to the eleventh embodiment of the invention; and

FIG. 17 is a diagram schematically illustrating an example of the correction result of image data superposed on a diagnostic image according to the eleventh embodiment of the invention.

[0016] Best Mode for Carrying Out the Invention Hereinafter, first to twelfth embodiment of the invention will be described with reference to the accompanying drawings.

(First embodiment)

[0017] First, a first embodiment of the invention will be described with reference to FIGS. 1 to 6.

[Structure of ultrasonic diagnostic apparatus]

[0018] FIG. 1 is a block diagram illustrating an ultrasonic diagnostic apparatus according to the first embodiment of the invention.

[0019] As shown in FIG. 1, the ultrasonic diagnostic apparatus according to the first embodiment includes a main body 10, an ultrasonic probe 11, a monitor 12, and an input device 13.

[0020] The main body 10 includes a transmitting/receiving unit 21, a B-mode processing unit 22, a Doppler processing unit 23, an image generating circuit 24, a control processor 25, an internal storage device 26, an interface 29, and a storage unit 30 having an image memory 30a and a software storage unit 30b.

[0021] For example, the transmitting/receiving unit 21 provided in the main body 10 is composed of hardware, such as an integrated circuit, or it may be a software program that is modularized in a software manner. Next, each component will be described below.

[0022] The ultrasonic probe 11 transmits or receives ultrasonic waves to or from a part of an object P to be examined, and is provided with a piezoelectric vibrator for transmitting/receiving ultrasonic waves. The piezoelectric vibrator is divided into a plurality of elements, and each of the elements forms a part of a so-called channel. When the ultrasonic probe 11 includes a 2D array vibrator, it can obtain three-dimensional data.

[0023] The ultrasonic waves (hereinafter, referred to 'transmission ultrasonic waves') transmitted from the ultrasonic probe 11 to the object P to be examined are sequentially reflected from the surfaces where acoustic impedance is discrete in the human body and are transmitted to the ultrasonic probe 11 as echo signals. The amplitude of the echo signals depends on the difference in acoustic impedance between the discrete surfaces from which the ultrasonic waves are reflected. When the transmission ultrasonic wave is reflected from the surface of a movable object, such as blood-stream or a heart wall, a frequency shift occurs in the echo signal due to a speed component of the ultrasonic wave reflected from the movable object in the transmission direction by the Doppler effect.

[0024] The monitor 12 displays as a diagnostic display bloodstream information or morphological information in the object P to be examined on the basis of video signals transmitted from the image generating circuit 24. In addition, the monitor 12 displays an ROI mark on the diagnostic image.

[0025] The input device 13 is connected to the main body 10 and includes a track ball input unit 131, a button input unit 132, and a switch input unit 133 for inputting instructions of an operator to the main body 10.

[0026] FIG. 2 is a diagram schematically illustrating the track ball input unit 131 according to the first embodiment.

[0027] As shown in FIG. 2, the track ball input unit 131 includes a track ball 131a used for designating the number of ROIs and a track ball 131b used for designating the size of ROI.

[0028] FIG. 3 is a diagram schematically illustrating the button input unit 132 according to the first embodiment of the invention.

[0029] As shown in FIG. 3, the button input unit 132 includes an audio adjust button 132a used to instruct the start or end of the detection of movement, a start button 132b used to instruct to start or end the superposition of image data, and a flash button 132c used to instruct to perform high-sound pressure scanning, and a freeze button 132d used to instruct to stop the low-sound pressure scanning.

[0030] The instructions from the operator include an instruction to designate the shape of ROI, an instruction to designate the time when low-sound pressure scanning is performed, an instruction to designate the time when blur correction is performed, and an instruction to display or not display an ROI mark. The input device 13 further includes track balls, buttons, and switches corresponding to the instructions, in addition to the track balls 131a to 131b and the

buttons 132a to 132c.

[0031] The transmitting/receiving unit 21 includes a pulse circuit, a delay circuit, and a trigger generating circuit. The pulse circuit repeatedly generates rate pulses for forming transmission ultrasonic waves at a predetermined rate frequency. The delay circuit gives a delay time required to condense a transmission ultrasonic wave for each channel and to determine transmission directivity to each of the rate pulses. The direction in which the ultrasonic waves from the ultrasonic probe 11 are transmitted is controlled by adjusting the delay time given by the delay circuit. The trigger generating circuit supplies a driving pulse to the ultrasonic probe 11 at a predetermined timing on the basis of the rate pulse whose delay time has been adjusted.

[0032] The transmitting/receiving unit 21 has a function of changing, for example, delay information, a transmission frequency, and a transmission driving voltage in an instant according to the instructions from the control processor 25. In particular, in order to change the transmission driving voltage, the transmitting/receiving unit 21 is formed of a linear-amplifier-type transmitting circuit capable of switching the value of the transmission driving voltage in an instant or a mechanism capable of electrically switching a plurality of power supply units.

[0033] Further, the transmitting/receiving unit 21 includes an amplifying circuit, an A/D converter, and an adder. The amplifier circuit amplifies the echo signal for each channel received by the ultrasonic probe 11. The A/D converter gives a delay time required to determine the reception directivity of ultrasonic waves to the echo signal amplified for every channel. The adder adds the delayed echo signals for each channel to generate a reception signal. In this way, a reflection component in a direction corresponding to the reception directivity of the echo signal is emphasized.

[0034] The B-mode processing unit 22 performs logarithmic amplification and an envelope curve detecting process on the reception signal output from the transmitting/receiving unit 21 to generate intensity data for representing the intensity of the reception signal as brightness.

[0035] The Doppler processing unit 23 obtains information on the speed of bloodstream, tissue, and bubbles of a contrast medium on the basis of the reception signal output from the transmitting/receiving unit 21 to generate blood stream data for average speed, dispersion, power, and a combination thereto.

[0036] The image generating circuit 24 converts the coordinates of the intensity data and the bloodstream data respectively output from the B-mode processing unit 22 and the Doppler processing unit 23 into scanning line signal strings of a video format that is representatively used for a television. In this way, a tomographic image related to the shape of the tissue of the object P to be examined, an image in which contrast medium bubbles flowing into a blood vessel are emphasized, an average speed image related to the speed of bloodstream, a dispersion image, a power image, and an image of a combination thereof are generated. The image generating circuit 24 includes a storage memory for storing image data. This structure makes it possible for an operator to view the image formed during examination after diagnosis.

[0037] The control processor (CPU) 25 serves as an information processing device and controls all components of the ultrasonic diagnostic apparatus. The control processor 25 reads out a control program for generating images and displaying the images from the internal storage device 26 and expands the read control program in the software storage unit 30b, thereby controlling various processes.

[0038] The control processor 25 creates a search area on the image data and detects the brightness of pixels included in the search area. In addition, the control processor 25 generates motion vectors for realizing the motion between image data on the basis of the brightness of a plurality of pixels included in ROI of a plurality of image data.

[0039] The internal storage device 26 stores control programs for generating images and displaying the images, diagnostic information (ID, for example, doctor's observations and diagnosis), a diagnostic protocol, transmitting/receiving conditions, and data groups. In particular, the internal storage device 26 stores control programs for executing, for example, a scanning sequence for transmitting/receiving ultrasonic waves, setting of ROI, blur correction, a differential image generating process, a brightness value holding process, and a superposition display process. In addition, the internal storage device 26 is used to store the image data in the image memory 30a, if necessary. Further, data stored in the internal storage device 26 may be transmitted to an external peripheral apparatus through the interface 29.

[0040] The interface 29 is an interface for the input device 13, a network, and an additional external storage device. Data for an obtained ultrasonic image or the analysis result thereof may be transmitted to another apparatus through the interface 29 over the network.

[0041] The image memory 30a is a storage memory for storing image data output from the image data generating circuit 24. An operator can call the image data stored in the storage memory after diagnosis, and the image data is displayed as a still picture or a moving picture composed of a plurality of frames. The image memory 30a stores output signals of the transmitting/receiving unit 21 (referred to as radio frequency signals), brightness signals having passed through the transmitting/receiving unit 21, and other raw data, and image data acquired over the network, as occasion demands.

[Usage of ultrasonic diagnostic apparatus]

[0042] First, the operator operates the track ball 131a and the track ball 131b to designate the number of ROIs and

the size of ROI, respectively. In this embodiment, the shape of ROI is previously set to a rectangular shape, and is designated by operating, for example, the track balls.

[0043] Next, low sound pressure scanning starts. The low sound pressure scanning is performed to display the reflux of bloodstream as an image, and is performed several times. The low sound pressure scanning may start before the number of ROIs and the size thereof are set.

[0044] Ultrasonic waves used for the low sound pressure scanning are set to a sufficiently low sound pressure not to break the contrast medium bubbles. Therefore, whenever the low sound pressure scanning is performed, image data corresponding to one frame of images of the contrast medium bubbles is generated. The generated image data is stored in the image memory 30a and simultaneously displayed on the monitor 12.

[0045] When the start button 132b is turned on during the low sound pressure scanning, image data generated in the next stage are superposed to generate superposed image data. A maximum brightness value holding operation is used to superpose image data. The maximum brightness value holding operation is a method of using pixels having the highest brightness among a plurality of pixels spatially corresponding to each other to form an image on the basis of image data corresponding to a plurality of frames. Therefore, when the maximum brightness value holding operation is performed, images of the contrast medium bubbles extracted from the image data are connected to each other, and as a result, the structure of a blood vessel of the object P to be examined is extracted from the superposed image data. The superposed image data is displayed on the monitor 12 as a diagnostic image. That is, when the start button 132b is turned on during the low sound pressure scanning, MFI starts.

[0046] When the start button 132b is turned off during the superposition of image data, the superposition of image data performed up to now stops, and the image data generated whenever the low sound pressure scanning is performed is displayed on the monitor 12.

[0047] When the flash button 132c is turned on during the low sound pressure scanning, high sound pressure scanning corresponding to one frame is performed. The high sound pressure scanning is called 'flash'.

[0048] The ultrasonic waves used for the high sound pressure scanning are set to a sufficiently high sound pressure level to break a contrast medium bubble. Therefore, when the high sound pressure scanning is performed, all contrast medium bubbles existing on the scanning surface are broken, which causes the image of the contrast medium bubbles to disappear from the diagnostic image displayed on the monitor 12. As a result, a dark image is displayed on the monitor 12. However, the dark image does not last for a long time. When a certain amount of time has elapsed, the image of a thick blood vessel formed by the contrast medium bubbles appears gradually.

[0049] When the freeze button 132d is turned on during the low sound pressure scanning, the low sound pressure scanning stops. In this case, when the superposition of image data is performed or when the movement detecting mode is executed, these operations also stop.

[0050] When the audio adjust button 132a is turned on during the low sound pressure scanning, the movement detecting mode starts. The movement detecting mode is a standby mode in movement detection, but no process is actually performed in the movement detecting mode.

[0051] Next, the movement detecting mode will be described below.

[0052] FIG. 4 is a flow chart illustrating a sequence of setting ROI according to this embodiment.

[0053] As shown in FIG. 4, when the start button 132b is turned on in the movement detecting mode (step S1), a sequence of setting ROI starts (step S2), and image data immediately after that time is designated to standard image data.

[0054] When the standard image data is designated, various types of image processing are performed on the standard image data to generate reference image data actually used as a search target of ROI (step S3). For example, an average value process or a threshold value process is performed on the standard image data as image processing.

[0055] When the average value process is used, image data for several frames that are generated immediately before the standard image data is used to generate the reference image data on the basis of the average brightness of a plurality of pixels spatially corresponding to each other in the image data.

[0056] When the threshold value process is used, the average brightness of all frames of the standard image data or brightness higher than the average brightness is set to a threshold value, and the reference image data is generated on the basis of the brightness of pixels of the standard image data binarized by the threshold value.

[0057] Therefore, little noise exists in the reference image data generated by the average value process or the threshold value process, but only the image of the contrast medium bubble or only the tissue of a living body is reflected to the reference image data.

[0058] When the reference image data is generated, a search area having the same size and shape as ROI is generated on the reference image data. The search area moves across all entire reference image data. Whenever the search image area moves by one pixel, the brightness of the pixel included therein is detected (step S4).

[0059] Whenever image areas (hereinafter, referred to as 'image areas satisfying conditions of ROI') in which the number of pixels having brightness higher than a threshold value K is larger than a threshold value M are detected, one of the image areas having the largest number of pixels having brightness higher than the threshold value K is searched (Yes in step S5), and ROI is set to the image area (step S6). In this way, the sequence of setting ROI is completed (step S7).

[0060] As shown in FIG. 5, the set ROI is superposed on the diagnostic image displayed on the monitor 12 as a rectangular-frame-shaped ROI mark. When a plurality of ROIs are used, the sequence of setting ROI is repeatedly performed by a number of times corresponding to the number of ROIs used. Immediately after a contrast medium is injected into an object to be examined or flash transmission is performed, a high-brightness area (that is, an area having the contrast medium injected thereinto) is not displayed on a screen. Therefore, in general, the high-brightness area appears gradually on the screen. When one high-brightness area appears on the image, one ROI is set according to the sequence of setting ROI, and when two high-brightness areas appear on the image, two ROIs are set. In this way, the number of ROIs set increases with an increase in the number of high-brightness areas on the image. For example, when three ROIs are used, three high-brightness areas satisfying conditions of ROI appear on the image. In this embodiment, the sequence of setting ROI is repeatedly performed until three ROIs corresponding to the three high-brightness areas are set.

[0061] If no image area satisfying the conditions of ROI appears on the image even when the search area moves across all the reference image data (No in step S5), the sequence of setting ROI ends (step S7).

[0062] When the image area satisfying the conditions of ROI does not appear and thus the sequence of setting ROI ends, image data subsequently generated is designated to the standard image data, and a sequence of searching ROI is performed again. In this way, the sequence of setting ROI is repeated until ROI is set.

[0063] Then, an area (a corresponding area) corresponding to ROI is set on each image data subsequent to the standard image data on the basis of the ROI on the standard image data (reference image data). The setting of the corresponding area makes it possible to sweep an area having the same shape and size as ROI on the next image data and to set an area having a brightness distribution pattern closest to that of ROI as the corresponding area.

[0064] When ROI is set to each image data according to the above-mentioned procedure, motion vectors representing the movement of the standard image data and the image data subsequent to the standard image data are generated from the correlation between the brightness of pixels included in ROI of the standard image data and the brightness of pixels included in the corresponding area of each image data subsequent to the standard image data. However, a method of generating the motion vectors is not limited thereto. For example, SAD (sum of absolute difference), which is a block matching method generally used to recognize movement, may be used as the method of generating the motion vectors.

[0065] When the motion vectors are generated, the display position of the image data subsequent to the standard image data is corrected on the basis of the motion vectors. In this way, corrected image data having little motion blur with respect to the standard image data is generated.

[0066] Whenever the corrected image data is generated, the corrected image data is superposed on the standard image data by the maximum brightness value holding operation. In the period in which the corrected image data is superposed, images of contrast medium bubbles flowing into the scanning surface are connected to each other, and the structure of blood vessels of the object P to be examined is extracted to the diagnostic image displayed on the monitor 12. In addition, the blur of the corrected image data superposed on the standard image data is corrected by a pre-process, which causes a very clear diagnostic image to be displayed on the monitor 12 even when corrected image data corresponding to a plurality of frames is superposed. Therefore, it is possible to obtain a very clear diagnostic image without being affected by the movement of the object P to be examined or the jiggling of a hand holding the ultrasonic probe 11.

[0067] When there is no area satisfying the conditions of ROI in image data for first and second frames, image data for a third frame is designated as the standard image data. The image data for the first and second frames are superposed on the image data for the third frame, which is the standard image data, similar to corrected image data generated on the basis of image data for frames next a fourth frame.

[0068] The blur of the image data for the first and second frames is not corrected, but the image data for the first and second frames are so dark that an area satisfying the conditions of ROI does not appear. Therefore, even when these image data are superposed on the standard image data, the quality of a diagnostic image is not affected at all.

[0069] Next, blur correction immediately after flash will be described below.

[0070] When the start button 132b is turned on immediately after flash, almost dark image data is designated as the standard image data. However, in this embodiment, ROI is set to an area having relatively high brightness in the dark image data immediately after flash on the basis of the brightness of pixels included in the reference image data. Therefore, it is easy to obtain the correlation between the brightness of pixels in ROI of the reference image data and the brightness of pixels in ROI of image data subsequent to the standard image data, and the blur of the image data subsequent to the standard image data is accurately corrected. Thus, a very clear diagnostic image is displayed on the monitor 12.

[0071] Next, ROI and a diagnostic image after flash will be described below.

[0072] FIGS. 6A to 6E are diagrams schematically illustrating diagnostic images corresponding to five frames that are generated after flash according to this embodiment. In FIGS. 6A to 6E, a white portion indicates a bright area, and a hatched portion indicates a dark area.

[0073] FIG. 6A is a diagram illustrating a diagnostic image at the time of flash, FIG. 6B is a diagram illustrating a diagnostic image corresponding to a first frame after flash, FIG. 6C is a diagram illustrating a diagnostic image corre-

sponding to a second frame after flash, FIG. 6D is a diagram illustrating a diagnostic image corresponding to a third frame after flash, and FIG. 6E is a diagram illustrating a diagnostic image corresponding to a fourth frame after flash.

[0074] That is, the diagnostic image corresponding to the first frame is image data corresponding to the first frame that is generated at the beginning after flash. The diagnostic image corresponding to the second frame is the superposition of image data corresponding to the first and second frames. The diagnostic image corresponding to the third frame is the superposition of image data corresponding to the first to third frames. The diagnostic image corresponding to the fourth frame is the superposition of image data corresponding to the first to fourth frames. The diagnostic image corresponding to the fifth frame is the superposition of image data corresponding to the first to fifth frames.

[0075] As shown in FIG. 6A, when flash is performed, a dark diagnostic image is displayed on the monitor 12 once. When a predetermined time elapsed after the flash is performed, contrast medium bubbles flow from a thick blood vessels existing on the scanning surface, and the structure of the blood vessel of the object P to be examined is gradually extracted to the diagnostic image. In this case, when the sequence of setting ROI starts, ROI is set to an area satisfying conditions, as shown in FIG. 6B. When a predetermined time elapsed after ROI is set, the structure of the blood vessel becomes clearer, as shown in FIGS. 6C to 6E. In this case, the position of ROI set at the beginning does not vary.

[0076] In this embodiment, in the search of ROI, the brightness of pixels included in the search area is binarized by the threshold value K. However, the description is not limited thereto. For example, a histogram for the brightness of pixels included in the search area may be made, and the search of ROI may be performed on the basis of the brightness of the top predetermined percent (for example 20%) of pixels included in the search area. In this case, noise components have little effect on the search of ROI, which makes it unnecessary to perform image processing, such as the average value process or the threshold value process.

[0077] Alternatively, two threshold values may be provided, and the search of ROI may be performed on the basis of a pixel having a brightness value between the two threshold values. In general, when contrast medium bubbles flow into a thick blood vessel, the brightness of the blood vessel excessively increases. However, in some cases, the thick blood vessel may not sufficiently serve as a characteristic area for correcting blur due to the thickness of the blood vessel, even when ROI is set to the area including the thick blood vessel. Therefore, the pixel having excessively high brightness is excluded from the object of ROI search, which makes it possible to extract a characteristic area suitable for correcting blur as ROI.

