US 20090062650A1

(19) United States
(12) Patent Application Publication
(10) Pub. No.: US 2009/0062650 A1
(43) Pub. Date: Mar. 5, 2009
Miyaki

(54) ULTRASOUND DIAGNOSTIC APPARATUS

(75) Inventor: **Hironaka Miyaki**, Tokyo (JP)

Correspondence Address:
SCULLY SCOTT MURPHY & PRESSER, PC
400 GARDEN CITY PLAZA, SUITE 300
GARDEN CITY, NY 11530 (US)

(73) Assignee: **OLYMPUS MEDICAL SYSTEMS CORP.**, Tokyo (JP)

(21) Appl. No.: **12/183,410**

(22) Filed: **Jul. 31, 2008**

(30) **Foreign Application Priority Data**

Aug. 31, 2007 (JP) 2007-226621

Publication Classification

(51) **Int. Cl.**
A61B 8/06 (2006.01)
A61B 8/14 (2006.01)

(52) **U.S. Cl.** **600/443**; 382/131

(57) **ABSTRACT**

According to this invention, an ultrasound diagnostic apparatus is provided which generates a tomographic image of a subject site in a living body, including a region-of-interest setting section which sets a region-of-interest in the tomographic image, a data acquiring section which samples, from one piece of sound ray data within the region-of-interest, pieces of data at at least two positions including a piece of data at one position included in the one piece of sound ray data and a piece of data at at least one position upwardly or downwardly spaced apart from the one position by an interval of a predetermined number of pixels in a depth direction of the one piece of sound ray data, and a blood flow data calculating section which calculates a piece of blood flow data at the one position by performing spatial averaging on the pieces of data sampled by the data acquiring section.