(Effects of first embodiment)

[0078] In this embodiment, the image data immediately after the start button 132b is turned on is designated to the standard image data. Then, ROI is set to an area including a thick blood vessel in which the images of contrast medium bubbles are clustered close together on the basis of the brightness of reference image data generated from the standard image data.

[0079] Therefore, it is easy to obtain the correlation between the brightness of pixels in ROI of the reference image data and the brightness of pixels in a corresponding area of each image data subsequent to the standard image data, and the blur of the image data subsequent to the standard image data is accurately corrected. As a result, a very clear diagnostic image is generated by superposition.

[0080] In this embodiment, the image data immediately after the flash button 132c is pushed is designated to the standard image data. Then, ROI is set to an area including a thick blood vessel in which the images of contrast medium bubbles are rapidly restored on the basis of the brightness of reference image data generated from the standard image data.

[0081] In this way, even when few areas, serving as marks for correcting blur, exist in the reference image data, such as immediately after flash, ROI is automatically set to an area including a thick blood vessel in which contrast medium bubbles dye at relatively high speed.

[0082] Therefore, it is easy to obtain the correlation between the brightness of pixels in ROI of the reference image data and the brightness of pixels in a corresponding area of each image data subsequent to the standard image data, and the blur of the image data subsequent to the standard image data is accurately corrected. As a result, a very clear diagnostic image is generated by superposition.

[0083] In this embodiment, noise components are previously removed from the reference image data by image processing. Therefore, noise has no effect on the setting of ROI, which makes it possible to accurately set ROI in an area including a thick blood vessel.

[0084] In this embodiment, the number of pixels included in ROI is smaller than the number of pixels in all image data. Therefore, it is possible to reduce the amount of calculation required to calculate the correlation between the brightness of pixels in ROI of the reference image data generated from the standard image data and the brightness of pixels in a corresponding area of each image data subsequent to the standard image data.

[0085] In this embodiment, when the flash button 132c is turned on, blur correction starts instantaneously. Then, the images of contrast medium bubbles flowing into the scanning surface immediately after flash are superposed without

omission. As a result, the structure of blood vessels of the object P to be examined is accurately extracted to a diagnostic image.

[0086] In this embodiment, an ROI mark is superposed on a diagnostic image displayed on the monitor 12. Therefore, the operator can check whether ROI is accurately set while viewing the diagnostic image displayed on the monitor 12.

[0087] In this embodiment, the input device 13 includes a button or a switch for switching the display and non-display of the ROI mark. Therefore, when diagnosis is interrupted by the ROI mark, the operator can simply remove the ROI mark.

[0088] In this embodiment, the input device 13 includes a button for designating the time when blur correction starts, that is, the start button 132b, and the flash button 132c. Therefore, the operator can start blur correction at a desired timing, which makes it possible to obtain a diagnostic image very suitable for the symptoms or conditions of the object P to be examined.

[0089] In this embodiment, the input device 13 includes the track ball for designating the time when blur correction is performed. Therefore, the operator can repeatedly check a variation in the reflux of the bloodstream until a predetermined time elapses after the start of the blur correction.

[0090] Further, in this embodiment, MFI has been described above, but the invention is not limited thereto. That is, the invention can be applied to 'Panoramic imaging' described in 'Background Art' as long as a plurality of image data can be superposed.

[0091] In this embodiment, the number of ROIs and the sizes thereof are input by the input device 13, but the invention is not limited thereto. For example, the number of ROIs and the sizes thereof may be automatically set on the basis of the brightness of pixels included in the reference image data.

(First modification of first embodiment)

[0092] MFI may be executed on the basis of a plurality of image data that have been acquired by the low sound pressure scanning and stored in the image memory 30a. In this case, the blur of image data is also corrected prior to the standard image data, and the corrected image data is also superposed on the standard image data. That is, the corrected image data generated on the basis of the image data prior to the standard image data may be superposed on the standard image data. When the blur of image data prior to the standard image data is corrected, the influence of the deflection between frames is reduced, which makes it possible to improve the quality of a diagnostic image.

(Second modification of first embodiment)

[0093] A common ROI that can be used to correct the blur of a plurality of image data acquired by the low sound pressure scanning is set on the basis of the brightness of the plurality of image data. This is effective in executing MFI on the basis of a plurality of image data that have been acquired by the low sound pressure scanning and stored in the image memory 30a.

(Third modification of first embodiment)

[0094] Next, a third modification of this embodiment will be simply described with reference to FIG. 7.

[0095] FIG. 7 is a diagram schematically illustrating a diagnostic image having three ROI marks superposed thereon according to the third modification.

[0096] As shown in FIG. 7, the three ROI marks make it possible to correct the rotational deviation among frames of image data. Even when the three ROI marks are combined, the number of pixels included in the ROI marks is considerably smaller than the number of pixels of all image data, which makes it possible to considerably reduce the amount of calculation, as compared to a conventional technique for generating motion vectors using pixels of all image data.

(Fourth modification of first embodiment)

[0097] This embodiment may be effective in performing the maximum brightness value holding operation using three-dimensional image data (that is, between time-series volume data, the values of voxels whose spatial positions correspond to one another are traced over time, and a voxel having the largest value is used to form an image). In this case, a search area, an image area satisfying ROI conditions, and a set ROI are all three-dimensional areas, and the values of voxels included in each area are used to execute the above-mentioned algorithm, thereby correcting the blur among volume data.

(Fifth modification of first embodiment)

[0098] The diagnostic image generated by MFI using the blur correction according to this embodiment and the diag-

nostic image generated by MFI not using the blur correction according to this embodiment may be displayed at the same time (for example, the diagnostic images may be superposed side by side or the diagnostic images having different colors may be superposed). Alternatively, the diagnostic image using the blur correction and the diagnostic image not using the blur correction may be selectively displayed. In this way, it is possible to provide wide diagnostic information and realize a diagnostic image having a higher degree of freedom than that of the related art.

(Sixth modification of first embodiment)

[0099] In the blur correction according to this embodiment, when ROI is set in a bloodstream area of a thick blood vessel, the set ROI becomes a high-brightness area. Therefore, in this case, it is difficult to specify a corresponding area on each image data subsequent to the standard image data and to calculate the motion vectors.

[0100] In order to solve these problems, in the blur correction, ROI including a high-brightness area in which contrast medium bubbles are dyed (for example, an area having brightness equal to or higher than a first threshold value) and a low-brightness area not related to the contrast medium bubbles (for example, an area having brightness equal to or smaller than a second threshold value) may be used on the standard image data (reference image data). This structure prevents a brightness distribution pattern of ROI from having high brightness. Therefore, it is possible to appropriately specify an area corresponding to ROI on the frame subsequent to the standard image data and thus to perform appropriate blur correction.

(Second embodiment)

[0101] Next, a second embodiment of the invention will be described below with reference to the drawings.

[0102] In the second embodiment, even if ROI is set once, the setting of ROI is performed whenever image data is generated. That is, when new image data is generated even if ROI has been set already, image data immediately before that time is designated to the standard image data. Then, reference image data is generated from the newly designated standard image data, and ROI is set on the basis of the reference image data.

[0103] However, a sequence of setting ROI is performed only when ROI is set first. When ROI is set two or more times, ROI is reset on the basis of ROI used to correct the blur of the image data immediately before the latest stage and a resultant vector of all motion vectors having already been generated. The motion vector means a vector representing the motion of a continuous series of image data.

[0104] That is, ROI used to correct the blur of image data corresponding to an n-th frame is set on the basis of ROI used to correct the blur of image data corresponding to an (n-1)-th frame and a resultant vector of all motion vectors generated until the blur of the image data corresponding to an (n-1)-th frame is corrected.

(Third embodiment)

[0105] Next, a third embodiment of the invention will be described with reference to FIG. 8.

[0106] In the third embodiment, whenever image data is generated, a sequence of setting ROI is executed to set ROI on the basis of the brightness of each image data. However, in the second embodiment, the sequence of setting ROI is set only when ROI is set first. Therefore, once ROI is set, the next ROI is set on the basis of the set ROI and a motion vector. The third embodiment is different from the second embodiment on the above-mentioned point.

[0107] FIGS. 8A to 8E are diagram schematically illustrating diagnostic images corresponding to five frames generated after flash according to the third embodiment of the invention. In FIGS. 8A to 8E, a white portion indicates a bright area, and a hatched portion indicates a dark area.

[0108] FIG. 8A is a diagram illustrating a diagnostic image at the time of flash, FIG. 8B is a diagram illustrating a diagnostic image corresponding to a first frame after flash, FIG. 8C is a diagram illustrating a diagnostic image corresponding to a second frame after flash, FIG. 8D is a diagram illustrating a diagnostic image corresponding to a third frame after flash, and FIG. 8E is a diagram illustrating a diagnostic image corresponding to a fourth frame after flash.

[0109] That is, the diagnostic image corresponding to the first frame is image data corresponding to the first frame that is generated at the beginning after flash. The diagnostic image corresponding to the second frame is the superposition of image data corresponding to the first and second frames. The diagnostic image corresponding to the third frame is the superposition of image data corresponding to the first to third frames. The diagnostic image corresponding to the fourth frame is the superposition of image data corresponding to the first to fourth frames. The diagnostic image corresponding to the fifth frame is the superposition of image data corresponding to the first to fifth frames.

[0110] As shown in FIGS. 8B to 8D, in the diagnostic images corresponding to the second to fourth frames, ROIs are set at the same position. This is because the sequence of setting ROI is performed on the third and fourth frames of the image data and ROI better than the existing ROI is not detected. However, as shown in FIG. 8E, in the diagnostic image according to the fifth frame, a new ROI is set. The new ROI is represented by a solid line, and a removed ROI mark is

represented by a dotted line. The position of ROI moves because, when ROI is searched on the basis of the image data corresponding to the fifth frame, ROI better than the existing ROI is detected.

[0111] When the sequence of setting ROI is performed whenever image data is generated, it is possible to stably obtain a high-quality diagnostic image while accurately correcting the movement of the image data.

[0112] Further, the ultrasonic probe 11 moves in the direction in which a lens is disposed. Therefore, even when a blood vessel, which is a mark for blur correction until that time, (actually, the image of contrast medium bubbles) is removed from the scanning surface, it is possible to accurately correct the movement of the ultrasonic probe 11 in the lens direction since a new optimum ROI is set at a movement destination.

(Fourth embodiment)

[0113] Next, a fourth embodiment of the invention will be described below with reference to FIGS. 9 and 10.

[0114] When the ultrasonic probe deviates from an ultrasonic scanning surface (or an ultrasonic tomography or an ultrasonic image surface), the techniques described in the first to third embodiments can appropriately correct the blur of an image caused by the deviation. In the maximum brightness value holding operation, the maximum brightness value is selected from a plurality of images, and is projected onto an image. Therefore, even when the ultrasonic probe deviates in a direction (fanning direction) orthogonal to the ultrasonic scanning surface, clinical problems do not arise since information on a desired tomographic position is included in the image having the maximum brightness value projected thereon.

[0115] It is considered that a clinical value is high since the blur of an image in the fanning direction is corrected to realize the maximum brightness value holding operation using time-series image data related to the same tomographic image. In this embodiment, an ultrasonic diagnostic apparatus capable of correcting the blur of an image in the fanning direction and realizing appropriate IMF will be described below.

[0116] FIG. 9 is a flow chart illustrating the flow of MFI including the blur correction according to this embodiment. As shown in FIG. 9, when a contrast medium is injected into an object to be examined (step S40), a time-series two-dimensional image data group (which may not form volume data) on a portion to be diagnosed, which is shown in FIG. 10, is acquired (step S41). Then, standard image data is designated on the basis of the two-dimensional image data group at a time t1, and ROI for correcting blur is set according to the existing algorithm (step S42; see FIG. 4).

[0117] Subsequently, image data corresponding to the standard image data is selected from the two-dimensional image data groups collected at different times (step S43). That is, for example, it is assumed that two-dimensional image data groups corresponding to seven frames are time-serially collected in step S41 and image data corresponding to a fourth frame in the two-dimensional image data group collected at the time t1 is regarded as the standard image data. In this case, image data having the strongest correlation with the standard image data is determined from image data corresponding to a fourth frame in a second two-dimensional image data group collected at a time t2 and image data corresponding to several frames (for example, third and fifth frames) immediately before and after the image data corresponding to the fourth frame, and is selected as corresponding image data.

[0118] Then, the same process as described above is performed using a third two-dimensional image data group collected at a time t3. For example, image data corresponding to a third frame is selected as corresponding image data at the time t3. In this case, image data having the strongest correlation with the standard image data is determined from image data corresponding to a third frame in the second two-dimensional image data group collected at the time t3 and image data corresponding to several frames (for example, second and fourth frames) immediately before and after the image data corresponding to the third frame, and is selected as corresponding image data. Similarly, corresponding image data is selected from each two-dimensional image data group collected at a time t4, ..., tn.

[0119] The method of determining the correlation is not a specific method. For example, pattern matching may be used to calculate a correlation value between the standard image data and each image to determine the correlation therebetween. When the selection of the corresponding image data at each time is performed in real time, an ultrasonic scanning area may be automatically controlled such that several frames immediately before and after the spatial position of the latest corresponding image data are collected, and the same selecting process will be performed using the obtained two-dimensional image data group.

[0120] Next, the blur correction is performed using the standard image data and the corresponding image data at each time (step S44), and a diagnostic image is generated by the maximum brightness value holding operation (step S45). The generated diagnostic image is sequentially or statically displayed on the monitor 12 in a predetermined format (step S46).

[0121] In the above-mentioned structure, image data having the strongest correlation with the standard image data is selected as corresponding image data from the image data groups collected at each time, and blur correction is performed using the corresponding image data. Therefore, even when the position of the standard image data moves in the fanning direction due to the positional deviation of the ultrasonic probe in the fanning direction, it is possible to select an image closest to the position of the standard image data before the movement as a corresponding image. The blur correction

using the corresponding image according to any one of the first to third embodiments makes it possible to realize the maximum brightness value holding operation using time-series image data for the same tomography.

(Fifth embodiment)

[0122] Next, a fifth embodiment of the invention will be described below. In the fifth embodiment, a correlation amount S , which is an index for generating a motion vector, is calculated, and blur correction (movement correction) is performed on the correction amount. An ultrasonic diagnostic apparatus according to this embodiment has substantially the same structure as that shown in FIG. 1. Therefore, only the components having different functions from those in the ultrasonic diagnostic apparatus shown in FIG. 1 will be described below.

[0123] A control processor 25 creates a search area on image data and moves the search area over all image data to detect the brightness of pixels included in the search area. Then, the control processor 25 sets ROI on the image data on the basis of the brightness of the pixels included in the search area. In addition, the control processor 25 calculates the correlation amounts S on the basis of the brightness of the pixels included in ROIs of a plurality of image data, and generates motion vectors indicating the movement between the image data on the basis of the obtained correlation amounts S . Subsequently, the control processor 25 performs movement correction on the image data on the basis of the motion vectors.

[0124] Next, a movement detection mode according to this embodiment of the invention will be described below.

[0125] First, steps S1 to S4 shown in FIG. 4 are sequentially performed to search image areas satisfying ROI conditions. When the image areas satisfying the ROI conditions are searched, an image area including the largest number of pixels having a brightness higher than K is specified among the searched image areas, and ROI is set into the specified image area. In this way, an ROI setting sequence is completed. As shown in FIG. 11, the set ROI is superposed as a rectangular ROI mark on a diagnostic image displayed on the monitor 12.

[0126] Meanwhile, when the image areas satisfying the ROI conditions are not searched on reference image data even when the search area is moved over the reference image data, the ROI setting sequence ends. When the image areas satisfying the ROI conditions are not searched and the ROI setting sequence ends, the subsequent image data is designated as the reference image data, and the ROI setting sequence is performed again. In this way, the ROI setting sequence is repeated until ROI is set.

[0127] Further, in this embodiment, ROI is automatically set, but the invention is not limited thereto. For example, ROI may be manually set by using the track ball input unit 131.

[0128] When ROI is set through the above-mentioned procedure, the next image data is designated to target image data. The target image data moves in the units of pixels in the X-axis and Y-axis directions on the basis of the position thereof at the time when it is generated. Whenever the target image data is moved by one pixel, the brightness $I(X, Y)$ of the pixels included in ROI of the reference image data and the brightness $I'(X, Y)$ of the pixels included in ROI of the target image data are extracted, and are substituted into Expression 1 given below. In this way, the correlation amounts S corresponding to the number of movements of the target image data are calculated.

[0129] When the correlation amounts S corresponding to a predetermined number of movements of the target image data are obtained, the smallest correlation amount S is searched from the obtained correction amounts S , and the amount of movement of the target image data corresponding to the smallest correlation amount S and the movement direction thereof are specified. Then, the motion vectors of the target image data are calculated on the basis of the specified movement amount and movement direction. The calculated motion vectors are stored in the image memory 30a so as to be associated with the corresponding target image data.

[0130] When the motion vectors of the target image data are obtained in this way, the display position of the target image data is corrected on the basis of the motion vectors. Then, corrected image data that little deviates from the standard image data is generated. The corrected image data is superposed on the standard image data by a maximum brightness value holding operation to generate superposed image data.

[0131] Meanwhile, when the superposed image data has already been generated, image data that is newly generated is designated to the target image data. The target image data is moved in the units of pixels in the X-axis and Y-axis directions on the basis of the position thereof at the time when it is generated. Whenever the target image data is moved by one pixel, the brightness $I(X, Y)$ of the pixels included in ROI of the superposed image data that has already been generated and the brightness $I'(X, Y)$ of the pixels included in ROI of the target image data are extracted, and are substituted into Expression 1 given below. In this way, the correlation amounts S corresponding to the number of movements of the target image data are calculated.

[0132] When the correlation amounts S corresponding to a predetermined number of movements of the target image data are obtained, the smallest correlation amount S is searched from the obtained correction amounts S , and the amount of movement of the target image data corresponding to the smallest correlation amount S and the movement direction thereof are specified. Then, the motion vectors of the target image data are calculated on the basis of the specified movement amount and movement direction. The calculated motion vectors are stored in the image memory

30a so as to be associated with the corresponding target image data.

[0133] When the motion vectors of the target image data are obtained in this way, the display position of the target image data is corrected on the basis of the motion vectors. Then, corrected image data that little deviates from the superposed image data which has already been generated is generated. The corrected image data is superposed on the superposed image data by a maximum brightness value holding operation. The superposed image data is sequentially updated through the above-mentioned procedure.

[0134] The correlation amount S is calculated by the following Expression 1:

[Expression 1]

$$S = \sum_X \sum_Y D(X, Y)$$

$$D(X, Y) = I(X, Y)_N - I'(X, Y)_{N-1} \quad (I(X, Y)_N -$$

$$I'(X, Y)_{N-1} > 0)$$

$$= 0 \quad (I(X, Y)_N - I'(X, Y)_{N-1} \leq 0).$$

[0135] In Expression 1, a symbol 'N' indicates the frame number of image data. As shown in FIG. 12, a first frame of the image data is treated as a first frame of the superposed image data. Therefore, an (N-1)-th frame of the superposed image data is superposed on the first frame of the image data (reference image data). In this way, the second to (N-1)-th frames of the superposed image data are superposed to the corresponding frames of the image data.

[0136] As can be seen from Expression 1, the correlation amount S used in this embodiment is the total sum of brightness increments when image data that is newly generated, that is, the target image data is superposed on the superposed image data.