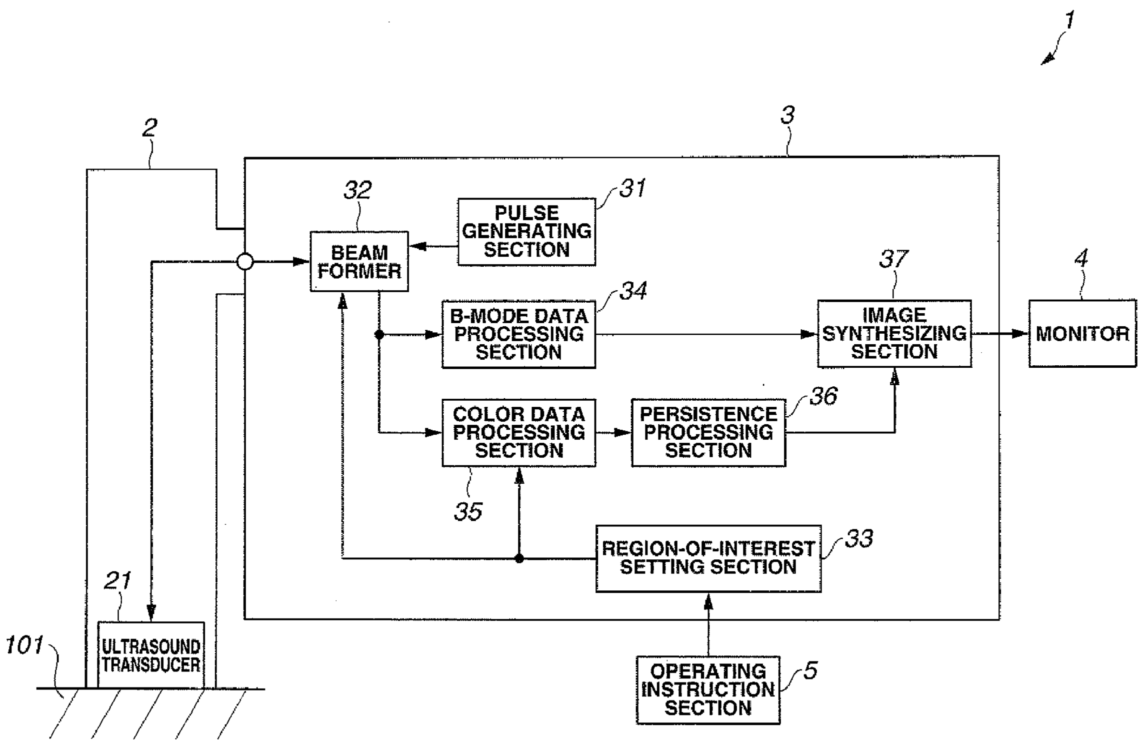


FIG.1

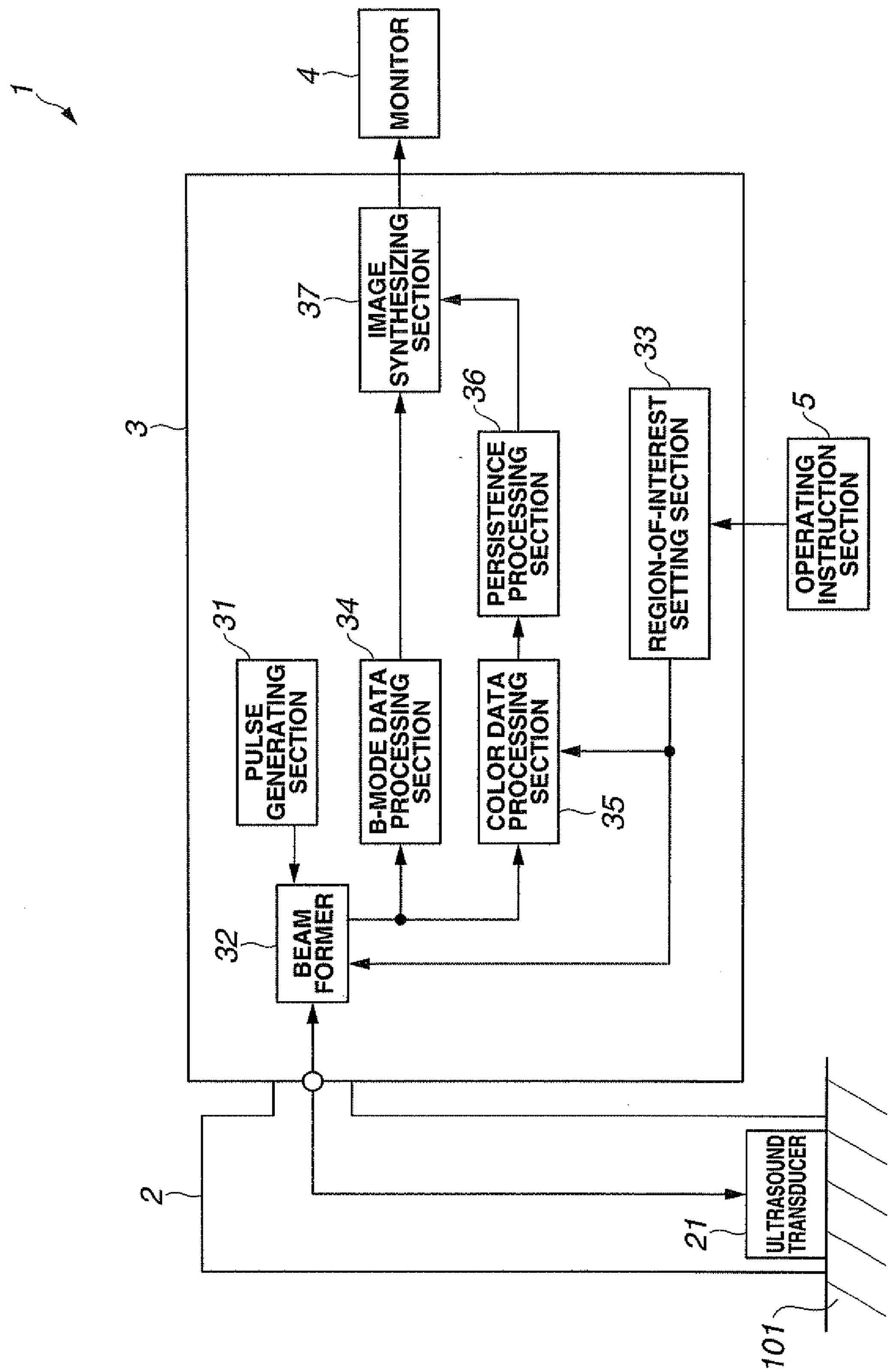

1
MONITOR
4
IMAGE SYNTHESIZING SECTION
37
3
PERSISTENCE PROCESSING SECTION
36
REGION-OF-INTEREST SETTING SECTION
33
OPERATING INSTRUCTION SECTION
5
PULSE GENERATING SECTION
31
B-MODE DATA PROCESSING SECTION
34
COLOR DATA PROCESSING SECTION
35
BEAM FORMER
32
2
ULTRASOUND TRANSDUCER
21
101

FIG.2

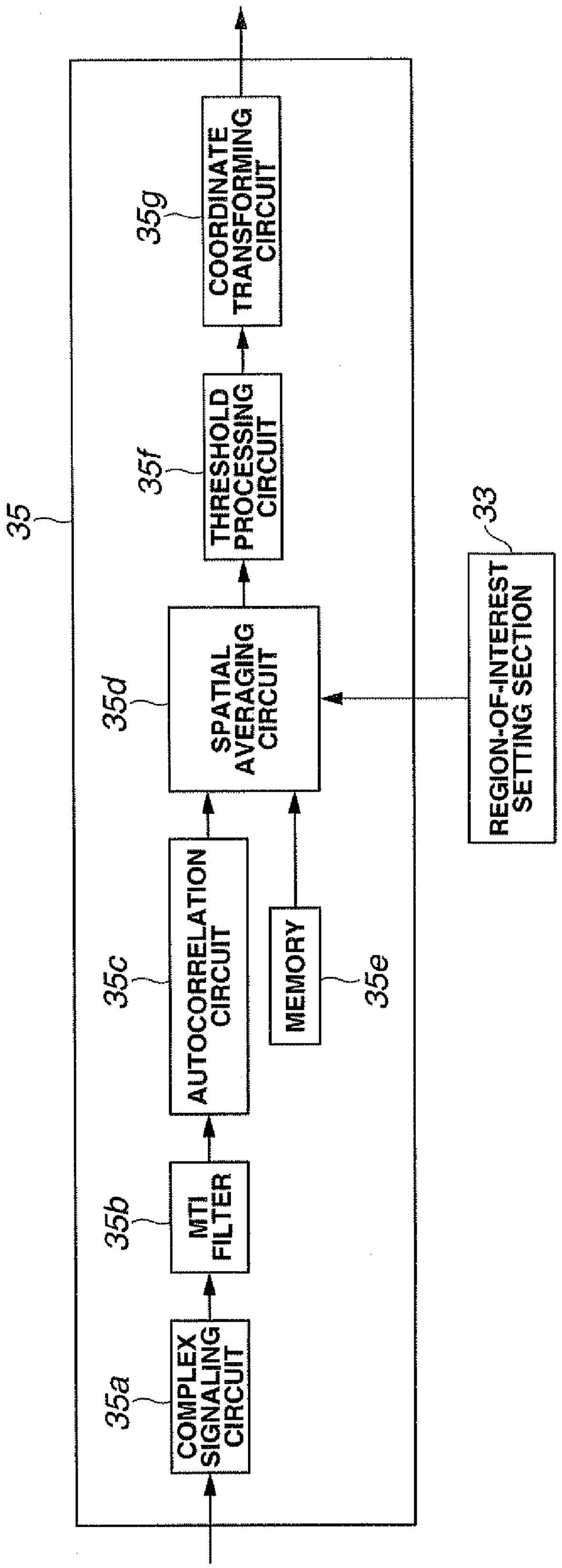

35
35a
COMPLEX SIGNALING CIRCUIT
35b
MTI FILTER
35c
AUTOCORRELATION CIRCUIT
35d
SPATIAL AVERAGING CIRCUIT
35e
MEMORY
35f
THRESHOLD PROCESSING CIRCUIT
35g
COORDINATE TRANSFORMING CIRCUIT
33
REGION-OF-INTEREST SETTING SECTION