[0137] When the start button 132b is turned on in the movement detection mode, image data generated thereafter is sequentially corrected to generate corrected image data. When the corrected image data is generated, the corrected image data is superposed on the superposed image data by the maximum brightness value holding operation.

[0138] Therefore, while the superposition of the corrected image data is performed, the structure of blood vessels of an object to be examined is extracted on a scanning surface. Since movement correction is performed on the corrected imaged data to be superposed by a pre-process, a very clear diagnostic image is displayed on the monitor 12. Therefore, it is possible to obtain a very clear diagnostic image without being affected by the movement of an object P to be examined or the movement of an operator's hand holding the ultrasonic probe 11.

[0139] Further, in this embodiment, an example where the start button 132b is pushed during low-sound pressure scanning has been described above, but the invention is not limited thereto. For example, the start button 132b may be pushed when movement correction is performed immediately after flash. Therefore, a detailed description thereof will be omitted.

(Effects of fifth embodiment)

[0140] In this embodiment, the total sum of brightness increments when image data that is newly generated is superposed on the superposed image data is used as the correlation amount S serving as an index for generating motion vectors. Therefore, even when the dyed bubbles of the contrast medium appear or disappear abnormally, the dyed bubbles of the contrast medium are continuously displayed, so that motion vectors are generated. As a result, even when MFI is performed, the accuracy of motion vectors of the target image data is improved, which makes it possible to obtain a very clear diagnostic image.

[0141] In this embodiment, ROI is set to an area including a thick blood vessel having the bubbles of the contrast medium concentrated thereon. Therefore, even when there is little area serving as a mark for movement correction, for example, immediately after flash, ROI of the superposed image data is easily correlated to image data that is newly generated.

[0142] In this embodiment, the number of pixels included in ROI is smaller than the total number of pixels of image data. Therefore, the amount of calculation required to calculate the correction amount S between ROI of the superposed image data and ROI of the target image data is considerably reduced.

[0143] In this embodiment, the ROI marks superposed on the diagnostic image are displayed on the monitor 12. Therefore, the operator can check whether ROI is appropriately set from the diagnostic image displayed on the monitor 12.

[0144] In this embodiment, a movement correcting sequence starts only when ROI is set. Therefore, when there is no area serving as an index for movement correction, the target image data is not corrected.

[0145] In this embodiment, the motion vectors are stored in the image memory 30a so as to be associated with the target image data. Therefore, when the superposed image data is reconstructed on the basis of the image data having been stored in the image memory 30a, it is unnecessary to generate the motion vector, which makes it possible to generate a clear diagnostic image with a small amount of calculation.

[0146] Further, in this embodiment, MFI has been described above, but the invention is not limited thereto. That is, the invention can be applied to 'Panoramic Imaging' described in the 'Background Art' as long as a technique for superposing a plurality of image data can be used.

[0147] Furthermore, in this embodiment, the number of ROIs and the sizes thereof are input through the input device 13, but the invention is not limited thereto. For example, the number of ROIs and the sizes thereof may be automatically set on the basis of the brightness of the pixels included in the reference image data.

[0148] Moreover, in this embodiment, ROI is automatically set on the basis of the brightness of the reference image data, but the invention is not limited thereto. For example, ROI may be set so as to be operatively associated with a focal point of an ultrasonic wave transmitted by the transmitting/receiving unit 21, or it may be set according to instructions from the operators.

[0149] Further, in this embodiment, the motion vectors are stored in the image memory 30a so as to be associated with the target image data, but the invention is not limited thereto. For example, the corrected image data may be stored in the image memory 30a. In this case, it is unnecessary to correct the target image data, which makes it possible to generate a clear diagnostic image with a very small amount of calculation.

(Sixth embodiment)

[0150] Next, a sixth embodiment of the invention will be described with reference to FIG. 13. FIG. 13 is a diagram schematically illustrating a diagnostic image having ROI marks superposed thereon according to the sixth embodiment of the invention.

[0151] In the sixth embodiment, as shown in FIG. 13, the control processor 25 sets first to fourth ROIs on reference image data. The fourth ROI corresponds to ROI according to the fifth embodiment. Therefore, in the sixth embodiment, the control processor 25 sets the first to third ROIs in addition to ROI according to the fifth embodiment. The sizes of the first to third ROIs are smaller than the size of the fourth ROI.

[0152] When the first to fourth ROIs are set, first to third motion vectors indicating the movement of target image data are calculated on the basis of a correlation amount S' between the first to third ROIs of the target image data and the first to third ROIs of the superposed image data. In this embodiment, SAD is used as the correlation amount S' .

[0153] When the first to third motion vectors are calculated, the target image data is moved on the basis of the first to third motion vectors. Whenever the target image data is moved, the first to third correlation amounts S are calculated on the basis of the fourth ROI of the superposed image data and the fourth ROI of the target image data by Expression 1, similar to the fifth embodiment.

[0154] When the first to third correlation amounts S are calculated, the smallest correlation amount S is detected from the first to third correlation amounts S , and a vector of the target image data corresponding to the smallest correlation amount is used as the motion vector. Then, the display position of the target image data is corrected on the basis of the motion vector.

[0155] As described above, in this embodiment, the motion vector is selected from the first to third vectors that are acquired beforehand. That is, only three calculating processes are needed to generate the motion vector (calculating processes using Expression 1). Therefore, it is possible to considerably reduce the amount of calculation required to calculate the motion vector, as compared to the fifth embodiment. In addition, even when the motion vector varies with parts of the object to be examined, the accuracy of the motion vector is not excessively lowered.

[0156] In this embodiment, a so-call SAD is used as the correlation amount S' , but the invention is not limited thereto. That is, the correlation amount S' may be calculated by Expression 1. The use of Expression 1 also makes it possible to reduce the amount of calculation, since the sizes of the first to third ROIs are smaller than that of the fourth ROI.

[0157] Further, in this embodiment, the motion vector is calculated by Expression 1 on the basis of the first to third motion vectors that are obtained beforehand, but the invention is not limited thereto. For example, the motion vector may be the mode value or the average value of the first to third motion vectors. The use of the mode value or the average value makes it possible to reduce the amount of calculation.

(Seventh embodiment)

[0158] In a seventh embodiment of the invention, a zero vector is used in addition to the first to third vectors used in the sixth embodiment. That is, in this embodiment, even when the target image data does not move, the fourth correlation amount S is calculated by Expression 1 on the basis of the fourth ROI of the target image data and the fourth ROI of the superposed image data that has already been generated or the fourth ROI of the reference image data, similar to

the fifth embodiment.

[0159] When the first to fourth correlation amounts S are calculated, the smallest correlation amount S is detected from the first to fourth correlation amounts S , and a vector of the target image data corresponding to the smallest correlation amount is used as the motion vector. Then, the display position of the target image data is corrected on the basis of the motion vector.

[0160] As described above, in this embodiment, even when the target image data does not move, the fourth correlation amount S is calculated by Expression 1. Therefore, even when the ultrasonic probe 11 is inclined to the lens to cause the first and third vectors to vary, the accuracy of the motion vector that is actually used is not excessively lowered.

(Eighth embodiment)

[0161] In an eighth embodiment of the invention, it is assumed that three-dimensional image data is generated. Therefore, a three-dimensional ROI is set on reference image data. When the three-dimensional ROI is used, the amount of calculation required to calculate the correlation amount S is considerably increased.

[0162] For the reason, in this embodiment, first to third two-dimensional ROIs are used instead of the three-dimensional ROI. The first to third ROIs are included in the three-dimensional ROI and are orthogonal to one another. In addition, the first to third ROIs are generated as MPR of the three-dimensional ROI. The first to third ROIs used in the eighth embodiment are different from the first to third ROIs used in the sixth or seventh embodiment.

[0163] When the first to third ROIs are generated, first to third vectors respectively corresponding to the first to third ROIs are generated by the same method as that in the fifth embodiment. The first to third vectors used in the eighth embodiment are different from the first to third vectors used in the sixth or seventh embodiment.

[0164] When the first to third vectors are generated, a third-dimensional motion vector that is actually used to correct the movement of the target image data is generated on the basis of the first to third vectors.

[0165] As described above, in this embodiment, the first to third two-dimensional ROIs are used instead of the three-dimensional ROI. Therefore, even when three-dimensional image data is generated, the amount of calculation required to calculate the correlation amount S is considerably decreased.

[0166] Further, in this embodiment, the third-dimensional motion vector is generated on the basis of the first to third vectors, and then the target image data is corrected. However, the invention is not limited thereto. For example, the target image data may be corrected for each of the first to third vectors. In this case, three correcting processes are needed, and it is not necessary to generate the motion vector.

(Ninth embodiment)

[0167] In a ninth embodiment of the invention, the control processor 25 detects the sum of brightnesses of the pixels included in ROI of the superposed image data. When the sum of brightnesses is larger than a predetermined value, the control processor 25 stops correcting the movement of the target image data. Therefore, even when a plurality of image data are superposed on each other and ROI of the superposed image data has an excessively high brightness, the accuracy of the motion vector is not excessively lowered.

(Tenth embodiment)

[0168] In a tenth embodiment of the invention, it is assumed that both bloodstream image data and tissue image data are displayed. The bloodstream image data corresponds to the image data in each of the above-described embodiments. The tissue image data does not vary over time unlike the bloodstream image data, which makes it easy to calculate the motion vector. Therefore, in this embodiment, ROI is set to the tissue image data, and the motion vector is generated by Expression 1 in the same manner as that in the first embodiment. Then, the movement of only the bloodstream image data is corrected on the basis of the generated motion vector.

[0169] When the movement of the bloodstream image data is corrected on the basis of ROI set to the tissue image data as in the tenth embodiment, a more clear diagnostic image is obtained. In addition, in this embodiment, the tissue image data is displayed on the monitor 12 without being corrected. Therefore, the tissue image data displayed on the monitor 12 makes it easy for the operator to check the movement and to view the state of the object P to be examined. As a result, the operator can perform a medical examination with confidence.

(Eleventh embodiment)

[0170] FIGS. 14, 15, 16, and 17 are diagrams illustrating the correction results of image data superposed on a diagnostic image according to an eleventh embodiment of the invention. In the eleventh embodiment, the correction result of the target image data is superposed on the diagnostic image. The correction results are displayed in several types as shown

in FIGS. 14, 15, 16, and 17.

[0171] As shown in FIG. 14, only a motion vector V of the target image data is displayed as the correction result of the target image data. Therefore, it is very easy to confirm the correction result of the target image data in a moment. As shown in FIG. 15, a locus L of an end point of the motion vector V is displayed as the correction result of the target image data. Therefore, it is very easy to know a change in the motion vector V over time. As shown in FIG. 16, a plurality of motion vectors V that are sequentially generated are displayed as the correction result of the target image data, similar to FIG. 14, but a time axis t is added to an X-axis and a Y-axis. FIG. 17 shows the correction result of three-dimensional volume data. As shown in FIG. 17, only the motion vector V of the target image data is displayed, similar to FIG. 14.

[0172] As described above, when the correction result is superposed on the diagnostic image displayed on the monitor 12, the operator can easily confirm the correction result and use a correcting function with confidence.

(Twelfth embodiment)

[0173] A twelfth embodiment of the invention relates to an application of the acquired motion vector. For example, the acquired motion vector is used to move a range gate of a pulse wave. In this case, when the range gate of pulsed-wave Doppler is set in a desired blood vessel, it is possible to continuously acquire signals from the desired blood vessel even when the object P to be examined or the ultrasonic probe 11 moves a little. The motion vector is used to correct the position of a color ROI, to maintain the same cross section of an object to be examined, and to follow an interesting area by using brightness analyzing software, in addition to moving the range gate of pulse-wave Doppler.

[0174] Conversely, when a background image is corrected with the range gate of the pulse wave or the position of the color ROI being fixed, the operator can view a diagnostic image including an interesting area. This is very useful to observe a variation in brightness over time or to analyze a diagnostic image.

[0175] The invention is not limited to the above-described embodiments, but various modifications and changes of the invention can be made without departing from the scope of the invention which is defined in the appended claims.

A plurality of components described in the embodiments may be appropriately combined with each other to form various modifications. For example, some components may be removed from all the components in the above-described embodiments. In addition, different components in the above-described embodiments may be combined with each other.

Industrial Applicability

[0176] According to the present invention, it is possible to provide an ultrasonic diagnostic apparatus and an ultrasonic image generating method capable of preventing the quality of an image from being lowered even when an object to be examined or an ultrasonic probe moves a little.

Claims

1. An ultrasonic diagnostic apparatus for scanning a structure of a blood vessel as an object within a person to be examined, having injected contrast medium bubbles therein, with ultrasonic waves to acquire an ultrasonic image of the object, the apparatus comprising:

a transmitting/receiving unit (21) configured to repeatedly transmit the ultrasonic waves to the object and acquire echo signals returning from the object;
an image data generating unit configured to generate a plurality of time-series images indicating a shape of the object on the basis of the echo signals;
a setting unit (25) configured to set an interesting area (ROI), which is smaller than the entire image area, wherein the setting of the interesting area (ROI) includes

- during low sound pressure scanning, where ultrasonic waves are set to a sufficiently low sound pressure not to break the contrast medium bubbles, after turning on a movement detecting mode,
- designating images generated immediately after turning on the movement detecting mode to standard image data,
- to generate reference image data to be used as a search target of the interesting area (ROI), performing an average value process or a threshold value process on the standard image data such that only the image of the contrast medium bubbles or the tissue of the living body is reflected to the reference image data,
- generating a search area having the same size and shape as the interesting area (ROI) on the reference image data and moving the search area across all entire reference image data, and
- from those image areas, in which the number of pixels having brightness higher than a threshold value K

is larger than a threshold value M, setting the image area having the largest number of pixels having brightness higher than the threshold value K as the interesting area (ROI);

a vector generating unit configured to compare at least one image different from the reference image data based on data in the interesting area (ROI) to generate a motion vector indicating the motion between the reference image data and the at least one image, wherein

a corresponding area corresponding to the interesting area (ROI) is set on the at least one image generated subsequent to the standard image data on the basis of the interesting area (ROI) on the reference image data, the corresponding area having the same shape and size as the interesting area (ROI) and having a brightness distribution pattern closest to that of the interesting area (ROI), and

the motion vector is generated from the correlation between the brightness of pixels included in the interesting area (ROI) of the standard image data and the brightness of pixels included in the corresponding area;

an image correcting unit configured to correct a blur between the reference image data and the at least one image on the basis of the motion vector, thereby generating a plurality of corrected image data; and

an image generating unit (24) configured to generate a display image on the basis of the plurality of corrected image data by sequentially performing a brightness value holding operation using the plurality of corrected image data to generate the display image.

2. The ultrasonic diagnostic apparatus according to claim 1, wherein the image generating unit is further configured to perform a combining process using the plurality of corrected image data to generate the display image.

3. The ultrasonic diagnostic apparatus according to claim 1, wherein, when each image data includes an area dyed by a contrast medium, the setting unit is further configured to set the interesting area so as to include at least a part of the dyed area.

4. The ultrasonic diagnostic apparatus according to claim 1, further comprising:

a detecting unit configured to detect the time when a contrast medium flows into the object, wherein the setting unit is further configured to set the interesting area on the basis of the plurality of image data at the time when a small amount of contrast medium flows.

5. The ultrasonic diagnostic apparatus according to claim 1, wherein the setting unit is further configured to set the interesting area so as to include a position having a brightness value larger than a predetermined threshold value on the basis of the brightness value at each position on the image.

6. The ultrasonic diagnostic apparatus according to claim 5, wherein the setting unit is further configured to make a histogram related to the brightness values of the image, and to determine the predetermined threshold value on the basis of the histogram.

7. The ultrasonic diagnostic apparatus according to claim 1, wherein the setting unit is further configured to set the interesting area so as to include a position having a brightness value between a first predetermined threshold value and a second predetermined threshold value on the basis of the brightness at each position on the image.

8. The ultrasonic diagnostic apparatus according to claim 7, wherein the setting unit is further configured to make a histogram related to the brightness values of the image, and determines at least one of the first threshold value and the second threshold value on the basis of the histogram.

9. The ultrasonic diagnostic apparatus according to claim 1, wherein the setting unit is further configured to determine at least one of the position, size, and shape of the interesting area and the number of interesting areas on the basis of the brightness at each position on the image.

10. The ultrasonic diagnostic apparatus according to claim 1, wherein the setting unit is further configured to set the interesting area to the plurality of images subjected to a noise reducing process.

11. The ultrasonic diagnostic apparatus according to claim 1,

wherein, whenever the image data generating unit generates the image data, the setting unit is further configured to update the interesting area on the basis of an interesting area used to correct the blur of the previous image data and a resultant vector of a plurality of motion vectors that have been generated by the vector generating unit.

5 **12.** The ultrasonic diagnostic apparatus according to claim 1,
 wherein, whenever the image data generating unit generates the image data, the setting unit is further configured to search the interesting area on the basis of the brightness of the previous image data and to update the interesting area.

10 **13.** The ultrasonic diagnostic apparatus according to claim 1,
 wherein the setting unit is further configured to set a common interesting area used to correct the blur of a plurality of image data generated by the image data generating unit, on the basis of the brightness of the plurality of image data.

15 **14.** The ultrasonic diagnostic apparatus according to claim 1,
 wherein the transmitting/receiving unit (21) is further configured to perform first ultrasonic transmission at first sound pressure that breaks the contrast medium bubbles and second ultrasonic transmission at second sound pressure for imaging the reflux of a bloodstream at which the contrast medium bubbles are not broken, and
 an image generated immediately after the first ultrasonic transmission is switched to the second ultrasonic transmission is designated as a reference image.

20 **15.** The ultrasonic diagnostic apparatus according to claim 1,
 wherein the transmitting/receiving unit (21) is further configured to perform first ultrasonic transmission at first sound pressure that breaks the contrast medium bubbles and second ultrasonic transmission at second sound pressure for imaging the reflux of a bloodstream at which the contrast medium bubbles are not broken, and
 25 the interesting area is searched again immediately after the first ultrasonic transmission is switched to the second ultrasonic transmission, and the interesting area is updated.

30 **16.** The ultrasonic diagnostic apparatus according to claim 1, further comprising:
 a designating unit configured to designate a time when the image correcting unit starts correcting the blur of the image data.

35 **17.** The ultrasonic diagnostic apparatus according to claim 1, further comprising:
 a designating unit configured to designate a time when the image correcting unit corrects the blur of the image data or the number of frames.

40 **18.** The ultrasonic diagnostic apparatus according to claim 1,
 wherein the display unit is further configured to display the interesting area on the ultrasonic image.

45 **19.** The ultrasonic diagnostic apparatus according to claim 1, further comprising:
 a switching unit configured to perform switching between the display and non-display of the interesting area.

50 **20.** The ultrasonic diagnostic apparatus according to claim 1, further comprising:
 a designating unit configured to designate at least one of the position, size, and shape of the interesting area and the number of interesting areas.

55 **21.** The ultrasonic diagnostic apparatus according to claim 1, further comprising:

a display unit,

wherein the image generating unit is further configured to generate a first display image on the basis of the plurality of images after the blur correction and to generate a second display image on the basis of the plurality of images before the blur correction, and
 the display unit is further configured to simultaneously or selectively display the first display image and the second display image.

22. The ultrasonic diagnostic apparatus according to claim 1, further comprising:

an image superposing unit configured to, when the reference image data is designated from the plurality of image data generated by the image data generating unit, sequentially superpose subsequent image data on

the reference image data to generate a superposed image data,
 wherein the vector generating unit is further configured to generate a motion vector indicating the movement
 of target image data among the image data subsequent to the reference image data that are generated by the
 image data generating unit, on the basis of the brightness of an interesting area of the target image data and
 the brightness of an interesting area of the superposed image data generated from the plurality of image data
 preceding the target image data, and
 the image correcting unit is further configured to correct the target image data on the basis of the motion vector
 generated by the vector generating unit before the image superposing unit superposes the target image data.

23. The ultrasonic diagnostic apparatus according to claim 22,
 wherein the vector generating unit is further configured to generate the motion vector on the basis of an increment
 in the brightness of the interesting area generated when the target image data is superposed.

24. The ultrasonic diagnostic apparatus according to claim 22, wherein the
 setting unit is further configured to automatically set the interesting area on the basis of the brightness of the image
 data generated by the image data generating unit.

25. The ultrasonic diagnostic apparatus according to claim 22, wherein the
 setting unit is further configured to automatically set the interesting area on the basis of a focal point of an ultrasonic
 wave transmitted by the transmitting/receiving unit (21).

26. The ultrasonic diagnostic apparatus according to claim 22, wherein the
 setting unit is further configured to set the interesting area according to instructions from an operator.

27. The ultrasonic diagnostic apparatus according to claim 22,
 wherein the image correcting unit is further configured to correct the target image area when the setting unit sets
 the interesting area.

28. The ultrasonic diagnostic apparatus according to claim 22,
 wherein the vector generating unit is further configured to move the target image data according to a plurality of
 vectors acquired beforehand, to calculate the increment in the brightness of the interesting area generated when
 the target image data is superposed for every vector, and to select the motion vector from the plurality of vectors
 on the basis of the increment in the brightness of the interesting area.

29. The ultrasonic diagnostic apparatus according to claim 28,
 wherein the vector generating unit is further configured to generate the plurality of vectors on the basis of the
 brightness of an interesting area smaller than the interesting area in the target image data and the brightness of an
 interesting area smaller than the interesting area in the superposed image data generated from the plurality of image
 data preceding the target image data.

30. The ultrasonic diagnostic apparatus according to claim 28,
 wherein one of the plurality of vectors is a zero vector.

31. The ultrasonic diagnostic apparatus according to claim 22,
 further adapted to display the motion vector generated by the vector generating unit on the diagnostic image.

32. The ultrasonic diagnostic apparatus according to claim 22,
 further adapted to display a locus of an end point of the motion vector generated by the vector generating unit on
 the diagnostic image.

33. The ultrasonic diagnostic apparatus according to claim 22,
 wherein, when the image data generating unit generates three-dimensional image data, the vector generating unit
 is further configured to use first to third two-dimensional interesting areas that are included in the interesting area
 and are orthogonal to one another to generate first to third two-dimensional vectors, respectively, and to generate
 the motion vector on the basis of the first to third vectors.

34. The ultrasonic diagnostic apparatus according to claim 22,
 wherein, when the image data generating unit generates three-dimensional image data, the vector generating unit

is further configured to use first to third two-dimensional interesting areas that are included in the interesting area and are orthogonal to one another to generate first to third two-dimensional vectors, respectively, and the image correcting unit is further configured to correct the target image data on the basis of the first to third vectors generated by the vector generating unit.

5 35. The ultrasonic diagnostic apparatus according to claim 22, wherein, when the sum of brightnesses in the interesting area is larger than a predetermined value, the image correcting unit is further configured to stop correcting the target image data.

10 36. The ultrasonic diagnostic apparatus according to claim 22, wherein the image correcting unit is further configured to correct the target image data on the basis of the motion vector generated by the vector generating unit, and to maintain a displayed area of the object to be examined on the diagnostic image.

15 37. The ultrasonic diagnostic apparatus according to claim 22, further comprising: a range gate correcting unit configured to correct the position of a range gate in pulsed-wave Doppler on the basis of the motion vector generated by the vector generating unit.

20 38. The ultrasonic diagnostic apparatus according to claim 22, further comprising: a storage unit (30) configured to store the image data generated by the image data generating unit and the motion vector generated by the vector generating unit such that they are associated with each other.

25 39. The ultrasonic diagnostic apparatus according to claim 22, further comprising: a storage unit (30) configured to store the image data corrected by the image correcting unit.

30 40. The ultrasonic diagnostic apparatus according to claim 22, wherein the image data generating unit is further configured to generate the image data including bloodstream image data indicating bloodstream information of the object to be examined as brightness and tissue image data indicating tissue information of the object to be examined as brightness, on the basis of each echo signal received by the transmitting/receiving unit (21), when reference bloodstream image data is designated from a plurality of bloodstream image data generated by the image data generating unit, the image superposing unit is further configured to sequentially superpose, on the reference bloodstream image data, the bloodstream image data subsequent to the reference bloodstream image data to generate a superposed bloodstream image data, and to sequentially superpose, on the tissue image data corresponding to the reference bloodstream image data, the tissue image data subsequent thereto to generate a superposed tissue image data, the vector generating unit is further configured to generate a motion vector indicating the movement of the tissue image data corresponding to target bloodstream image data among a plurality of bloodstream image data subsequent to the reference bloodstream image data, on the basis of the brightness of an interesting area of the tissue image data corresponding to the target bloodstream image data and the brightness of an interesting area of the superposed tissue image data generated from the plurality of tissue image data preceding the tissue image data, and before the image superposing unit superposes the target bloodstream image data, the image correcting unit is further configured to correct the target bloodstream image data on the basis of the motion vector generated by the vector generating unit.

45 41. A method of generating an ultrasonic diagnostic image by scanning a structure of a blood vessel as an object within a person to be examined, having injected contrast medium bubbles therein, with ultrasonic waves, the method comprising:

50 repeatedly transmitting the ultrasonic waves to the object and generating a plurality of time-series image data indicating a shape of the object on the basis of echo signals returning from the object; setting an interesting area (ROI) which is smaller than the entire image area, wherein the setting of the interesting area (ROI) includes

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- during low sound pressure scanning, where ultrasonic waves are set to a sufficiently low sound pressure not to break the contrast medium bubbles, after turning on a movement detecting mode,
 - designating images generated immediately after turning on the movement detecting mode to standard image data,

- to generate reference image data to be used as a search target of the interesting area (ROI), performing an average value process or a threshold value process on the standard image data such that only the image of the contrast medium bubbles or the tissue of the living body is reflected to the reference image data,
 - generating a search area having the same size and shape as the interesting area (ROI) on the reference
 5 image data and moving the search area across all entire reference image data, and
 - from those image areas, in which the number of pixels having brightness higher than a threshold value K is larger than a threshold value M, setting the image area having the largest number of pixels having brightness higher than the threshold value K as the interesting area (ROI);

10 comparing at least one image different from the reference image data based on data in the interesting area (ROI) to generate a motion vector, which indicates the motion between the reference image data and the at least one image, wherein
 a corresponding area corresponding to the interesting area (ROI) is set on the at least one image generated subsequent to the standard image data on the basis of the interesting area (ROI) on the reference image data,
 15 the corresponding area having the same shape and size as the interesting area (ROI) and having a brightness distribution pattern closest to that of the interesting area (ROI), and
 the motion vector is generated from the correlation between the brightness of pixels included in the interesting area (ROI) of the standard image data and the brightness of pixels included in the corresponding area;
 correcting a blur between the reference image data and the at least one image on the basis of the motion vector,
 20 thereby generating a plurality of corrected image data; and
 generating a display image on the basis of the plurality of corrected image data by sequentially performing a brightness value holding operation using, the plurality of corrected image data to generate the display image.

25 Patentansprüche

1. Ultraschalldiagnosegerät zum Scannen einer Struktur eines Blutgefäßes als ein Objekt innerhalb einer zu untersuchenden Person, in das Kontrastmittelblasen injiziert worden sind, mit Ultraschallwellen zum Erfassen einer Ultraschallbilds des Objekts, wobei das Gerät aufweist:

30 eine Sende/Empfangs-Einheit (21), die konfiguriert ist zum wiederholten Senden der Ultraschallwellen an das Objekt und zum Erfassen von Echosignalen, die von dem Objekt zurückkommen;
 eine Bilddatenerzeugungseinheit, die konfiguriert ist zum Erzeugen einer Mehrzahl von Zeitserienbildern, die eine Form des Objekts angeben, basierend auf den Echosignalen;
 35 eine Einstellungseinheit (25), die konfiguriert ist zum Einstellen eines interessierenden Bereichs (ROI), der kleiner ist als der gesamte Bildbereich, wobei das Einstellen des interessierenden Bereichs (ROI) aufweist während eines Scannens mit niedrigem Schalldruck, bei dem die Schallwellen auf einen ausreichend geringen Schalldruck eingestellt sind, der die Kontrastmittelblasen nicht zerstört, nach Einschalten eines Bewegungsdetektionsmodus, Bestimmen von Bildern, die unmittelbar nach dem Einschalten des Bewegungsdetektionsmodus erzeugt werden, als Standardbilddaten,
 40 zum Erzeugen von Referenzbilddaten, die zu verwenden sind als Suchziel des interessierenden Bereichs (ROI), Durchführen eines Durchschnittswertprozesses oder eines Schwellenwertprozesses für die Standardbilddaten derart, dass nur das Bild der Kontrastmittelblasen des Gewebes des lebenden Körpers als die Referenzbilddaten reflektiert werden,
 45 Erzeugen eines Suchbereichs, der eine geringe Größe und Form aufweist, als interessierender Bereich (ROI) auf den Referenzbilddaten und Bewegen des Suchbereichs über alle Gesamtreferenzbilddaten, und von denjenigen Bildbereichen, in denen die Anzahl von Pixeln, die eine Helligkeit größer als ein Schwellenwert K haben, größer ist als ein Schwellenwert M, Einstellen des Bildbereichs, der die größte Anzahl von Pixeln mit der Helligkeit größer als der Schwellenwert K hat, als der interessierende Bereich (ROI);
 50 eine Vektorerzeugungseinheit, die konfiguriert ist zum Vergleichen von mindestens einem Bild, das von den Referenzbilddaten verschieden ist, basierend auf Daten in dem interessierenden Bereich (ROI), um einen Bewegungsvektor zu erzeugen, der die Bewegung zwischen den Referenzbilddaten und dem mindestens einen Bild angibt, wobei
 ein entsprechender Bereich, der dem interessierenden Bereich (ROI) entspricht, auf das mindestens eine Bild
 55 eingestellt wird, das nachfolgend zu den Standardbilddaten erzeugt wird, basierend auf dem interessierenden Bereich (ROI) auf den Referenzbilddaten, wobei der entsprechende Bereich die gleiche Form und Größe aufweist, wie der interessierende Bereich (ROI) und ein Helligkeitsverteilungsmuster aufweist, das dem des interessierenden Bereichs (ROI) am nächsten kommt, und

der Bewegungsvektor aus der Korrelation zwischen der Helligkeit der Pixel, die in dem interessierenden Bereich (ROI) der Standardbilddaten vorhanden sind, und der Helligkeit der Pixel, die in dem entsprechenden Bereich vorhanden sind, erzeugt wird;

eine Bildkorrekturereinheit, die konfiguriert ist zum Korrigieren einer Unschärfe zwischen den Referenzbilddaten und dem mindestens einen Bild basierend auf dem Bewegungsvektor, wodurch eine Mehrzahl von korrigierten Bilddaten erzeugt werden; und

eine Bilderzeugungseinheit (24), die konfiguriert ist zum Erzeugen eines Anzegebilds basierend auf der Mehrzahl von korrigierten Bilddaten durch aufeinanderfolgendes Durchführen einer Helligkeitswerthalteoperation unter Verwendung der Mehrzahl von korrigierten Bilddaten, um das Anzegebild zu erzeugen.

2. Ultraschalldiagnosegerät nach Anspruch 1, bei dem die Bilderzeugungseinheit ferner konfiguriert ist zum Durchführen eines Kombinierungsprozesses unter Verwendung der Mehrzahl von korrigierten Bilddaten, um das Anzegebild zu erzeugen.

3. Ultraschalldiagnosegerät nach Anspruch 1, bei dem, wenn alle Bilddaten einen Bereich aufweisen, der durch ein Kontrastmittel eingefärbt ist, die Einstellungseinheit ferner konfiguriert ist zum Einstellen des interessierenden Bereichs, um mindestens einen Teil des eingefärbten Bereichs aufzuweisen.

4. Ultraschalldiagnosegerät nach Anspruch 1, ferner mit:
einer Detektionseinheit, die konfiguriert ist zum Detektieren der Zeit, bei der ein Kontrastmittel in das Objekt strömt, wobei die Einstellungseinheit ferner konfiguriert ist zum Einstellen des interessierenden Bereichs basierend auf der Mehrzahl von Bilddaten zu dem Zeitpunkt, bei der eine geringe Menge des Kontrastmediums strömt.

5. Ultraschalldiagnosegerät nach Anspruch 1, bei dem die Einstellungseinheit ferner konfiguriert ist zum Einstellen des interessierenden Bereichs, um eine Stelle aufzuweisen, die einen Helligkeitswert aufweist, der größer ist als ein vorbestimmter Schwellenwert, basierend auf dem Helligkeitswert an jeder Stelle auf dem Bild.

6. Ultraschalldiagnosegerät nach Anspruch 5, bei dem die Einstellungseinheit ferner konfiguriert ist zum Bilden eines Histogramms bezüglich der Helligkeitswerte des Bilds, und zum Bestimmen des vorbestimmten Schwellenwerts basierend auf dem Histogramm.

7. Ultraschalldiagnosegerät nach Anspruch 1, bei dem die Einstellungseinheit ferner konfiguriert ist zum Einstellen des interessierenden Bereichs, um eine Stelle aufzuweisen, die einen Helligkeitswert aufweist zwischen einem ersten vorbestimmten Schwellenwert und einem zweiten vorbestimmten Schwellenwert, basierend auf der Helligkeit an jeder Stelle auf dem Bild.

8. Ultraschalldiagnosegerät nach Anspruch 7, bei dem die Einstellungseinheit ferner konfiguriert ist zum Bilden eines Histogramms bezüglich der Helligkeitswerte des Bilds, und zum Bestimmen von mindestens einem von dem ersten Schwellenwert und dem zweiten Schwellenwert basierend auf dem Histogramm.

9. Ultraschalldiagnosegerät nach Anspruch 1, bei dem die Einstellungseinheit ferner konfiguriert ist zum Bestimmen von mindestens der Position, Größe und/oder Form des interessierenden Bereichs, und der Anzahl von interessierenden Bereichen basierend auf der Helligkeit an jeder Stelle auf dem Bild.

10. Ultraschalldiagnosegerät nach Anspruch 1, bei dem die Einstellungseinheit ferner konfiguriert ist zum Einstellen des interessierenden Bereichs auf die Mehrzahl von Bildern, die einem Rauschreduzierungsprozess unterworfen worden sind.

11. Ultraschalldiagnosegerät nach Anspruch 1, bei dem, wenn die Bilddatenerzeugungseinheit die Bilddaten erzeugt, die Einstellungseinheit ferner konfiguriert ist zum Aktualisieren des interessierenden Bereichs basierend auf einem interessierenden Bereich, der verwendet wird zum Korrigieren der Unschärfe der vorherigen Bilddaten, und eines resultierenden Vektors einer Mehrzahl von Bewegungsvektoren, die von der Vektorerzeugungseinheit erzeugt worden sind.

12. Ultraschalldiagnosegerät nach Anspruch 1, bei dem, wenn die Bilddatenerzeugungseinheit die Bilddaten erzeugt, die Einstellungseinheit ferner konfiguriert ist zum Suchen des interessierenden Bereichs basierend auf der Helligkeit vorheriger Bilddaten und Aktualisieren des interessierenden Bereichs.

13. Ultraschalldiagnosegerät nach Anspruch 1, bei dem die Einstellungseinheit ferner konfiguriert ist zum Einstellen eines gemeinsamen interessierenden Bereichs, der verwendet wird zum Korrigieren der Unschärfe einer Mehrzahl von Bilddaten, die von der Bilddatenerzeugungseinheit erzeugt werden, basierend auf der Helligkeit der Mehrzahl von Bilddaten.

14. Ultraschalldiagnosegerät nach Anspruch 1, bei dem die Sende/Empfangs-Einheit (21) ferner konfiguriert ist zum Durchführen einer ersten Ultraschallsendung mit einem ersten Schalldruck, der die Kontrastmediumblasen zerstört, und einer zweiten Ultraschallsendung mit einem zweiten Schalldruck zum Abbilden eines Rückflusses eines Blutstroms, bei dem die Kontrastmediumblasen nicht zerstört sind, wobei ein Bild, das unmittelbar nach einem Umschalten der ersten Ultraschallsendung auf die zweite Ultraschallsendung erzeugt wird, als ein Referenzbild bestimmt wird.

15. Ultraschalldiagnosegerät nach Anspruch 1, bei dem die Sende/Empfangs-Einheit (21) ferner konfiguriert ist zum Durchführen einer ersten Ultraschallsendung mit einem ersten Schalldruck, der die Kontrastmediumblasen zerstört, und einer zweiten Ultraschallsendung mit einem zweiten Schalldruck zum Abbilden des Rückflusses eines Blutstroms, bei dem die Kontrastmediumblasen nicht zerstört sind, wobei der interessierende Bereich erneut gesucht wird, unmittelbar nachdem die erste Ultraschallsendung zu der zweiten Ultraschallsendung geschaltet worden ist, und der interessierende Bereich aktualisiert wird.

16. Ultraschalldiagnosegerät nach Anspruch 1, ferner mit:
einer Bestimmungseinheit, die konfiguriert ist zum Bestimmen eines Zeitpunkts, bei dem die Bildkorrekturereinheit das Korrigieren der Unschärfe der Bilddaten startet.

17. Ultraschalldiagnosegerät nach Anspruch 1, ferner mit:
einer Bestimmungseinheit, die konfiguriert ist zum Bestimmen eines Zeitpunkts, bei dem die Bildkorrekturereinheit die Unschärfe der Bilddaten oder die Anzahl von Rahmen korrigiert.

18. Ultraschalldiagnosegerät nach Anspruch 1, bei dem die Anzeigeeinheit ferner konfiguriert ist zum Anzeigen des interessierenden Bereichs auf dem Ultraschallbild.

19. Ultraschalldiagnosegerät nach Anspruch 1, ferner mit:
einer Schalteinheit, die konfiguriert ist zum Durchführen eines Schaltens zwischen der Anzeige und Nichtanzeige des interessierenden Bereichs.

20. Ultraschalldiagnosegerät nach Anspruch 1, ferner mit:
einer Bestimmungseinheit, die konfiguriert ist zum Bestimmen von mindestens der Position, Größe und/oder Form des interessierenden Bereichs und der Anzahl von interessierenden Bereichen.

21. Ultraschalldiagnosegerät nach Anspruch 1, ferner mit:
einer Anzeigeeinheit, wobei die Bilderzeugungseinheit ferner konfiguriert ist zum Erzeugen eines ersten Anzeigebilds basierend auf der Mehrzahl von Bildern nach der Unschärfekorrektur, und zum Erzeugen eines zweiten Anzeigebilds basierend auf der Mehrzahl von Bildern vor der Unschärfekorrektur, und die Anzeigeeinheit ferner konfiguriert ist zum gleichzeitigen oder selektiven Anzeigen des ersten Anzeigebilds und des zweiten Anzeigebilds.