FIG.3

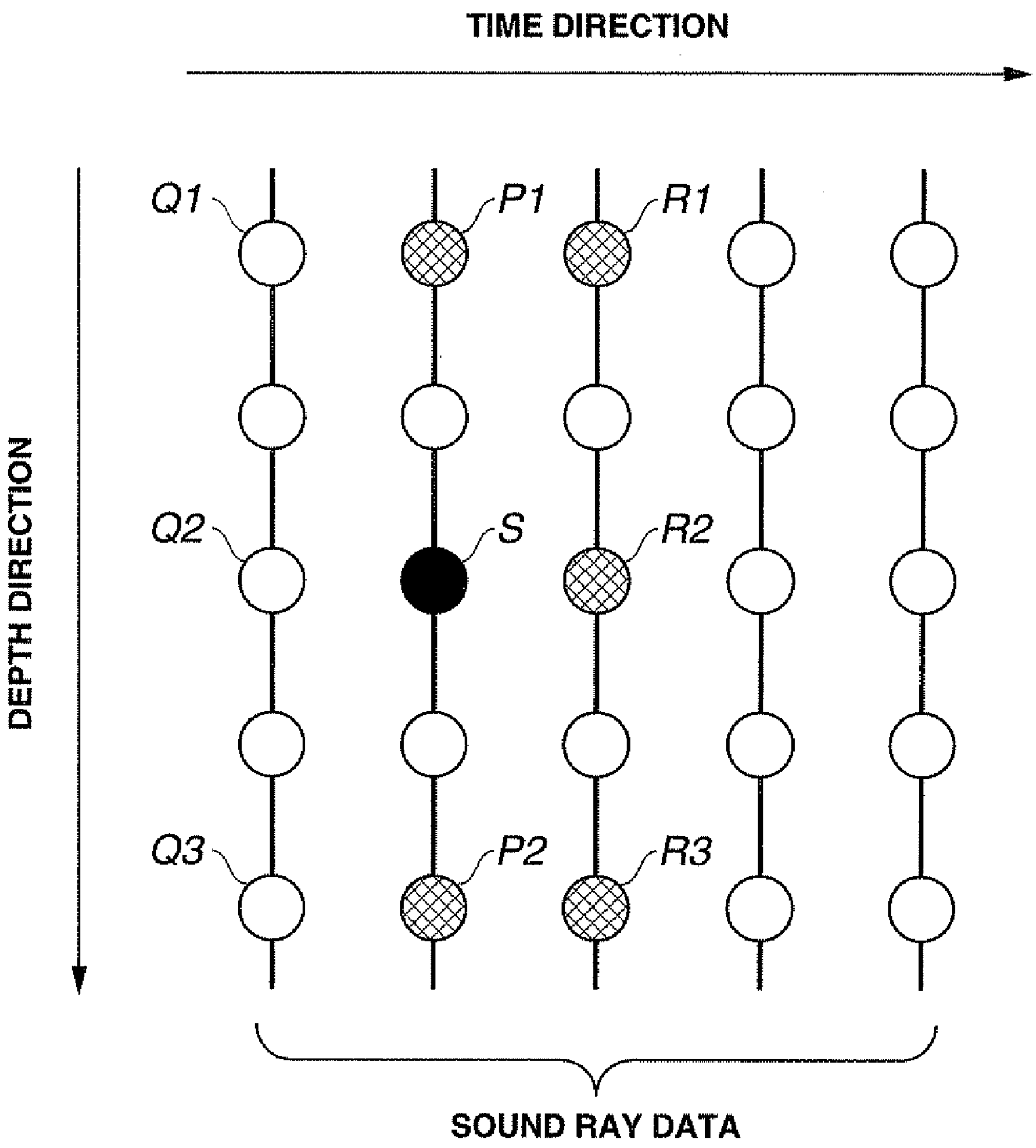
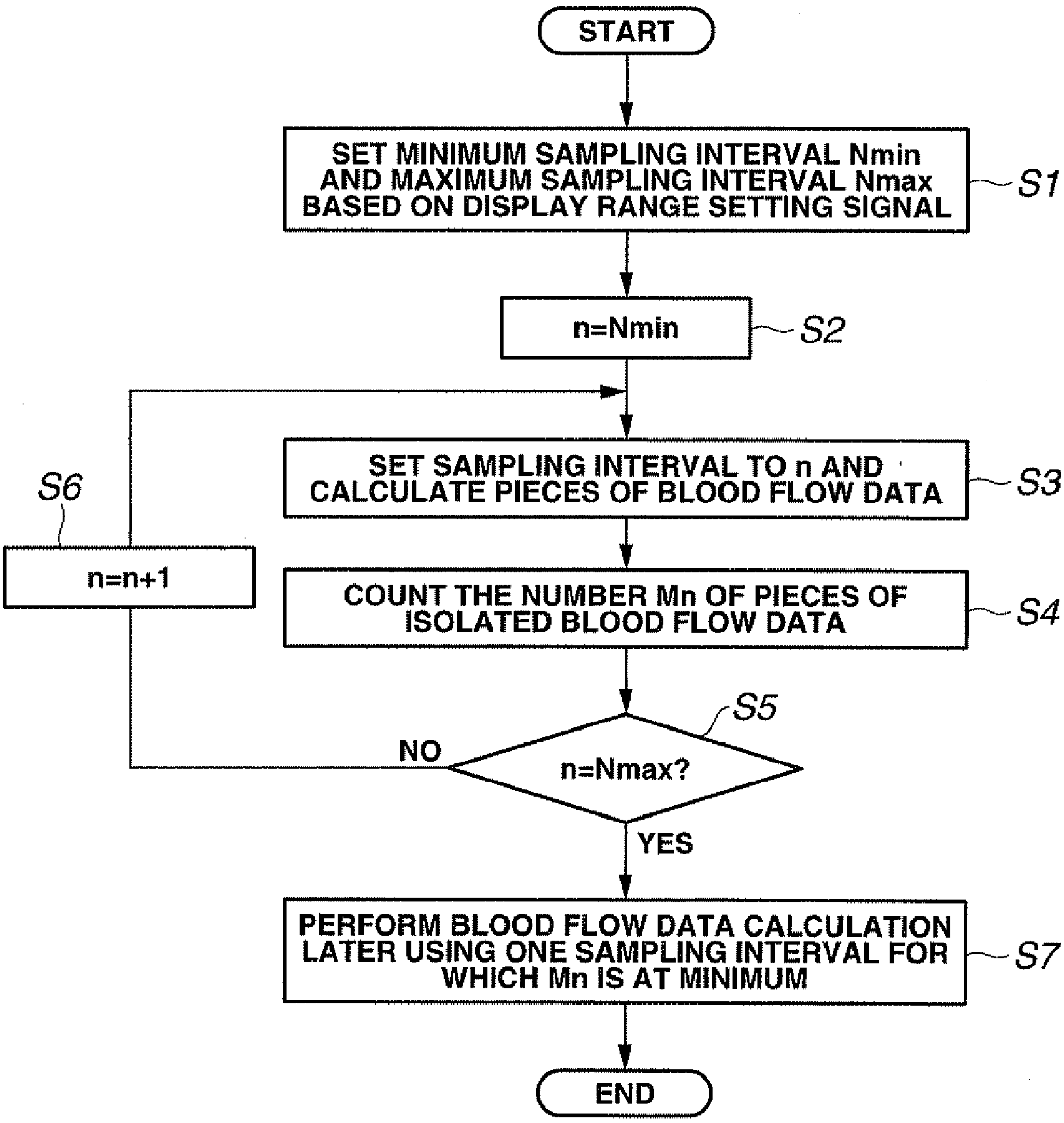