22. Ultraschalldiagnosegerät nach Anspruch 1, ferner mit:
einer Bildüberlagerungseinheit, die konfiguriert ist zum sequentiellen Überlagern aufeinanderfolgender Bilddaten auf die Referenzbilddaten, wenn die Referenzbilddaten von der Mehrzahl von Bilddaten, die von der Bilddatenerzeugungseinheit erzeugt worden sind, bestimmt werden, um überlagerte Bilddaten zu erzeugen, wobei die Vektorerzeugungseinheit ferner konfiguriert ist zum Erzeugen eines Bewegungsvektors, der die Bewegung der Zielbilddaten von den Bilddaten nachfolgend den Referenzbilddaten, die von der Bilddatenerzeugungseinheit erzeugt worden sind, angibt, basierend auf der Helligkeit eines interessierenden Bereichs der Zielbilddaten und der Helligkeit eines interessierenden Bereichs der überlagerten Bilddaten, die von der Mehrzahl von Bilddaten erzeugt worden sind, die den Zielbilddaten vorangehen, und die Bildkorrekturereinheit ferner konfiguriert ist zum Korrigieren der Zielbilddaten basierend auf dem Bewegungsvektor, der erzeugt wird von der Vektorerzeugungseinheit bevor die Bildüberlagerungseinheit die Zielbilddaten

überlagert.

23. Ultraschalldiagnosegerät nach Anspruch 22, bei dem die Vektorerzeugungseinheit ferner konfiguriert ist zum Erzeugen des Bewegungsvektors basierend auf einer Helligkeitszunahme des interessierenden Bereichs, die erzeugt wird, wenn die Zielbilddaten überlagert werden.
24. Ultraschalldiagnosegerät nach Anspruch 22, bei dem die Einstellungseinheit ferner konfiguriert ist zum automatischen Einstellen des interessierenden Bereichs basierend auf der Helligkeit der Bilddaten, die von der Bilddatenerzeugungseinheit erzeugt werden.
25. Ultraschalldiagnosegerät nach Anspruch 22, bei dem die Einstellungseinheit ferner konfiguriert ist zum automatischen Einstellen des interessierenden Bereichs basierend auf einem Fokuspunkt einer Ultraschallwelle, die von der Sende/Empfangs-Einheit (21) gesendet wird.
26. Ultraschalldiagnosegerät nach Anspruch 22, bei dem die Einstellungseinheit ferner konfiguriert ist zum Einstellen des interessierenden Bereichs gemäß Befehlen von einem Operator.
27. Ultraschalldiagnosegerät nach Anspruch 22, bei dem die Bildkorrekturereinheit ferner konfiguriert ist zum Korrigieren des Zielbildbereichs, wenn die Einstellungseinheit den interessierenden Bereich festlegt.
28. Ultraschalldiagnosegerät nach Anspruch 22, bei dem die Vektorerzeugungseinheit ferner konfiguriert ist zum Bewegen der Zielbilddaten gemäß einer Mehrzahl von zuvor erfassten Vektoren, um die Helligkeitszunahme des interessierenden Bereichs, die erzeugt wird, wenn die Zielbilddaten für jeden Vektor überlagert werden, zu berechnen, und den Bewegungsvektor von der Mehrzahl von Vektoren basierend auf der Helligkeitszunahme des interessierenden Bereichs auszuwählen.
29. Ultraschalldiagnosegerät nach Anspruch 28, bei dem die Vektorerzeugungseinheit ferner konfiguriert ist zum Erzeugen der Mehrzahl von Vektoren basierend auf der Helligkeit eines interessierenden Bereichs, der kleiner ist als der interessierende Bereich in den Zielbilddaten, und der Helligkeit des interessierenden Bereichs, der kleiner ist als der interessierende Bereich in den überlagerten Bilddaten, die von der Mehrzahl von Bilddaten erzeugt werden, die den Zielbilddaten vorausgehen.
30. Ultraschalldiagnosegerät nach Anspruch 28, bei dem einer von der Mehrzahl von Vektoren ein Nullvektor ist.
31. Ultraschalldiagnosegerät nach Anspruch 22, ferner angepasst zum Anzeigen des Bewegungsvektors, der von der Vektorerzeugungseinheit erzeugt wird, auf dem Diagnosebild.
32. Ultraschalldiagnosegerät nach Anspruch 22, ferner angepasst zum Anzeigen eines Orts eines Endpunkts des Bewegungsvektors, der von der Vektorerzeugungseinheit erzeugt wird, auf dem Diagnosebild.
33. Ultraschalldiagnosegerät nach Anspruch 22, bei dem, wenn die Bilddatenerzeugungseinheit dreidimensionale Bilddaten erzeugt, die Vektorerzeugungseinheit ferner konfiguriert ist zum Verwenden eines ersten bis dritten zweidimensionalen interessierenden Bereichs, die in dem interessierenden Bereich vorhanden und senkrecht zueinander sind, um einen ersten bis dritten zweidimensionalen Vektor jeweils zu erzeugen, und zum Erzeugen des Bewegungsvektors basierend auf dem ersten bis dritten Vektor.
34. Ultraschalldiagnosegerät nach Anspruch 22, bei dem, wenn die Bilddatenerzeugungseinheit dreidimensionale Bilddaten erzeugt, die Vektorerzeugungseinheit ferner konfiguriert ist zum Verwenden eines ersten bis dritten zweidimensionalen interessierenden Bereichs, die in dem interessierenden Bereich vorhanden sind und senkrecht zueinander sind, um jeweils einen ersten bis dritten zweidimensionalen Vektor zu erzeugen, und die Bildkorrekturereinheit ferner konfiguriert ist zum Korrigieren der Zielbilddaten basierend auf dem ersten bis dritten Vektor, die von der Vektorerzeugungseinheit erzeugt werden.
35. Ultraschalldiagnosegerät nach Anspruch 22, bei dem, wenn die Summe der Helligkeiten in dem interessierenden Bereich größer ist als ein vorbestimmter Wert, die Bildkorrekturereinheit ferner konfiguriert ist zum Stoppen der Korrektur der Zielbilddaten.
36. Ultraschalldiagnosegerät nach Anspruch 22, bei dem die Bildkorrekturereinheit ferner konfiguriert ist zum Korrigieren

der Zielbilddaten basierend auf dem Bewegungsvektor, der von der Vektorerzeugungseinheit erzeugt wird, zum Aufrechterhalten eines angezeigten Bereichs des Objekts, das zu untersuchen ist, auf dem Diagnosebild.

37. Ultraschalldiagnosegerät nach Anspruch 22, ferner mit:
einer Bereichstorkorrektureinheit, die konfiguriert ist zum Korrigieren der Stelle eines Bereichstors in einer gepulsten Dopplerwelle basierend auf dem Bewegungsvektor, der von der Vektorerzeugungseinheit erzeugt wird.

38. Ultraschalldiagnosegerät nach Anspruch 22, ferner mit:
einer Speichereinheit (30), die konfiguriert ist zum Speichern der Bilddaten, die von der Bilddatenerzeugungseinheit erzeugt werden, und des Bewegungsvektors, der von der Vektorerzeugungseinheit erzeugt wird, derart dass sie einander zugeordnet sind.

39. Ultraschalldiagnosegerät nach Anspruch 22, ferner mit:
einer Speichereinheit (30), die konfiguriert ist zum Speichern der Bilddaten, die von der Bildkorrekturereinheit korrigiert worden sind.

40. Ultraschalldiagnosegerät nach Anspruch 22, bei dem die Bilddatenerzeugungseinheit ferner konfiguriert ist zum Erzeugen der Bilddaten, die Blutstrombilddaten aufweisen, die Blutstrominformation des zu untersuchenden Objekts angeben, als Helligkeit, und Gewebebilddaten, die Gewebeanformation des zu untersuchenden Objekts angeben, als Helligkeit, basierend auf jedem Echosignal, das von der Sende/Empfangs-Einheit (21) empfangen wird, wenn Referenzblutstrombilddaten von einer Mehrzahl von Blutstrombilddaten, die von der Bilddatenerzeugungseinheit erzeugt werden, bestimmt werden, die Bildüberlagerungseinheit ferner konfiguriert ist zum sequentiellen Überlagern, auf den Referenzblutstrombilddaten, der Blutstrombilddaten, die nachfolgend zu den Referenzblutstrombilddaten sind, um überlagerte Blutstrombilddaten zu erzeugen, und zum sequentiellen Überlagern, auf den Gewebebilddaten, die den Referenzblutstrombilddaten entsprechen, der Gewebebilddaten, die dazu nachfolgend sind, um überlagerte Gewebebilddaten zu erzeugen, die Vektorerzeugungseinheit ferner konfiguriert ist zum Erzeugen eines Bewegungsvektors, der die Bewegung der Gewebebilddaten angibt, die den Zielblutstrombilddaten von der Mehrzahl von Blutstrombilddaten entsprechen, die nachfolgend zu den Referenzblutstrombilddaten sind, basierend auf der Helligkeit eines interessierenden Bereichs der Gewebebilddaten, die den Zielblutstrombilddaten entsprechen, und der Helligkeit eines interessierenden Bereichs der überlagerten Gewebebilddaten, die von der Mehrzahl von Gewebebilddaten erzeugt werden, die den Gewebebilddaten vorangehen, und bevor die Bildüberlagerungseinheit die Zielblutstrombilddaten überlagert, die Bildkorrekturereinheit ferner konfiguriert ist zum Korrigieren der Zielblutstrombilddaten basierend auf dem Bewegungsvektor, der von der Vektorerzeugungseinheit erzeugt wird.

41. Verfahren zum Erzeugen eines Ultraschalldiagnosebilds durch Scannen einer Struktur eines Blutgefäßes eines Objekts innerhalb einer zu untersuchenden Person, in das Kontrastmediumblasen injiziert worden sind, mit Ultraschallwellen, wobei das Verfahren aufweist:

wiederholtes Senden der Ultraschallwellen zu dem Objekt und Erzeugen einer Mehrzahl von Zeitserienbilddaten, die eine Form des Objekts angeben, basierend auf Echosignalen, die von dem Objekt zurückkommen;
Einstellen eines interessierenden Bereichs (ROI), der kleiner ist als der gesamte Bildbereich, wobei das Einstellen des interessierenden Bereichs (ROI) aufweist

während eines Scannens mit geringem Schalldruck, bei dem die Ultraschallwellen auf einen ausreichend geringen Schalldruck eingestellt sind, um die Kontrastmediumblasen nicht zu zerstören, nach Einschalten eines Bewegungsdetektionsmodus, Bestimmen von Bildern, die erzeugt werden, unmittelbar nach dem Einschalten des Bewegungsdetektionsmodus als Standardbilddaten,

zum Erzeugen von Referenzbilddaten, die zu verwenden sind als Suchziel des interessierenden Bereichs (ROI), Durchführen eines Durchschnittswertprozesses oder eines Schwellenwertprozesses für die Standardbilddaten derart, dass nur das Bild der Kontrastmediumblasen des Gewebes des lebenden Körpers auf die Referenzbilddaten reflektiert werden,

Erzeugen eines Suchbereichs gleicher Größe und Form als interessierender Bereich (ROI) auf den Referenzbilddaten, und Bewegen des Suchbereichs über die gesamten Referenzbilddaten, und

von denjenigen Bildbereichen, in denen die Anzahl der Pixel, die eine Helligkeit aufweisen, die höher als ein Schwellenwert K ist, größer ist als ein Schwellenwert M, Einstellen des Bildbereichs mit der größten Anzahl von Pixeln mit der Helligkeit größer als der Schwellenwert K als interessierender Bereich (ROI);

Vergleichen mindestens eines Bilds, das von den Referenzbilddaten verschieden ist, basierend auf Daten in

dem interessierenden Bereich (ROI), um einen Bewegungsvektor zu erzeugen, der die Bewegung angibt zwischen den Referenzbilddaten und dem mindestens einen Bild, wobei ein entsprechender Bereich, der dem interessierenden Bereich (ROI) entspricht, festgelegt wird auf das mindestens eine Bild, das nachfolgend zu den Standardbilddaten erzeugt wird, basierend auf dem interessierenden Bereich (ROI) auf den Referenzbilddaten, wobei der entsprechende Bereich die gleiche Form und Größe wie der interessierende Bereich (ROI) aufweist, und ein Helligkeitsverteilungsmuster aufweist, das dem des interessierenden Bereichs (ROI) am nächsten ist, und der Bewegungsvektor erzeugt wird aus der Korrelation zwischen der Helligkeit der Pixel, die in dem interessierenden Bereich (ROI) der Standardbilddaten vorhanden sind, und der Helligkeit der Pixel, die in dem entsprechenden Bereich vorhanden sind;

Korrigieren einer Unschärfe zwischen den Referenzbilddaten und dem mindestens einen Bild basierend auf dem Bewegungsvektor, wodurch eine Mehrzahl von korrigierten Bilddaten erzeugt werden; und Erzeugen eines Anzegebilds basierend auf der Mehrzahl von korrigierten Bilddaten durch aufeinanderfolgendes Durchführen einer Helligkeitswerthalteoperation unter Verwendung der Mehrzahl von korrigierten Bilddaten, um das Anzegebild zu erzeugen.

Revendications

1. Appareil de diagnostic par ultrasons pour balayer une structure d'un vaisseau sanguin en tant qu'objet chez une personne à examiner, dans lequel des bulles de produit de contraste ont été injectées, avec des ondes ultrasonores pour acquérir une image ultrasonore de l'objet, l'appareil comprenant :

une unité de transmission/réception (21) configurée pour transmettre de façon répétée les ondes ultrasonores à l'objet et acquérir des signaux d'écho revenant de l'objet ;
 une unité de génération de données d'images configurée pour générer une pluralité d'images de séries temporelles indiquant une forme de l'objet sur la base des signaux d'écho ;
 une unité de réglage (25) configurée pour régler une zone d'intérêt (ROI), qui est plus petite que l'ensemble de la zone d'image, où réglage de la zone d'intérêt (ROI) comprend

- lors d'un balayage à basse pression acoustique, où les ondes ultrasonores sont réglées sur une pression acoustique suffisamment basse pour ne pas briser les bulles de produit de contraste, après activation d'un mode de détection de mouvement, une désignation des images générées immédiatement après l'activation du mode de détection de mouvement par des données d'images standard,
- une génération des données d'images de référence à utiliser comme cible de recherche de la zone d'intérêt (ROI), en effectuant un traitement de valeur moyenne ou un traitement de valeur seuil sur les données d'images standard de sorte que seule l'image des bulles de produit de contraste ou du tissu du corps vivant est réfléchiée vers les données d'images de référence,
- une génération d'une zone de recherche ayant la même taille et la même forme que la zone d'intérêt (ROI) sur les données d'images de référence et un déplacement de la zone de recherche sur l'ensemble des données d'images de référence, et
- de ces zones d'images, dans lesquelles le nombre de pixels ayant une luminosité supérieure à la valeur seuil K est supérieure à une valeur seuil M, un réglage de la zone d'image ayant le plus grand nombre de pixels ayant une luminosité supérieure à la valeur seuil K comme étant la zone d'intérêt (ROI) ;

une unité de génération de vecteur configurée pour comparer au moins une image différente des données d'images de référence sur la base de données dans la zone d'intérêt (ROI) pour générer un vecteur de mouvement indiquant le mouvement entre les données d'images de référence et ladite au moins une image, où une zone correspondante correspondant à la zone d'intérêt (ROI) est réglée sur ladite au moins une image générée après les données d'images standard sur la base de la zone d'intérêt (ROI) sur les données d'images de référence, la zone correspondante ayant la même forme et taille que la zone d'intérêt (ROI) et ayant un motif de distribution de luminosité le plus proche de celui de la zone d'intérêt (ROI), et le vecteur de mouvement est généré à partir de la corrélation entre la luminosité des pixels compris dans la zone d'intérêt (ROI) des données d'images standard et la luminosité des pixels compris dans la zone correspondante ;

une unité de correction d'images configurée pour corriger un flou entre les données d'images de référence et ladite au moins une image sur la base du vecteur de mouvement, générant ainsi une pluralité de données d'images corrigées ; et

une unité de génération d'image (24) configurée pour générer une image d'affichage sur la base d'une pluralité de données d'images corrigées en effectuant séquentiellement une opération de maintien de valeur de luminosité en utilisant la pluralité de données d'images corrigées pour générer l'image d'affichage.

- 5 **2.** Appareil de diagnostic par ultrasons selon la revendication 1,
dans lequel l'unité de génération d'images est en outre configurée pour effectuer un procédé de combinaison en utilisant la pluralité de données d'images corrigées pour générer l'image d'affichage.
- 10 **3.** Appareil de diagnostic par ultrasons selon la revendication 1,
dans lequel, lorsque chaque donnée d'images comprend une zone teinte par un produit de contraste, l'unité de réglage est en outre configurée pour régler la zone d'intérêt de manière à comprendre au moins une partie de la zone teinte.
- 15 **4.** Appareil de diagnostic par ultrasons selon la revendication 1, comprenant en outre :

une unité de détection configurée pour détecter le moment où un produit de contraste s'écoule dans les objets, dans lequel l'unité de réglage est en outre configurée pour régler la zone d'intérêt sur la base de la pluralité de données d'images au moment où une petite quantité de produit de contraste s'écoule.
- 20 **5.** Appareil de diagnostic par ultrasons selon la revendication 1,
dans lequel l'unité de réglage est en outre configurée pour régler la zone d'intérêt de manière à comprendre une position ayant une valeur de luminosité supérieure à une valeur de seuil prédéterminée sur la base de la valeur de luminosité à chaque position de l'image.
- 25 **6.** Appareil de diagnostic par ultrasons selon la revendication 5,
dans lequel l'unité de réglage est en outre configurée pour créer un histogramme lié aux valeurs de luminosité de l'image, et pour déterminer la valeur seuil prédéterminée sur la base de l'histogramme.
- 30 **7.** Appareil de diagnostic par ultrasons selon la revendication 1,
dans lequel l'unité de réglage est en outre configurée pour régler la zone d'intérêt de manière à inclure une position ayant une valeur de luminosité comprise entre une première valeur seuil prédéterminée et une deuxième valeur seuil prédéterminée sur la base de la luminosité à chaque position de l'image.
- 35 **8.** Appareil de diagnostic par ultrasons selon la revendication 7,
dans lequel l'unité de réglage est en outre configurée pour faire un histogramme relatif aux valeurs de luminosité de l'image, et détermine au moins une valeur parmi la première et la deuxième valeurs de seuil sur la base de l'histogramme.
- 40 **9.** Appareil de diagnostic par ultrasons selon la revendication 1,
dans lequel l'unité de réglage est en outre configurée pour déterminer au moins un éléments parmi la position, la taille et la forme de la zone d'intérêt et le nombre de zones d'intérêt sur la base de la luminosité à chaque position de l'image.
- 45 **10.** Appareil de diagnostic par ultrasons selon la revendication 1,
dans lequel l'unité de réglage est en outre configurée pour régler la zone d'intérêt sur la pluralité d'images soumises à un procédé de réduction de bruit.
- 50 **11.** Appareil de diagnostic par ultrasons selon la revendication 1,
dans lequel, chaque fois que l'unité de génération de données d'images génère les données d'images, l'unité de réglage est en outre configurée pour mettre à jour la zone d'intérêt sur la base d'une zone d'intérêt utilisée pour corriger le flou des données d'images précédentes et un vecteur résultant d'une pluralité de vecteurs de mouvement qui ont été générés par l'unité de génération de vecteur.
- 55 **12.** Appareil de diagnostic par ultrasons selon la revendication 1,
dans lequel, chaque fois que l'unité de génération de données d'images génère les données d'images, l'unité de réglage est en outre configurée pour rechercher la zone d'intérêt sur la base de la luminosité des données d'images précédentes et pour mettre à jour la zone d'intérêt.