TIME DIRECTION
DEPTH DIRECTION
Q1
P1
R1
Q2
S
R2
Q3
P2
R3
SOUND RAY DATA

FIG.4


START
SET MINIMUM SAMPLING INTERVAL Nmin AND MAXIMUM SAMPLING INTERVAL Nmax BASED ON DISPLAY RANGE SETTING SIGNAL
S1
n=Nmin
S2
SET SAMPLING INTERVAL TO n AND CALCULATE PIECES OF BLOOD FLOW DATA
S3
S6
n=n+1
COUNT THE NUMBER Mn OF PIECES OF ISOLATED BLOOD FLOW DATA
S4
S5
NO
n=Nmax?
YES
PERFORM BLOOD FLOW DATA CALCULATION LATER USING ONE SAMPLING INTERVAL FOR WHICH Mn IS AT MINIMUM
S7
END

ULTRASOUND DIAGNOSTIC APPARATUS

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims benefit of Japanese Application No. 2007-226621 filed in Japan on Aug. 31, 2007, the contents of which are incorporated by this reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to an ultrasound diagnostic apparatus and, more particularly, to an ultrasound diagnostic apparatus capable of calculating blood flow data on the basis of sound ray data.

[0004] 2. Description of the Related Art

[0005] Ultrasound diagnostic apparatuses capable of acquiring a tomographic image of a living body as a subject and a blood flow image within a region-of-interest of the tomographic image by transmitting an ultrasound wave into the living body and receiving a reflected wave obtained when the ultrasound wave is reflected in a living tissue as a subject site in the living body are conventionally widely used. A tomographic image and blood flow image of a living body acquired by the ultrasound diagnostic apparatus are used, e.g., when a user such as a surgeon diagnoses an invasion depth of a lesion, observes an intraorgan state, or performs other operations.

[0006] As an example of an apparatus for acquiring a tomographic image and blood flow image of a living body as described above using an electronic scan type ultrasound transducer, an ultrasound Doppler device disclosed in Japanese Patent Application Laid-Open Publication No. 1-148244 is widely known.

[0007] If blood flow image data is generated using pieces of sound ray data acquired by an electronic scan type ultrasound transducer, a process of extracting respective pieces of data at a plurality of adjacent sample points from each piece of sound ray data and then generating blood flow image data for one pixel by grouping and averaging the pieces of data at the plurality of sample points is conventionally performed, for example.

SUMMARY OF THE INVENTION

[0008] An ultrasound diagnostic apparatus according to the present invention is an ultrasound diagnostic apparatus which generates a tomographic image of a subject site in a living body by receiving as sound ray data a reflected wave of an ultrasound wave transmitted to the subject site and performing predetermined signal processing on the sound ray data, including a region-of-interest setting section which sets a region-of-interest in the tomographic image, a data acquiring section which samples, from one piece of sound ray data within the region-of-interest, pieces of data at at least two positions including a piece of data at one position included in the one piece of sound ray data and a piece of data at at least one position upwardly or downwardly spaced apart from the one position by an interval of a predetermined number of pixels in a depth direction of the one piece of sound ray data, and a blood flow data calculating section which calculates a piece of blood flow data at the one position by performing spatial averaging on the pieces of data sampled by the data acquiring section.

[0009] An ultrasound diagnostic apparatus according to the present invention is an ultrasound diagnostic apparatus which generates a tomographic image of a subject site in a living body by receiving as sound ray data a reflected wave of an ultrasound wave transmitted to the subject site and performing predetermined signal processing on the sound ray data, including a region-of-interest setting section which sets a region-of-interest in the tomographic image, a data acquiring section which samples pieces of pixel data in sound ray data within the region-of-interest while switching between sampling intervals in order, starting with a first sampling interval and ending with a second sampling interval, in a depth direction of the sound ray data, and a blood flow data calculating section which calculates a piece of blood flow data for each of the sampling intervals by performing spatial averaging on the pieces of pixel data sampled by the data acquiring section, wherein the blood flow data calculating section sets, as a sampling interval at the time of calculation of blood flow data in the sound ray data, one of the sampling intervals for which the number of isolated blood flow data is at a minimum, on the basis of the pieces of blood flow data for the sampling intervals.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1** is a diagram showing an example of a configuration of a main portion of an ultrasound diagnostic system in which an ultrasound diagnostic apparatus according to the present embodiment is used;

[0011] FIG. **2** is a diagram showing an example of a detailed configuration of a color data processing section of the ultrasound diagnostic apparatus in FIG. **1**;

[0012] FIG. **3** is a schematic view showing an example of processing performed in a spatial averaging circuit in FIG. **2**; and

[0013] FIG. **4** is a flow chart showing a variation of the processing performed in the spatial averaging circuit in FIG. **2**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] An embodiment of the present invention will be described below with reference to the drawings.