13. Appareil de diagnostic par ultrasons selon la revendication 1,
dans lequel l'unité de réglage est en outre configurée pour régler une zone d'intérêt commune utilisée pour corriger
le flou d'une pluralité de données d'images générées par l'unité de génération de données d'images, sur la base
de la luminosité de la pluralité de données d'images.

14. Appareil de diagnostic par ultrasons selon la revendication 1,
dans lequel l'unité de transmission/réception (21) est en outre configurée pour effectuer une première transmission
ultrasonore à une première pression sonore qui brise les bulles de produit de contraste et une deuxième transmission
ultrasonore à une deuxième pression sonore pour l'imagerie du reflux d'une circulation sanguine à laquelle les bulles
de produit de contraste ne sont pas brisées, et
une image générée immédiatement après la commutation de la première transmission ultrasonore sur la deuxième
transmission ultrasonore est désignée comme une image de référence.

15. Appareil de diagnostic par ultrasons selon la revendication 1,
dans lequel l'unité de transmission/réception (21) est en outre configurée pour effectuer une première transmission
ultrasonore à une première pression sonore qui brise les bulles de produit de contraste et à une deuxième trans-
mission ultrasonore à une deuxième pression sonore pour l'imagerie du reflux d'une circulation sanguine à laquelle
les bulles de produit de contraste ne sont pas brisées, et
la zone d'intérêt est de nouveau recherchée immédiatement après que la première transmission ultrasonore est
commutée sur la deuxième transmission ultrasonore, et la zone d'intérêt est mise à jour.

16. Appareil de diagnostic par ultrasons selon la revendication 1, comprenant en outre :
une unité de désignation configurée pour désigner un moment où l'unité de correction d'images démarre la correction
du flou des données d'images.

17. Appareil de diagnostic par ultrasons selon la revendication 1, comprenant en outre :
une unité de désignation configurée pour désigner un moment où l'unité de correction d'images corrige le flou des
données d'images ou le nombre de trames.

18. Appareil de diagnostic par ultrasons selon la revendication 1,
dans lequel l'unité d'affichage est en outre configurée pour afficher la zone d'intérêt sur l'image ultrasonore.

19. Appareil de diagnostic par ultrasons selon la revendication 1, comprenant en outre :
une unité de commutation configurée pour effectuer la commutation entre l'affichage et le non-affichage de la zone
d'intérêt.

20. Appareil de diagnostic par ultrasons selon la revendication 1, comprenant en outre :
une unité de désignation configurée pour désigner au moins une caractéristique parmi la position, la taille et la forme
de la zone d'intérêt et le nombre de zones d'intérêt.

21. Appareil de diagnostic par ultrasons selon la revendication 1, comprenant en outre :

une unité d'affichage,
dans lequel l'unité de génération d'images est en outre configurée pour générer une première image d'affichage
sur la base de la pluralité d'images après la correction du flou et pour générer une deuxième image d'affichage
sur la base de la pluralité d'images avant la correction du flou, et
l'unité d'affichage est en outre configurée pour afficher simultanément ou sélectivement la première image
d'affichage et la deuxième image d'affichage.

22. Appareil de diagnostic par ultrasons selon la revendication 1, comprenant en outre :

une unité de superposition d'images configurée pour, lorsque les données d'images de référence sont désignées
à partir de la pluralité de données d'images générées par l'unité de génération de données d'images, superposer
séquentiellement les données d'images suivantes sur les données d'images de référence pour générer des
données d'images superposées,
dans lequel l'unité de génération de vecteur est en outre configurée pour générer un vecteur de mouvement
indiquant le mouvement de données d'images cible parmi les données d'images suite aux données d'images
de référence qui sont générées par l'unité de génération de données d'images, sur la base de la luminosité

d'une zone d'intérêt des données d'images cibles et la luminosité d'une zone d'intérêt des données d'images superposées générées de la pluralité des données d'images précédant les données d'images cibles, et l'unité de correction d'images est configurée en outre pour corriger les données d'images cibles sur la base du vecteur de mouvement généré par l'unité de génération de vecteur avant que l'unité de superposition d'images ne superpose les données d'images cibles.

23. Appareil de diagnostic par ultrasons selon la revendication 22, dans lequel l'unité de génération de vecteur est en outre configurée pour générer le vecteur de mouvement sur la base d'un incrément de la luminosité de la zone d'intérêt générée lorsque les données d'images cibles sont superposées.
24. Appareil de diagnostic par ultrasons selon la revendication 22, dans lequel l'unité de réglage est en outre configurée pour régler automatiquement la zone d'intérêt sur la base de la luminosité des données d'images générées par l'unité de génération de données d'images.
25. Appareil de diagnostic par ultrasons selon la revendication 22, dans lequel l'unité de réglage est en outre configurée pour régler automatiquement la zone d'intérêt sur la base d'un point focal d'une onde ultrasonore transmise par l'unité de transmission/réception (21).
26. Appareil de diagnostic par ultrasons selon la revendication 22, dans lequel l'unité de réglage est en outre configurée pour régler la zone d'intérêt selon les instructions d'un opérateur.
27. Appareil de diagnostic par ultrasons selon la revendication 22, dans lequel l'unité de correction d'images est en outre configurée pour corriger la zone d'image cible lorsque l'unité de réglage règle la zone d'intérêt.
28. Appareil de diagnostic par ultrasons selon la revendication 22, dans lequel l'unité de génération de vecteur est en outre configurée pour déplacer les données d'images cibles en fonction d'une pluralité de vecteurs acquis préalablement, pour calculer l'incrément de la luminosité de la zone d'intérêt générée lorsque les données d'images cibles sont superposées pour chaque vecteur, et pour sélectionner le vecteur de mouvement parmi la pluralité de vecteurs sur la base de l'incrément de la luminosité de la zone d'intérêt.
29. Appareil de diagnostic par ultrasons selon la revendication 28, dans lequel l'unité de génération de vecteur est en outre configurée pour générer la pluralité de vecteurs sur la base de la luminosité d'une zone d'intérêt plus petite que la zone d'intérêt dans les données d'images cibles et de la luminosité d'une zone d'intérêt plus petite que la zone d'intérêt dans les données d'images superposées générées à partir de la pluralité des données d'images précédant les données d'images cibles.
30. Appareil de diagnostic par ultrasons selon la revendication 28, dans lequel un vecteur parmi la pluralité de vecteurs est un vecteur zéro.
31. Appareil de diagnostic par ultrasons selon la revendication 22, en outre adapté pour afficher le vecteur de mouvement généré par l'unité de génération de vecteur sur l'image diagnostique.
32. Appareil de diagnostic par ultrasons selon la revendication 22, adapté en outre pour afficher un locus d'un point d'extrémité du vecteur de mouvement généré par l'unité de génération de vecteur sur l'image de diagnostic.
33. Appareil de diagnostic par ultrasons selon la revendication 22, dans lequel, lorsque l'unité de génération de données d'images génère des données d'images tridimensionnelles, l'unité de génération de vecteur est en outre configurée pour utiliser des première à troisième zones d'intérêt bidimensionnelles qui sont incluses dans la zone d'intérêt et sont orthogonales les unes par rapport aux autres pour générer respectivement des premier à troisième vecteurs bidimensionnels, et pour générer le vecteur de mouvement sur la base des premier à troisième vecteurs.
34. Appareil de diagnostic par ultrasons selon la revendication 22, dans lequel, lorsque l'unité de génération de données d'images génère des données d'images tridimensionnelles,

l'unité de génération de vecteur est en outre configurée pour utiliser des première à troisième zones d'intérêt bidimensionnelles qui sont incluses dans la zone d'intérêt et sont orthogonales les unes par rapport aux autres pour générer respectivement des premier et troisième vecteurs bidimensionnels, et l'unité de correction d'image est en outre configurée pour corriger les données d'images cibles sur la base des premier à troisième vecteurs générés par l'unité de génération de vecteur.

35. Appareil de diagnostic par ultrasons selon la revendication 22, dans lequel, lorsque la somme de la luminosité dans la zone d'intérêt est supérieure à une valeur prédéterminée, l'unité de correction d'images est en outre configurée pour arrêter la correction des données d'images cibles.

36. Appareil de diagnostic par ultrasons selon la revendication 22, dans lequel l'unité de correction d'image est en outre configurée pour corriger les données d'images cibles sur la base du vecteur de mouvement généré par l'unité de génération de vecteur, et pour maintenir une zone affichée de l'objet à examiner sur l'image de diagnostic.

37. Appareil de diagnostic par ultrasons selon la revendication 22, comprenant en outre : une unité de correction de porte de distance configurée pour corriger la position d'une porte de distance de Doppler à ondes pulsées sur la base du vecteur de mouvement généré par l'unité de génération de vecteur.

38. Appareil de diagnostic par ultrasons selon la revendication 22, comprenant en outre : une unité de stockage (30) configurée pour stocker les données d'images générées par l'unité de génération de données d'images et le vecteur de mouvement généré par l'unité de génération de vecteur de sorte qu'ils sont associés entre eux.

39. Appareil de diagnostic par ultrasons selon la revendication 22, comprenant en outre : une unité de stockage (30) configurée pour stocker les données d'images corrigées par l'unité de correction d'image.

40. Appareil de diagnostic par ultrasons selon la revendication 22, dans lequel l'unité de génération de données d'images est en outre configurée pour générer les données d'images comprenant des données d'images de circulation sanguine indiquant des informations de circulation sanguine de l'objet à examiner en tant que luminosité et des données d'images de tissu indiquant des informations de tissu de l'objet à examiner en tant que luminosité, sur la base de chaque signal d'écho reçu par l'unité de transmission/réception (21),

lorsque les données d'images de circulation sanguine de référence sont désignées parmi une pluralité de données d'images de circulation sanguine générées par l'unité de génération des données d'images, l'unité de superposition d'images est en outre configurée pour superposer, en séquence sur les données d'images de circulation sanguine de référence, les données d'images de circulation sanguine après les données d'images de circulation sanguine de référence pour générer une des données d'images de circulation sanguine superposées, et pour superposer séquentiellement, sur les données d'images de tissu correspondant aux données d'images de circulation sanguine de référence, les données d'images de tissu après celles-ci pour générer des données d'images de tissu superposées,

l'unité de génération de vecteur est en outre configurée pour générer un vecteur de mouvement indiquant le mouvement des données d'images de tissu correspondant aux données d'images de circulation sanguine cibles parmi une pluralité de données d'images de circulation sanguine après les données d'images de référence, sur la base de la luminosité d'une zone d'intérêt des données d'images de tissu correspondant aux données d'images de circulation sanguine cibles et la luminosité d'une zone d'intérêt des données d'images de tissu superposées générées à partir de la pluralité de données d'images de tissu précédant les données d'images de tissu, et

avant que l'unité de superposition d'images ne superpose les données d'images de circulation sanguine cibles, l'unité de correction d'images est en outre configurée pour corriger les données d'images de circulation sanguine cibles sur la base du vecteur de mouvement généré par l'unité de génération de vecteur.

41. Procédé de génération d'une image diagnostique ultrasonore par balayage d'une structure d'un vaisseau sanguin en tant qu'objet chez une personne à examiner, dans lequel des bulles de produit de contraste ont été injectées, avec des ondes ultrasonores, le procédé comprenant les étapes consistant à :

transmettre de façon répétée des ondes ultrasonores à l'objet et générer une pluralité de données d'images de série temporelle indiquant une forme de l'objet sur la base de signaux d'écho revenant de l'objet; régler une zone d'intérêt (ROI) qui est plus petite que l'ensemble de la zone d'image, dans lequel le réglage

de la zone d'intérêt (ROI) comprend

- lors d'un balayage à basse pression acoustique, où les ondes ultrasonores sont réglées sur une pression acoustique suffisamment basse pour ne pas briser les bulles de produit de contraste, après avoir activé un mode de détection de mouvement, désigner les images générées immédiatement après avoir activé le mode de détection de mouvement aux données d'images standard,
- générer des données d'images de référence à utiliser comme cible de recherche de la zone d'intérêt (ROI), en effectuant un traitement de valeur moyenne ou un traitement de valeur seuil sur les données d'images standard de sorte que seule l'image des bulles de produit de contraste ou du tissu du corps vivant est réfléchi vers les données d'images de référence,
- générer une zone de recherche ayant la même taille et la même forme que la zone d'intérêt (ROI) sur les données d'images de référence et en déplacer la zone de recherche sur l'ensemble des données d'images de référence, et
- de ces zones d'images, dans lesquelles le nombre de pixels ayant une luminosité supérieure à une valeur seuil K est supérieure à une valeur seuil M, régler la zone d'image ayant le plus grand nombre de pixels ayant une luminosité supérieure à la valeur seuil K comme la zone d'intérêt (ROI) ;

comparer au moins une image différente des données d'images de référence sur la base de données dans la zone d'intérêt (ROI) pour générer un vecteur de mouvement, qui indique le mouvement entre les données d'images de référence et ladite au moins une image, où

une zone correspondante correspondant à la zone d'intérêt (ROI) est réglée sur ladite au moins une image générée après les données d'images standard sur la base de la zone d'intérêt (ROI) sur les données d'images de référence, la zone correspondante ayant la même forme et la même taille que la zone d'intérêt (ROI) et ayant un motif de distribution de luminosité proche de celui de la zone d'intérêt (ROI), et

le vecteur de mouvement est généré à partir de la corrélation entre la luminosité des pixels compris dans la zone d'intérêt (ROI) des données d'images standard et la luminosité des pixels compris dans la zone correspondante ;

corriger un flou entre les données d'images de référence et ladite au moins une image sur la base du vecteur de mouvement, générant ainsi une pluralité de données d'images corrigées ; et

générer une image d'affichage sur la base de la pluralité de données d'images corrigées en effectuant séquentiellement une opération de maintien de valeur de luminosité en utilisant la pluralité de données d'images corrigées pour générer l'image d'affichage.

FIG. 1

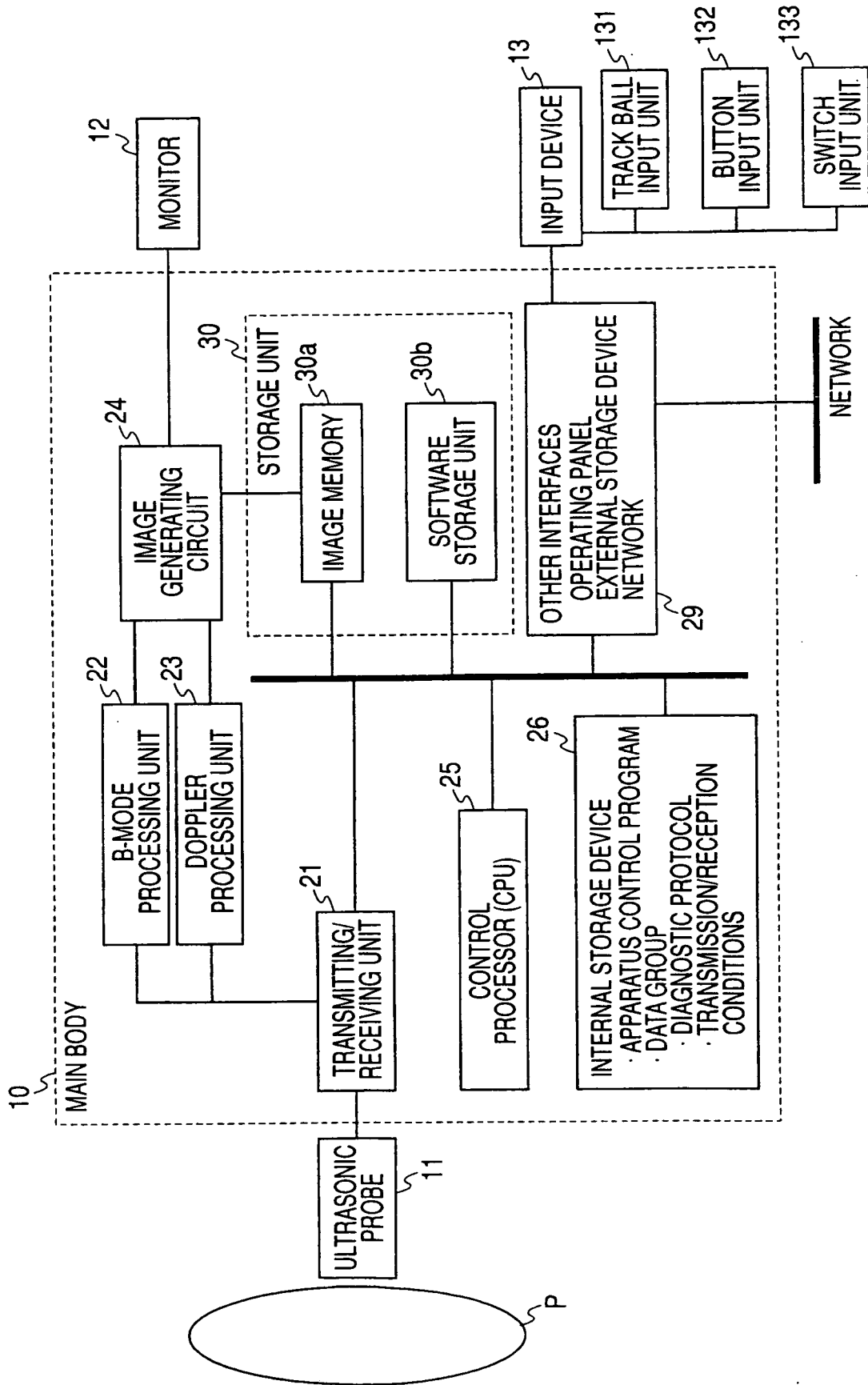


FIG. 2

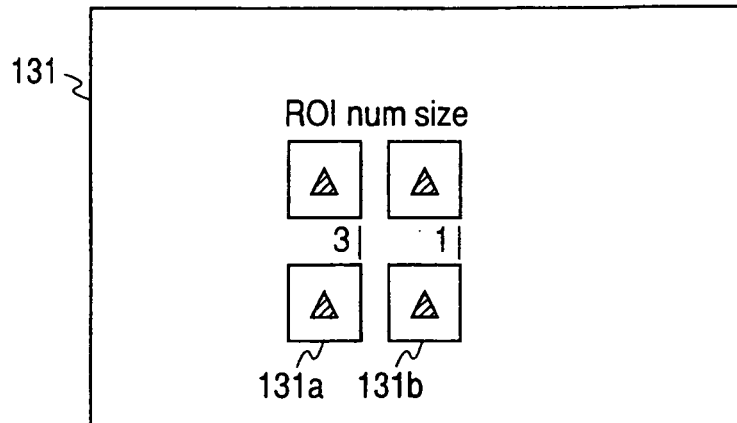


FIG. 3

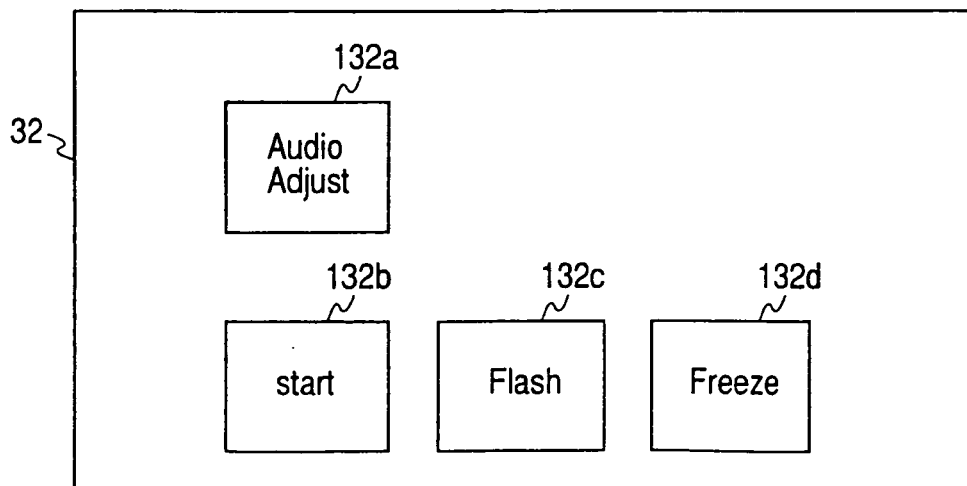


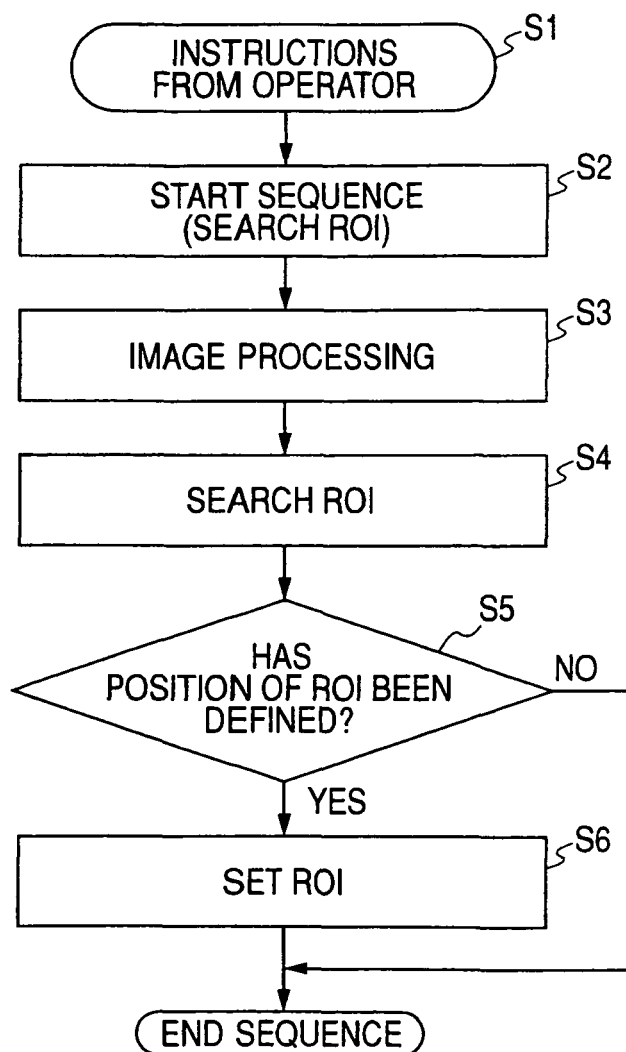
FIG. 4

FIG. 5

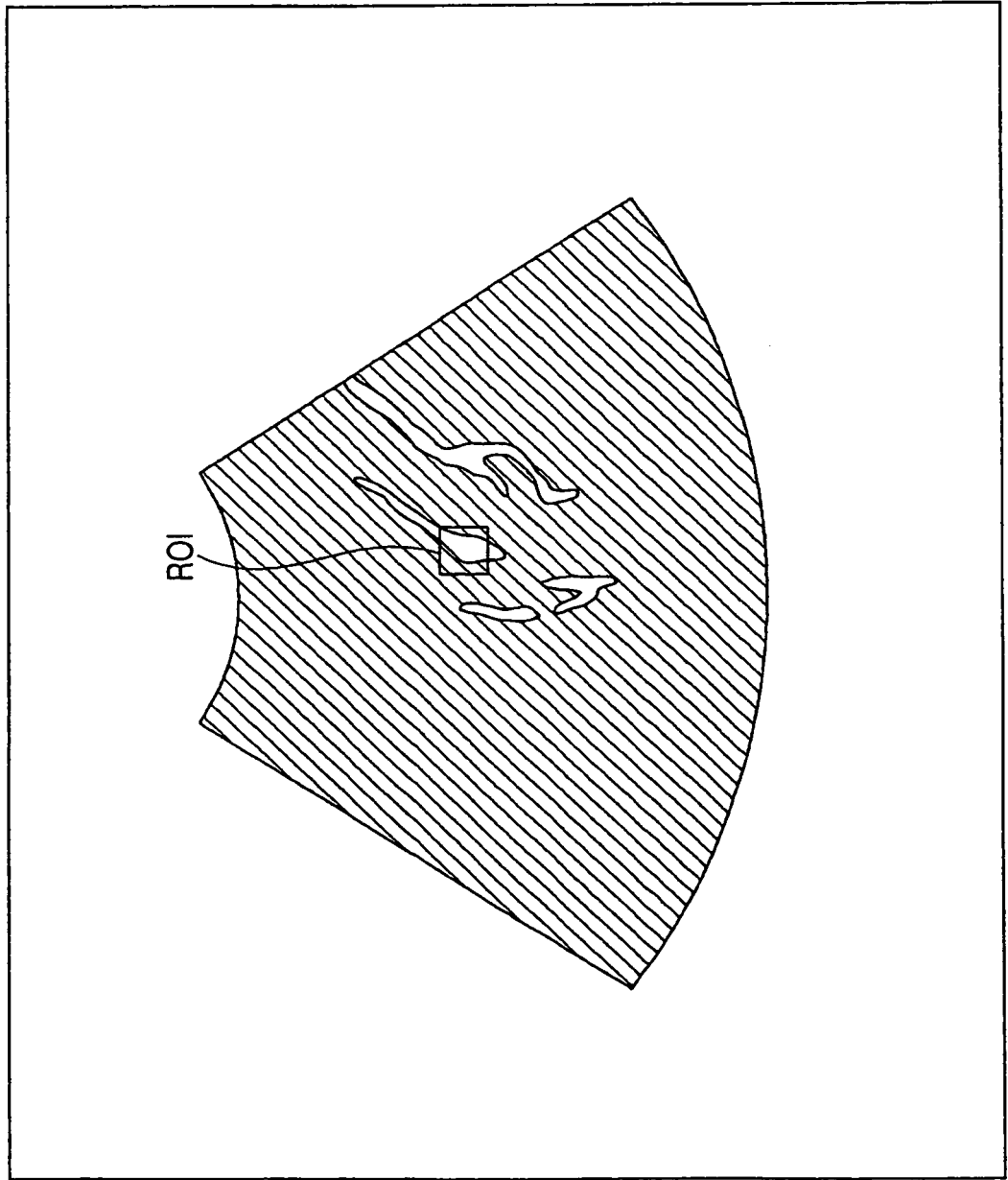


FIG. 6A

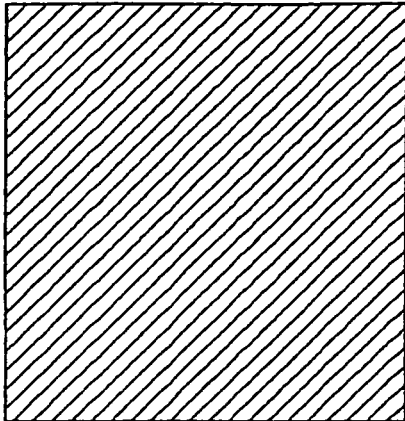


FIG. 6B

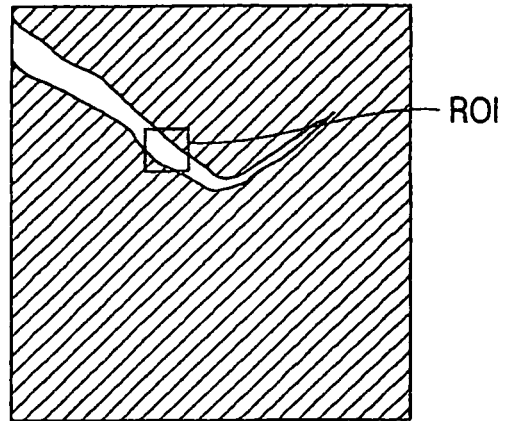


FIG. 6C

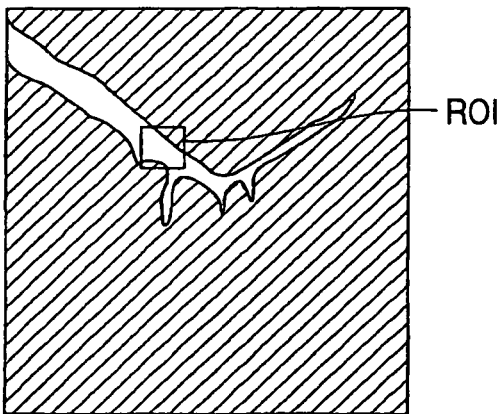


FIG. 6D

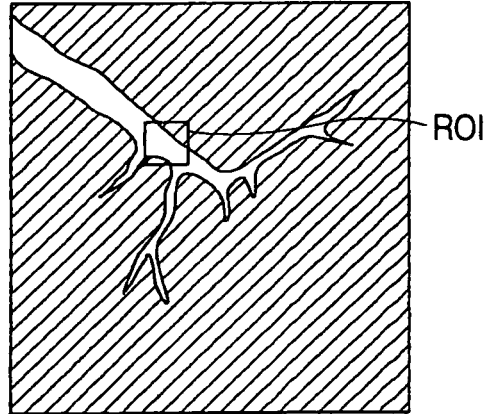


FIG. 6E

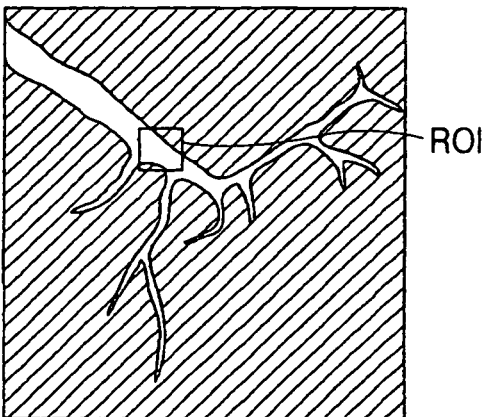


FIG. 7

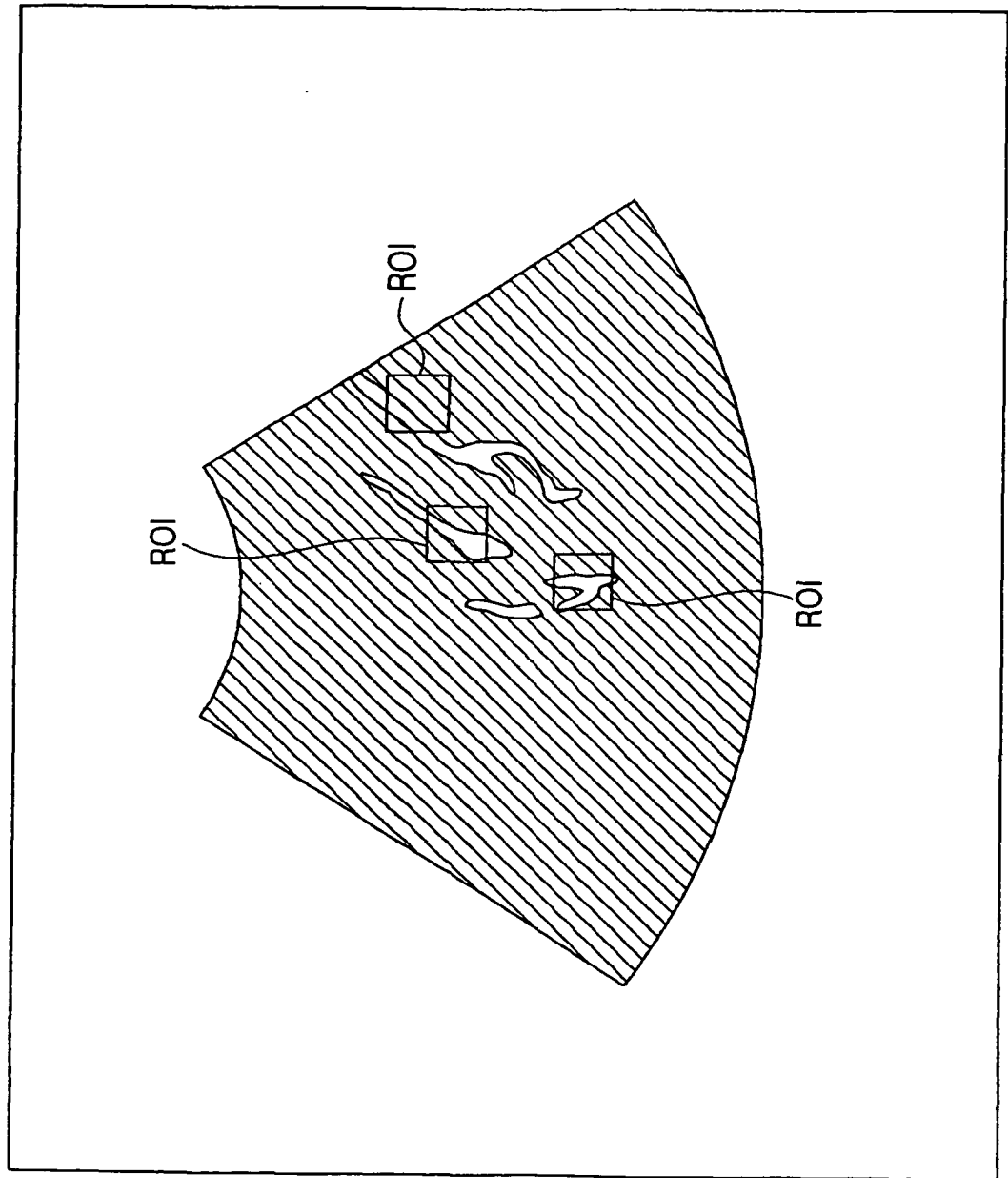


FIG. 8A

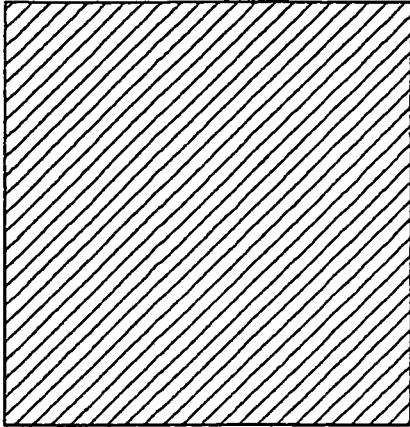


FIG. 8B

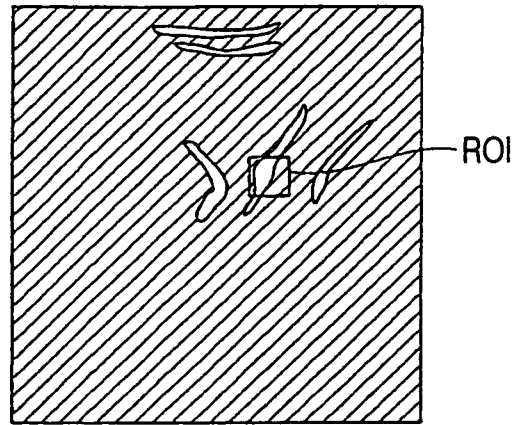


FIG. 8C

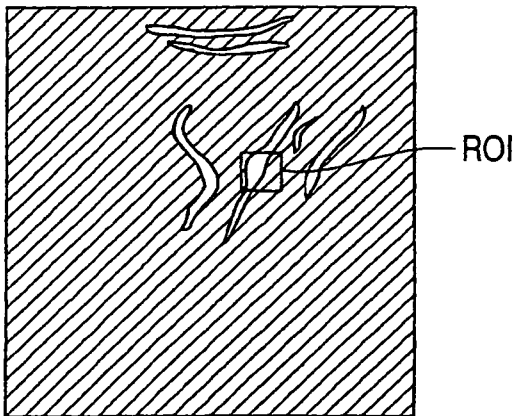


FIG. 8D

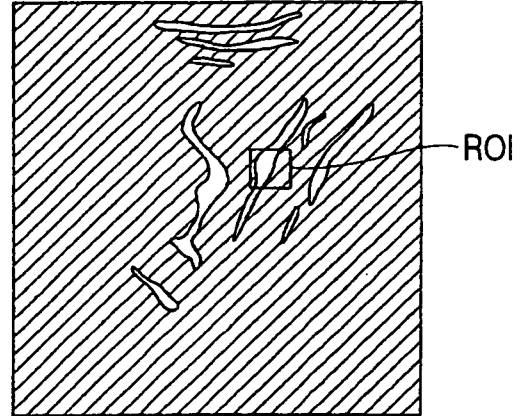


FIG. 8E

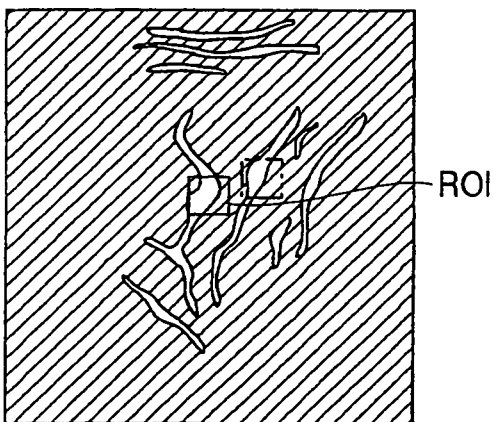


FIG. 9

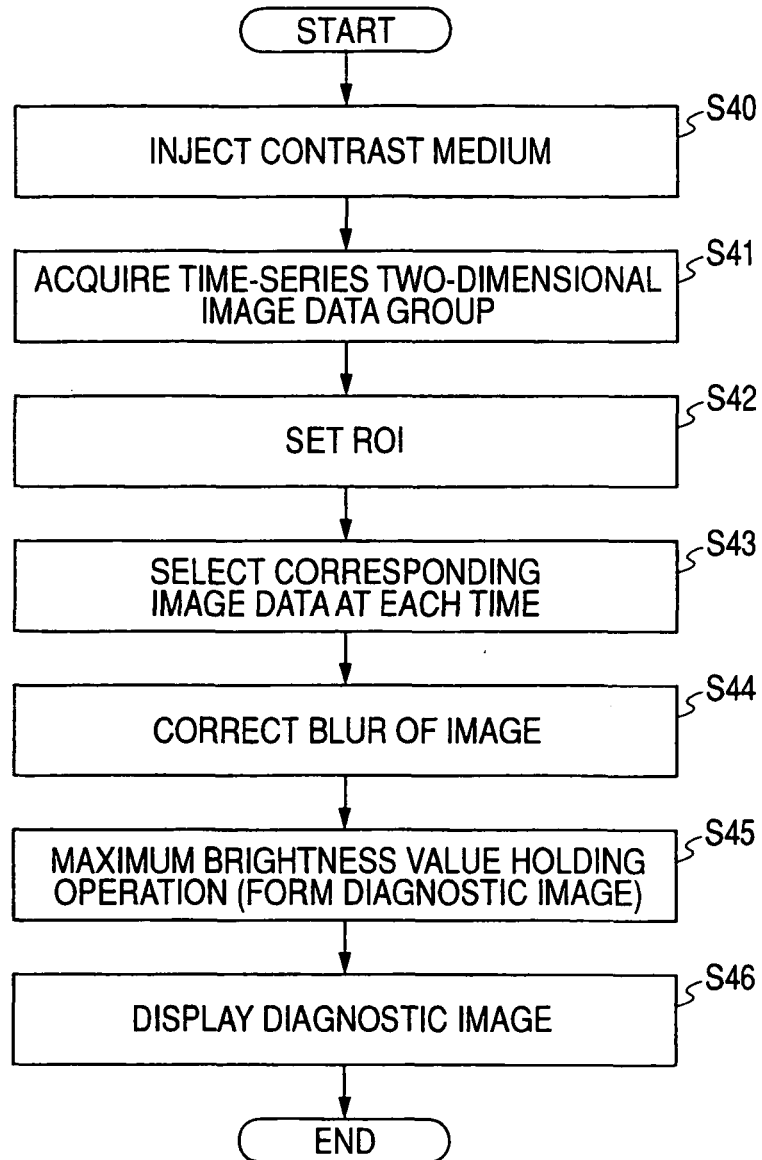


FIG. 10

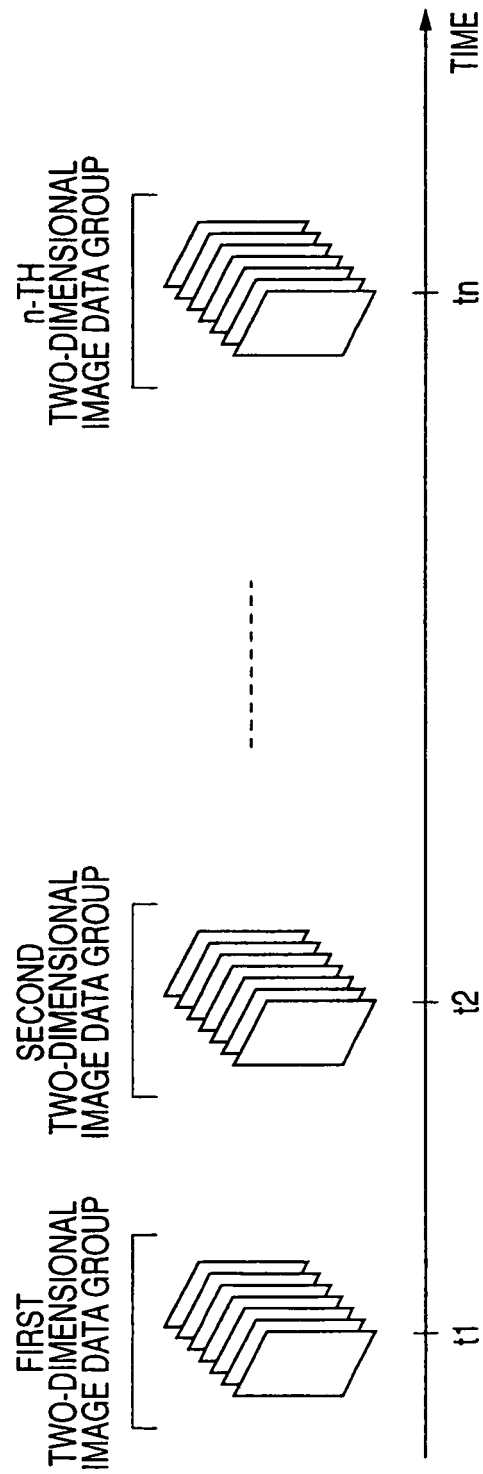


FIG. 11