[0015] FIGS. **1** to **4** relate to the embodiment of the present invention. FIG. **1** is a diagram showing an example of a configuration of a main portion of an ultrasound diagnostic system in which an ultrasound diagnostic apparatus according to the present embodiment is used. FIG. **2** is a diagram showing an example of a detailed configuration of a color data processing section of the ultrasound diagnostic apparatus in FIG. **1**. FIG. **3** is a schematic view showing an example of processing performed in a spatial averaging circuit in FIG. **2**. FIG. **4** is a flow chart showing a variation of the processing performed in the spatial averaging circuit in FIG. **2**.

[0016] As shown in FIG. **1**, a main portion of an ultrasound diagnostic system **1** is configured to have an ultrasound endoscope **2**, an ultrasound diagnostic apparatus **3** which processes echo signals from the ultrasound endoscope **2** and outputs the processed echo signals as video signals, a monitor **4** which displays an image on the basis of video signals outputted from the ultrasound diagnostic apparatus **3**, and an operating instruction section **5** including switches which is capable of outputting instruction signals for instructing sections of the ultrasound diagnostic system **1**.

[0017] The ultrasound endoscope **2** is configured to be detachable from the ultrasound diagnostic apparatus **3** on a proximal end side and has an ultrasound transducer **21** on a distal end side.

[0018] For example, the ultrasound transducer **21** has a configuration corresponding to an electronic scan method such as linear scanning and/or convex scanning. The ultrasound transducer **21** transmits an ultrasound wave to, e.g., a subject site **101** which is a living tissue on the basis of an ultrasound signal outputted from the ultrasound diagnostic apparatus **3**. The ultrasound transducer **21** receives a reflected wave of an ultrasound wave transmitted to the subject site **101** and outputs, as echo signals, respective pieces of scan information for sound rays based on the reflected wave to the ultrasound diagnostic apparatus **3**.

[0019] As shown in FIG. **1**, the ultrasound diagnostic apparatus **3** is configured to have a pulse generating section **31**, a beam former **32**, a region-of-interest setting section **33**, a B-mode data processing section **34**, a color data processing section **35**, a persistence processing section **36**, and an image synthesizing section **37**. Note that the above-described sections of the ultrasound diagnostic apparatus **3** are controlled by a control section (not shown) composed of a CPU and the like.

[0020] The pulse generating section **31** outputs a pulse signal for driving the ultrasound transducer **21** to the beam former **32** on the basis of a control signal outputted from the control section (not shown).

[0021] The beam former **32** generates and outputs an ultrasound signal for generating an ultrasound wave in the ultrasound transducer **21** on the basis of a pulse signal outputted from the pulse generating section **31**. The beam former **32** also performs processing such as amplification on echo signals outputted from the ultrasound transducer **21** and outputs the echo signals after the processing to the B-mode data processing section **34** and color data processing section **35**. The beam former **32** further sets, by itself range of ultrasound wave emission to the subject site **101** on the basis of a display range setting signal outputted from the region-of-interest setting section **33**. The beam former **32** outputs an ultrasound signal to the ultrasound transducer **21** on the basis of the emission range set by itself.

[0022] The region-of-interest setting section **33** having a function of a region-of-interest setting section sets a display range for a blood flow image of the subject site **101** to be displayed on the monitor **4** on the basis of an instruction signal from the operating instruction section **5** and outputs, as a display range setting signal, the settings to the color data processing section **35**.

[0023] The region-of-interest setting section **33** also sets a display range for a tomographic image acquired together with a blood flow image of the subject site **101** to a maximum displayable range (for the monitor **4**). Additionally, the region-of-interest setting section **33** combines the settings as the display range for a tomographic image with the settings as the display range for a blood flow image and outputs, as a display range setting signal, the combination to the beam former **32**.

[0024] The B-mode data processing section **34** generates a tomographic image of the subject site **101** on the basis of echo signals outputted from the beam former **32** and then outputs, as tomographic image signals, the tomographic image to the image synthesizing section **37**.

[0025] The color data processing section **35** generates a piece of blood flow data which is blood flow image data within a range set by the region-of-interest setting section **33** using color Doppler processing or power Doppler processing on the basis of echo signals outputted from the beam former **32** and a display range setting signal outputted from the region-of-interest setting section **33** and outputs the generated piece of blood flow data to the persistence processing section **36**.

[0026] As a configuration capable of at least one of color Doppler processing and power Doppler processing, the color data processing section **35** is configured to have a complex signaling circuit **35***a*, an MTI (Moving Target Indicator) filter **35***b*, an autocorrelation circuit **35***c*, a spatial averaging circuit **35***d*, a memory **35***e* storing predetermined information on spatial averaging performed in the spatial averaging circuit **35***d*, a threshold processing circuit **35***f*, and a coordinate transforming circuit **35***g*, as shown in, e.g., FIG. **2**.

[0027] The complex signaling circuit **35***a* performs quadrature detection processing on echo signals outputted from the beam former **32** and outputs the resultant signals to the MTI filter **35***b*.

[0028] The MTI filter **35***b* performs filtering processing on echo signals outputted from the complex signaling circuit **35***a* for removing a component in slow motion in a living body and outputs the echo signals to the autocorrelation circuit **35***c*.

[0029] The autocorrelation circuit **35***c* generates a piece of complex data representing a complex autocorrelation vector for each sound ray on the basis of echo signals outputted from the MTI filter **35***b* and outputs, as pieces of sound ray data, the pieces of complex data to the spatial averaging circuit **35***d*.

[0030] The spatial averaging circuit **35***d* reads, from the memory **35***e*, predetermined information indicating a correlation between a display range set by the region-of-interest setting section **33** and a sampling interval for pieces of sound ray data outputted from the autocorrelation circuit **35***c*, on the basis of a display range setting signal outputted from the region-of-interest setting section **33**. The spatial averaging circuit **35***d* then calculates, by spatial averaging, velocity and intensity of a blood flow within the range set by the region-of-interest setting section **33**, on the basis of the pieces of sound ray data outputted from the autocorrelation circuit **35***c* and the predetermined information read from the memory **35***e* and outputs, as a piece of blood flow data, the calculated velocity and intensity of the blood flow to the threshold processing circuit **35***f*.

[0031] The threshold processing circuit **35***f* performs a process of removing, e.g., one whose velocity component is not more than a predetermined value and one whose intensity component falls outside a predetermined range from pieces of blood flow data outputted from the spatial averaging circuit **35***d* and outputs pieces of blood flow data left after the process to the coordinate transforming circuit **35***g*.

[0032] The coordinate transforming circuit **35***g* sets a coordinate position for a piece of blood flow data outputted from the threshold processing circuit **35***f* to be within a range set by the region-of-interest setting section **33**, on the basis of the outputted piece of blood flow data and outputs the piece of blood flow data after the setting to the persistence processing section **36**.

[0033] Note that the color data processing section **35** may have a configuration supporting both of a mode of performing color Doppler processing Thereinafter abbreviated as "the color Doppler mode") and a mode of performing power Doppler processing (hereinafter abbreviated as "the power Doppler mode") and may be configured to be capable of switching between the two modes on the basis of an instruction signal from the operating instruction section **5**.

[0034] If the color data processing section **35** has a configuration capable of switching between the two modes, the pulse generating section **31** and beam former **32** may perform control in conjunction with switching between the color Doppler mode and the power Doppler mode such that the number of burst waves or the number of transmission of an ultrasound wave outputted from the ultrasound transducer **21** in the power Doppler mode is made larger than the number in the color Doppler mode. If the pulse generating section **31**, beam former **32**, and color data processing section **35** are configured in such a manner, the ultrasound diagnostic apparatus **3** can improve an S/N ratio of a blood flow image of the subject site **101** in the power Doppler mode.

[0035] The persistence processing section **36** is configured to have, e.g., table data for appropriately changing and outputting a luminance value of an inputted piece of blood flow data such that a blood flow image within a range set by the region-of-interest setting section **33** is displayed with a persistence on the monitor **4**. The persistence processing section **36** performs data conversion processing on a piece of blood flow data outputted from the color data processing section **35** using the table data and outputs the piece of blood flow data after the data conversion to the image synthesizing section **37**.

[0036] The image synthesizing section **37** generates video signals by combining tomographic image signals outputted from the B-mode data processing section **34** and pieces of blood flow data outputted from the persistence processing section **36** and outputs the generated video signals to the monitor **4**.

[0037] Action of the ultrasound diagnostic system **1** will now be described.

[0038] First, a user inserts the ultrasound endoscope **2** into a living body or the like and brings a distal end portion of the ultrasound endoscope **2** into contact with a desired observation part of the subject site **101** in the living body. After that, the user specifies a display range for a tomographic image of the subject site **101** to be displayed on the monitor **4** by manipulating a predetermined switch or the like provided at the operating instruction section **5** and vibrates the ultrasound transducer **21** provided at the distal end portion of the ultrasound endoscope **2** to transmit an ultrasound wave to the desired observation part of the subject site **101**.

[0039] The region-of-interest setting section **33** sets respective display ranges for a blood flow image and tomographic image of the subject site **101** to be displayed on the monitor **4** on the basis of an instruction signal from the operating instruction section **5** and outputs, as a display range setting signal, the settings to the beam former **32** and color data processing section **35**.

[0040] The beam former **32** sets, by itself, range of ultrasound wave emission to the subject site **101** on the basis of the display range setting signal outputted from the region-of-interest setting section **33** and outputs an ultrasound signal to the ultrasound transducer **21** on the basis of the emission range set by itself.

[0041] The ultrasound transducer **21** transmits an ultrasound wave to the subject site **101** in response to the ultrasound signal outputted from the beam former **32**. After that, the ultrasound transducer **21** receives a reflected wave of the ultrasound wave from the subject site **101** and outputs, as echo signals, the reflected wave to the ultrasound diagnostic apparatus **3**.

[0042] The echo signals inputted to the ultrasound diagnostic apparatus **3** are outputted to the B-mode data processing section **34** and color data processing section **35** through the beam former **32**.

[0043] The B-mode data processing section **34** generates a tomographic image of the subject site **101** on the basis of the echo signals outputted from the beam former **32** and then outputs, as tomographic image signals, the tomographic image to the image synthesizing section **37**.

[0044] In the meantime, the echo signals inputted to the color data processing section **35** are subjected to quadrature detection processing by the complex signaling circuit **35***a*, are subjected to filtering processing by the MTI filter **35***b*, and are converted into pieces of sound ray data by the autocorrelation circuit **35***c*. After that, the pieces of sound ray data are outputted to the spatial averaging circuit **35***d*.

[0045] The spatial averaging circuit **35***d* calculates pieces of blood flow data within the range set by the region-of-interest setting section **33** by spatial averaging, on the basis of the pieces of sound ray data outputted from the autocorrelation circuit **35***c*, the display range setting signal outputted from the region-of-interest setting section **33**, and predetermined information read from the memory **35***e*.

[0046] The spatial averaging performed by the spatial averaging circuit **35***d* will be specifically described.

[0047] Each point having a piece of data for one pixel (each point having a piece of data serving as a candidate for sampling) in a piece of sound ray data outputted from the autocorrelation circuit **35***c* is indicated by, e.g., a circle shown in FIG. **3**.

[0048] The spatial averaging circuit **35***d* performs sampling of sound ray data outputted from the autocorrelation circuit **35***c* at six points in FIG. **3** (a point S, a point P**1**, a point P**2**, a point R**1**, a point R**2**, and a point R**3**) as sample points on the basis of the predetermined information read from the memory **35***e* and performs spatial averaging (signal averaging) on a piece of data at each sample point, thereby calculating a piece of blood flow data at the point S.