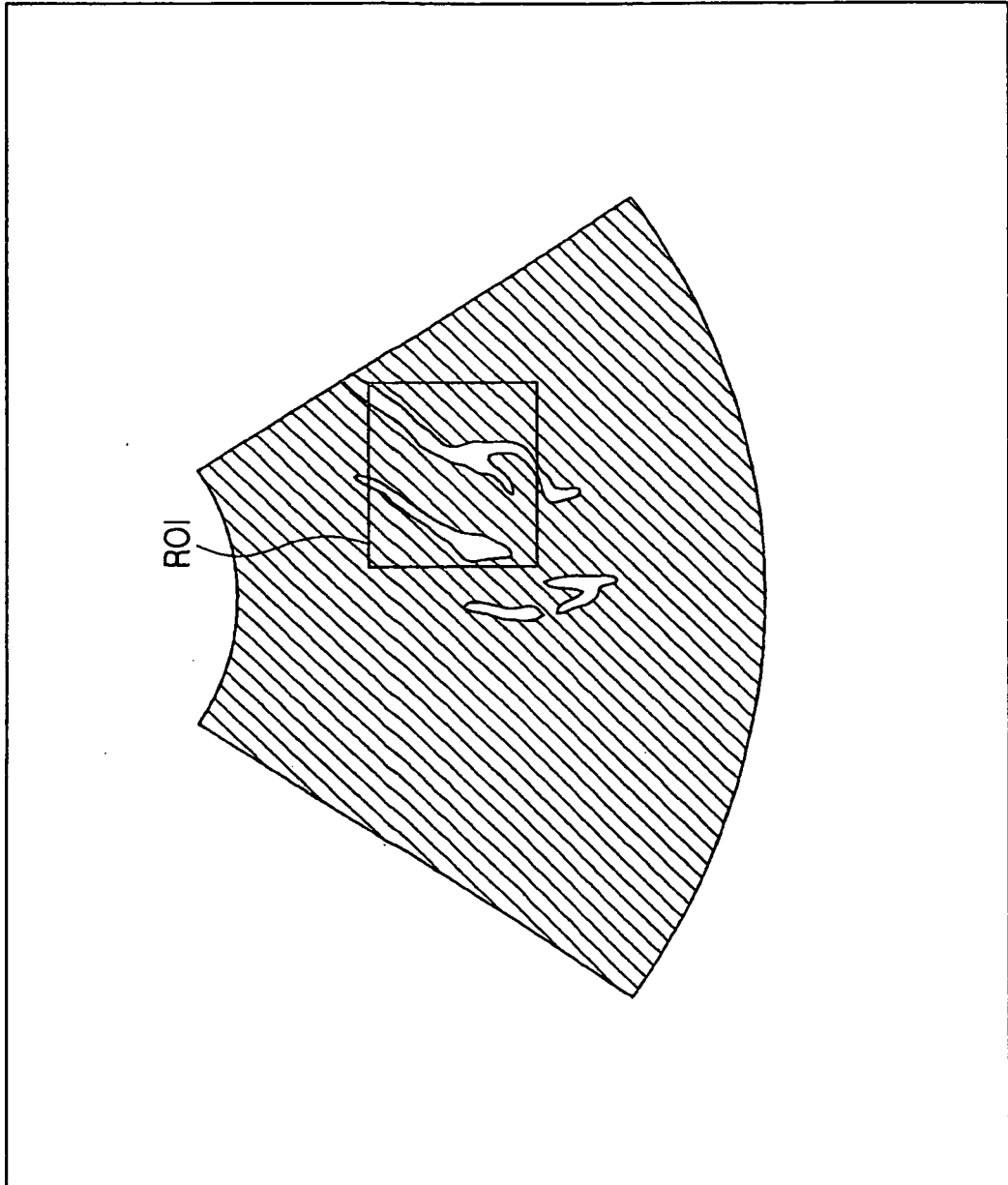


FIG. 12

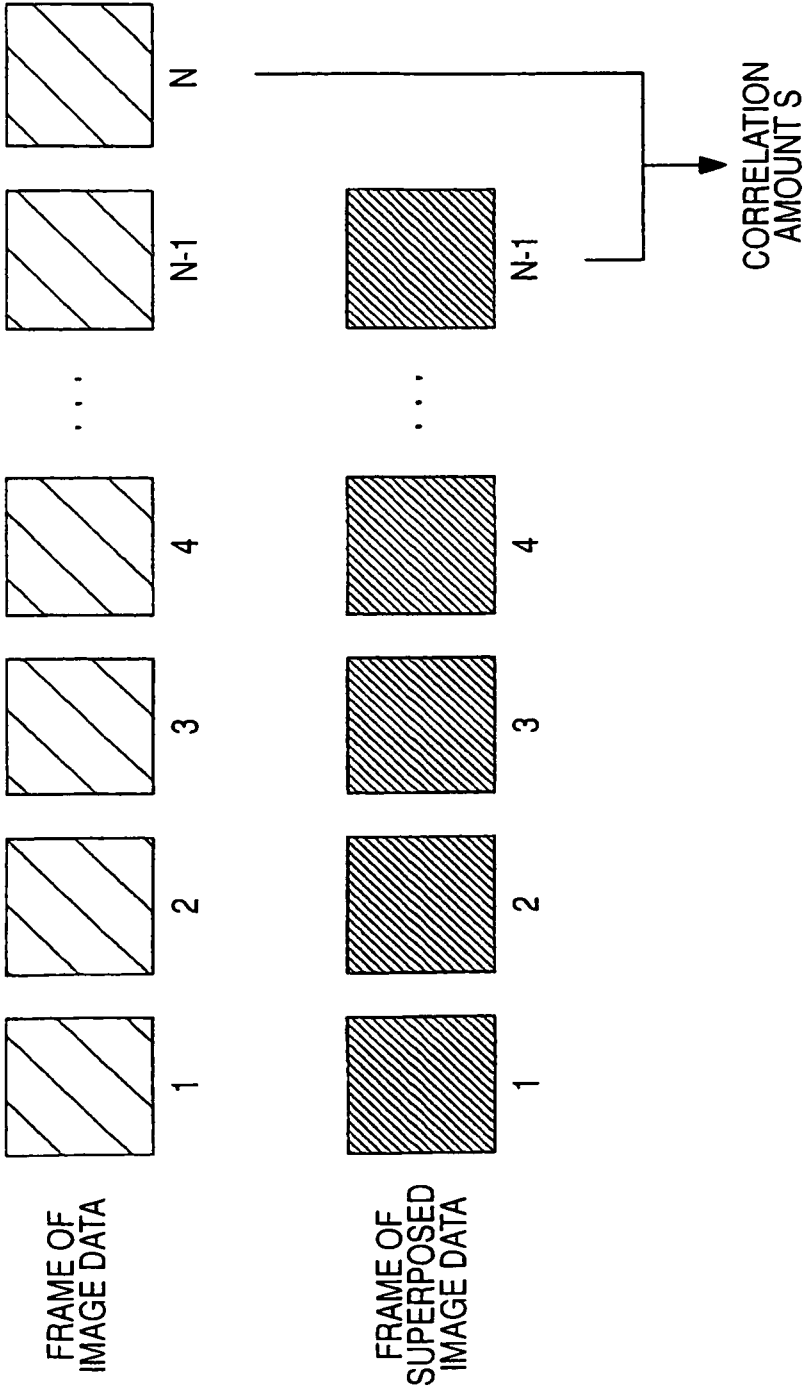


FIG. 13

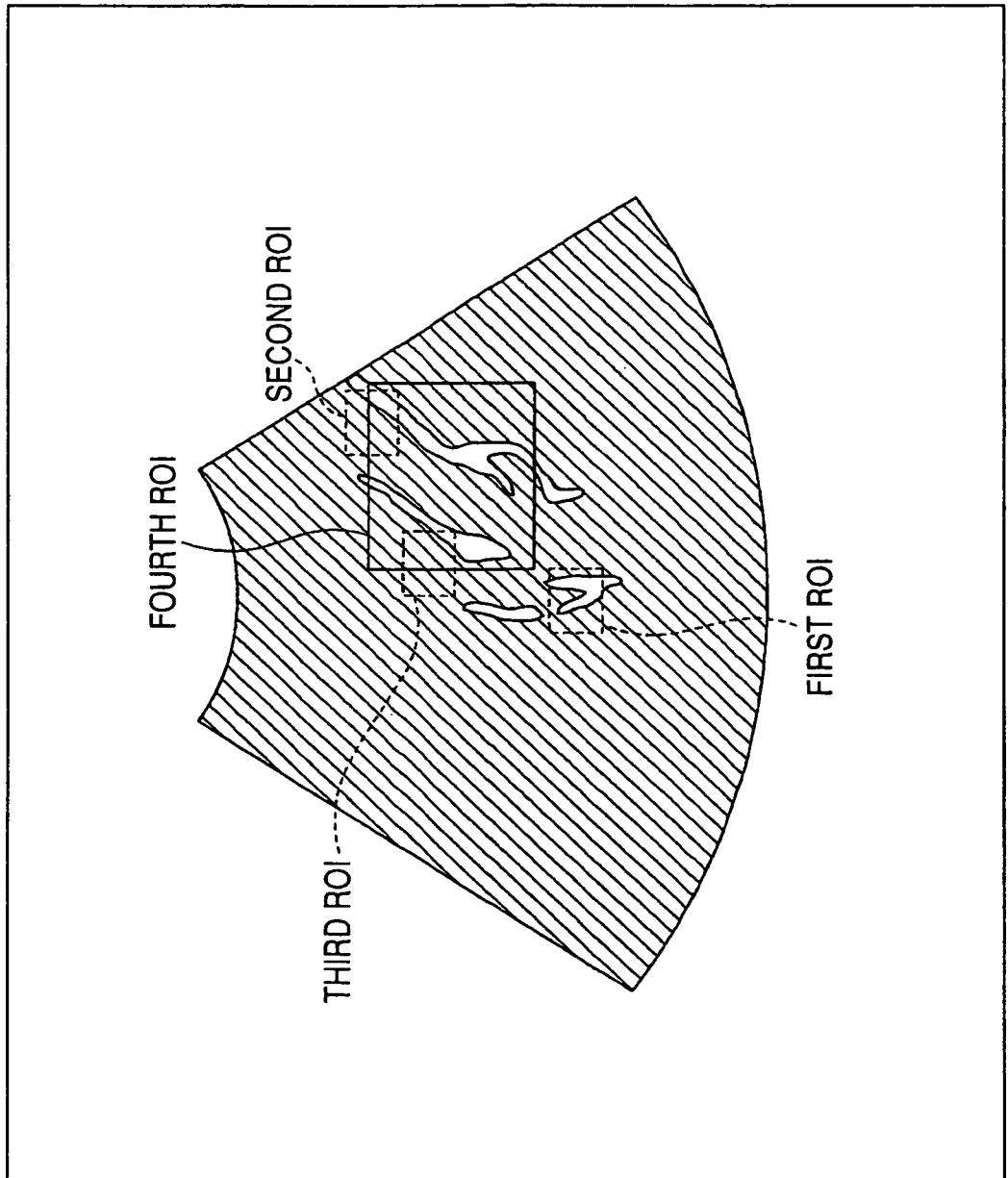


FIG. 14

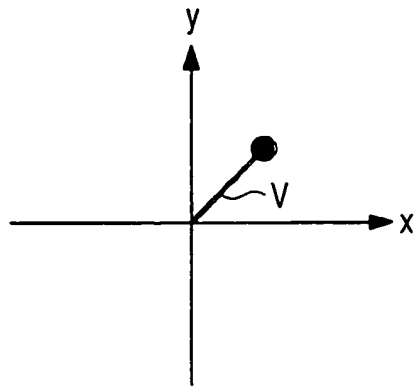


FIG. 15

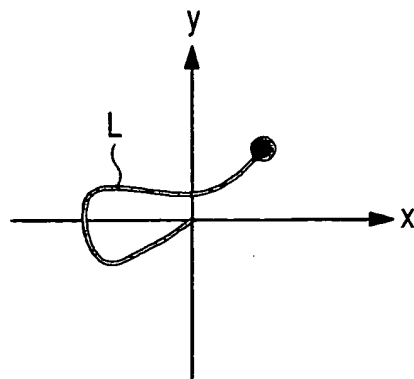


FIG. 16

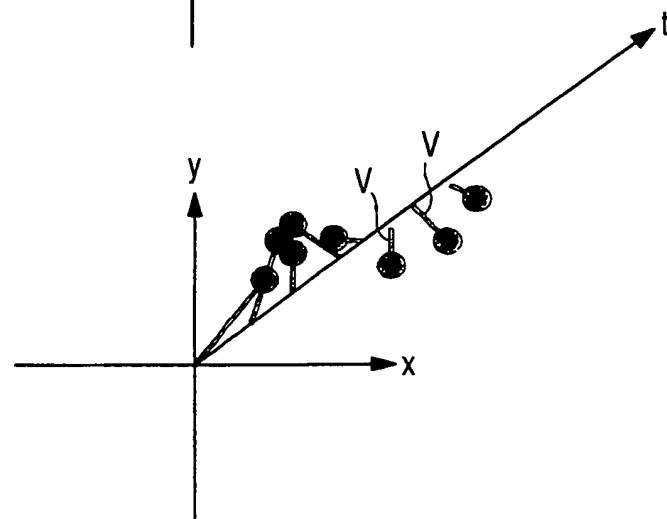
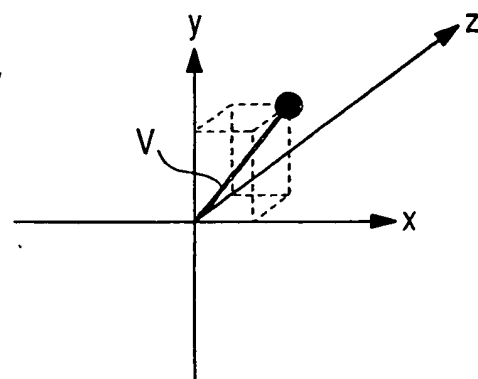


FIG. 17



REFERENCES CITED IN THE DESCRIPTION

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摘要(译)

本发明提供一种超声波诊断装置，该超声波诊断装置扫描被检查对象，其中对比介质气泡被超声波注入，以获取对象的超声图像。超声波诊断装置包括：图像数据生成单元，其基于从对象返回的回波信号生成指示关于待检查对象的形状的信息的多个图像数据；设置单元，其设置较小的感兴趣区域在多个图像数据中，作为参考图像数据的第一图像数据的整个图像区域，比较多个图像数据中的与第一图像数据不同的至少一个第二图像数据的矢量生成单元。生成指示第一图像数据和至少一个第二图像数据之间的运动的运动矢量的感兴趣区域，图像校正单元基于以下方式校正第一图像数据和至少一个第二图像数据的模糊。运动矢量和图像生成单元，其基于多个校正图像数据生成显示图像。

[Expression 1]

$$s = \sum_X \sum_Y D(X, Y)$$

$$D(X, Y) = I(X, Y)_N - I'(X, Y)_{N-1} \quad (I(X, Y)_N -$$

$$I'(X, Y)_{N-1} > 0)$$

$$= 0 \quad (I(X, Y)_N - I'(X, Y)_{N-1} \leq 0).$$