[0049] In other words, the spatial averaging circuit **35***d* having a function of a data acquiring section samples the respective pieces of data at the six points in total composed of the point S itself, the points P**1** and P**2**, which are upwardly and downwardly spaced apart from the point S by one pixel in a depth direction of a piece of sound ray data to which the point S belongs, and the points R**1**, R**2**, and R**3**, which are respectively located at same depth positions as the points P**1**, S, and P**2** in a next piece of sound ray data which is temporally continuous with the piece of sound ray data to which the point S belongs, at the time of calculating the piece of blood flow data at the point S in FIG. **3**. The spatial averaging circuit **35***d* having a function of a blood flow data calculating section performs spatial averaging (signal averaging) on the pieces of data at the six sample points, thereby calculating the piece of blood flow data at the point S.

[0050] If sampling is performed at sample points adjacent to each other in a depth direction of a piece of sound ray data in generation of a piece of blood flow data, noise components become almost in phase with each other, and a piece of blood flow data from which noise is not adequately removed may be generated. On the other hand, if sampling is performed at sample points widely spaced apart from each other in a depth direction of a piece of sound ray data, a piece of blood flow data including artifacts may be generated. For this reason, control information such as a program for causing the spatial averaging circuit **35***d* to perform sampling of sound ray data while changing a sampling interval depending on a distance in a depth direction of a region-of-interest set by the region-of-interest setting section **33** is stored in advance in the memory **35***e* as predetermined information which optimizes an S/N ratio of a piece of blood flow data calculated in the spatial averaging circuit **35***d*.

[0051] Using this information, the spatial averaging circuit **35***d* calculates the piece of blood flow data at the point S while appropriately changing sample points as sampling sites corresponding to the points P**1** and P**2** in FIG. **3** to, e.g., positions upwardly and downwardly spaced apart from the point S by two pixels or positions upwardly and downwardly spaced apart from the point S by three pixels in the depth direction of the piece of sound ray data to which the point S belongs, depending on a display range set by the region-of-interest setting section **33**. Note that along with a change in positions in the depth direction of the sample points corresponding to the points P**1** and P**2** in FIG. **3**, positions in a depth direction of sample points corresponding to the points R**1** and R**3** in FIG. **3** are similarly changed.

[0052] Note that the spatial averaging circuit **35***d* does not necessarily perform sampling at the six sample points described above to calculate the piece of blood flow data at the point S in FIG. **3**. More specifically, the spatial averaging circuit **35***d* may calculate the piece of blood flow data at the point S by, e.g., sampling pieces of data at nine sample points in total composed of points Q**1**, Q**2**, and Q**3** which are respectively located at same depth positions as the points P**1**, S, and P**2** in a previous piece of sound ray data which is temporally continuous with the piece of sound ray data to which the point S belongs and the above-described six sample points and performing spatial averaging (signal averaging) on the pieces of data at the nine sample points. The present embodiment is not limited to sampling at three sample points in one piece of sound ray data. For example, sampling may be performed at at least two sample points having a piece of data at one position included in one piece of sound ray data and a piece of data at at least one position upwardly or downwardly spaced apart from the one position by a predetermined number of pixels.

[0053] One whose velocity component is not more than a predetermined value and one whose intensity component falls outside a predetermined range are removed from the pieces of blood flow data outputted from the spatial averaging circuit **35***d* by the threshold processing circuit **35***f*. Pieces of blood flow data left after the removal are subjected to coordinate position setting by the coordinate transforming circuit **35***g* and are then outputted to the persistence processing section **36**.

[0054] The pieces of blood flow data outputted from the color data processing section **35** are subjected to data conversion processing by the persistence processing section **36**, are combined with the tomographic image signals in the image synthesizing section **37**, and then are outputted to the monitor **4**. With this operation, a high-quality blood flow image with noise such as dot noise suppressed is outputted to the monitor **4**.

[0055] Note that an interval of sampling by the spatial averaging circuit **35***d* is not limited to the above-described one which is appropriately changed depending on a distance in a depth direction of the range set by the region-of-interest setting section **33**. For example, the sampling interval may be a desired user-selectable sampling interval or may be a fixed sampling interval.

[0056] The ultrasound diagnostic system **1** of the present embodiment may be configured such that the sections perform operations corresponding to action to be described below, in order to achieve almost the same advantages as described above. Note that a following description will be given while a description of same portions as described above being appropriately omitted, for descriptive simplicity.

[0057] First, a user inserts the ultrasound endoscope **2** into a living body or the like and brings the distal end portion of the ultrasound endoscope **2** into contact with a desired observation part of the subject site **101** in the living body. After that, the user specifies a display range for a tomographic image of the subject site **101** to be displayed on the monitor **4** by manipulating a predetermined switch or the like provided at the operating instruction section **5**.

[0058] The region-of-interest setting section **33** sets respective display ranges for a blood flow image and tomographic image of the subject site **101** to be displayed on the monitor **4** on the basis of an instruction signal from the operating instruction section **5** and outputs, as a display range setting signal, the settings to the beam former **32** and color data processing section **35**.

[0059] The spatial averaging circuit **35***d* sets a minimum sampling interval Nmin and a maximum sampling interval Nmax in a depth direction of sound ray data on the basis of the display range setting signal outputted from the region-of-interest setting section **33** (step S**1** in FIG. **4**) and sets a variable n representing a sampling interval to Nmin (step S**2** in FIG. **4**).

[0060] After that, when an instruction to transmit an ultrasound wave to the desired observation part is given at the operating instruction section **5**, the ultrasound transducer **21** transmits an ultrasound wave to the subject site **101** under control of the beam former **32**. After that, the ultrasound transducer **21** receives a reflected wave of the ultrasound wave from the subject site **101** and outputs, as echo signals, the reflected wave to the beam former **32**.

[0061] The echo signals inputted to the ultrasound diagnostic apparatus **3** are outputted to the B-mode data processing section **34** and color data processing section **35** through the beam former **32**.

[0062] The B-mode data processing section **34** generates a tomographic image of the subject site **101** on the basis of the echo signals outputted from the beam former **32** and then outputs, as tomographic image signals, the tomographic image to the image synthesizing section **37**.

[0063] In the meantime, the echo signals inputted to the color data processing section **35** are subjected to quadrature detection processing by the complex signaling circuit **35***a*, are subjected to filtering processing by the MTI filter **35***b*, and are converted into pieces of sound ray data by the autocorrelation circuit **35***c*. After that, the pieces of sound ray data are outputted to the spatial averaging circuit **35***d*.

[0064] The spatial averaging circuit **35***d* performs the above-described spatial averaging (signal averaging) with a sampling interval for sample points in the depth direction of sound ray data set to n pixels, on the basis of the display range setting signal outputted from the region-of-interest setting section **33** and the pieces of sound ray data outputted from the autocorrelation circuit **35***c*, thereby calculating pieces of blood flow data within the range set by the region-of-interest setting section **33** (step S**3** in FIG. **4**).

[0065] The spatial averaging circuit **35***d* further counts the number Mn of pieces of isolated blood flow data of the calculated pieces of blood flow data (step S**4** in FIG. **4**) and temporarily stores, in itself, a count result. Note that, for example, the spatial averaging circuit **35***d* refers to pieces of data for eight pixels adjacent to one pixel having a piece of blood flow data and extracts the piece of blood flow data at the one pixel as a piece of isolated blood flow data if all of the pieces of data for the eight pixels have no piece of blood flow data.

[0066] After that, the spatial averaging circuit **35***d* determines whether the variable n is equal to Nmax (step **85** in FIG. **4**). If the spatial averaging circuit **35***d* has detected that the variable n is not equal to Nmax, the spatial averaging circuit **35***d* repeats the processes in steps S**3** to S**5** in FIG. **4** on the pieces of data outputted to the autocorrelation circuit **35***c* while adding 1 to the variable n (step S**6** in FIG. **4**), until the variable n becomes equal to Nmax. On the other hand, if the spatial averaging circuit **35***d* has detected that the variable n is equal to Nmax, the spatial averaging circuit **35***d* refers to values for Mn stored in itself. The spatial averaging circuit **35***d* performs blood flow data calculation later using one sampling interval for which Mn has a minimum value (step S**7** in FIG. **4**).

[0067] The ultrasound diagnostic system **1** of the present embodiment can output a high-quality blood flow image with noise such as dot noise suppressed to the monitor **4** even if an operation corresponding to the above-described action.

[0068] Note that the present invention is not limited to the above-described embodiment and that various modifications and applications can, of course, be made without departing from spirit and scope of the invention.

What is claimed is:

1. An ultrasound diagnostic apparatus which generates a tomographic image of a subject site in a living body by receiving as sound ray data a reflected wave of an ultrasound wave transmitted to the subject site and performing predetermined signal processing on the sound ray data, comprising:

a region-of-interest setting section which sets a region-of-interest in the tomographic image;

a data acquiring section which samples, from one piece of sound ray data within the region-of-interest, pieces of data at at least two positions including a piece of data at one position included in the one piece of sound ray data and a piece of data at at least one position upwardly or downwardly spaced apart from the one position by an interval of a predetermined number of pixels in a depth direction of the one piece of sound ray data; and

a blood flow data calculating section which calculates a piece of blood flow data at the one position by performing spatial averaging on the pieces of data sampled by the data acquiring section.

2. The ultrasound diagnostic apparatus according to claim **1**, wherein the data acquiring section samples pieces of data at at least four positions including the pieces of data at the at least two positions and pieces of data at at least two other positions at same depths as depths of the at least two positions in a next piece of sound ray data temporally continuous with the one piece of sound ray data.

3. The ultrasound diagnostic apparatus according to claim **1**, wherein

the interval of the predetermined number of pixels is an interval which is appropriately changed depending on a distance in a depth direction of the region-of-interest.

4. The ultrasound diagnostic apparatus according to claim **2**, wherein

the interval of the predetermined number of pixels is an interval which is appropriately changed depending on a distance in a depth direction of the region-of-interest.

5. An ultrasound diagnostic apparatus which generates a tomographic image of a subject site in a living body by receiving as sound ray data a reflected wave of an ultrasound wave transmitted to the subject site and performing predetermined signal processing on the sound ray data, comprising:

a region-of-interest setting section which sets a region-of-interest in the tomographic image;

a data acquiring section which samples pieces of pixel data in sound ray data within the region-of-interest while switching between sampling intervals in order, starting with a first sampling interval and ending with a second sampling interval, in a depth direction of the sound ray data; and

a blood flow data calculating section which calculates a piece of blood flow data for each of the sampling intervals by performing spatial averaging on the pieces of pixel data sampled by the data acquiring section, wherein

the blood flow data calculating section sets, as a sampling interval at the time of calculation of blood flow data in the sound ray data, one of the sampling intervals for which the number of isolated blood flow data is at a minimum, on the basis of the pieces of blood flow data for the sampling intervals.

* * * * *

专利名称(译)	超声诊断仪		
公开(公告)号	US20090062650A1	公开(公告)日	2009-03-05
申请号	US12/183410	申请日	2008-07-31
[标]申请(专利权)人(译)	奥林巴斯医疗株式会社		
申请(专利权)人(译)	奥林巴斯医疗系统股份有限公司.		
当前申请(专利权)人(译)	奥林巴斯医疗系统股份有限公司.		
[标]发明人	MIYAKI HIRONAKA		
发明人	MIYAKI, HIRONAKA		
IPC分类号	A61B8/06 A61B8/14		
CPC分类号	A61B8/06 A61B8/12 G01S15/8979 G01S7/52063 G01S15/8977 A61B8/13		
优先权	2007226621 2007-08-31 JP		
外部链接	USPTO		

摘要(译)

根据本发明，提供一种超声波诊断装置，其生成生物体内的被检体部位的断层图像，包括设定断层图像中的关注区域的关注区域设定部，数据取得从感兴趣区域内的一条声线数据中采集至少两个位置的数据的部分，包括在一条声线数据中包括的一个位置处的一条数据和在一条数据处的数据。至少一个位置在一个声线数据的深度方向上与一个位置向上或向下间隔预定数量的像素的间隔，以及血流数据计算部分，其计算一条血流数据通过对数据获取部分采样的数据进行空间平均，在一个位置处。