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(54) **ULTRASOUND DIAGNOSTIC DEVICE, IMAGE PARAMETER SETTING METHOD AND STORAGE MEDIUM**

(71) Applicant: **Konica Minolta, Inc.**, Chiyoda-ku Tokyo (JP)

(72) Inventor: **Tomohito SAKAI**, Yokohama-shi Kanagawa (JP)

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(57) **ABSTRACT**

An ultrasound diagnostic device, including: a transmitter which outputs a drive signal to an ultrasound probe that transmits and receives ultrasound waves; a receiver which obtains a reception signal from the ultrasound probe; a first hardware processor which generates ultrasound image data from the reception signal and performs image processing to the generated ultrasound image data; an operator which receives input of a depth of an ultrasound image to be displayed; and a second hardware processor which obtains a plurality of preset image parameters corresponding to the input depth, and controls the transmitter, the receiver and the first hardware processor to generate the ultrasound image data corresponding to the input depth according to the obtained plurality of image parameters.

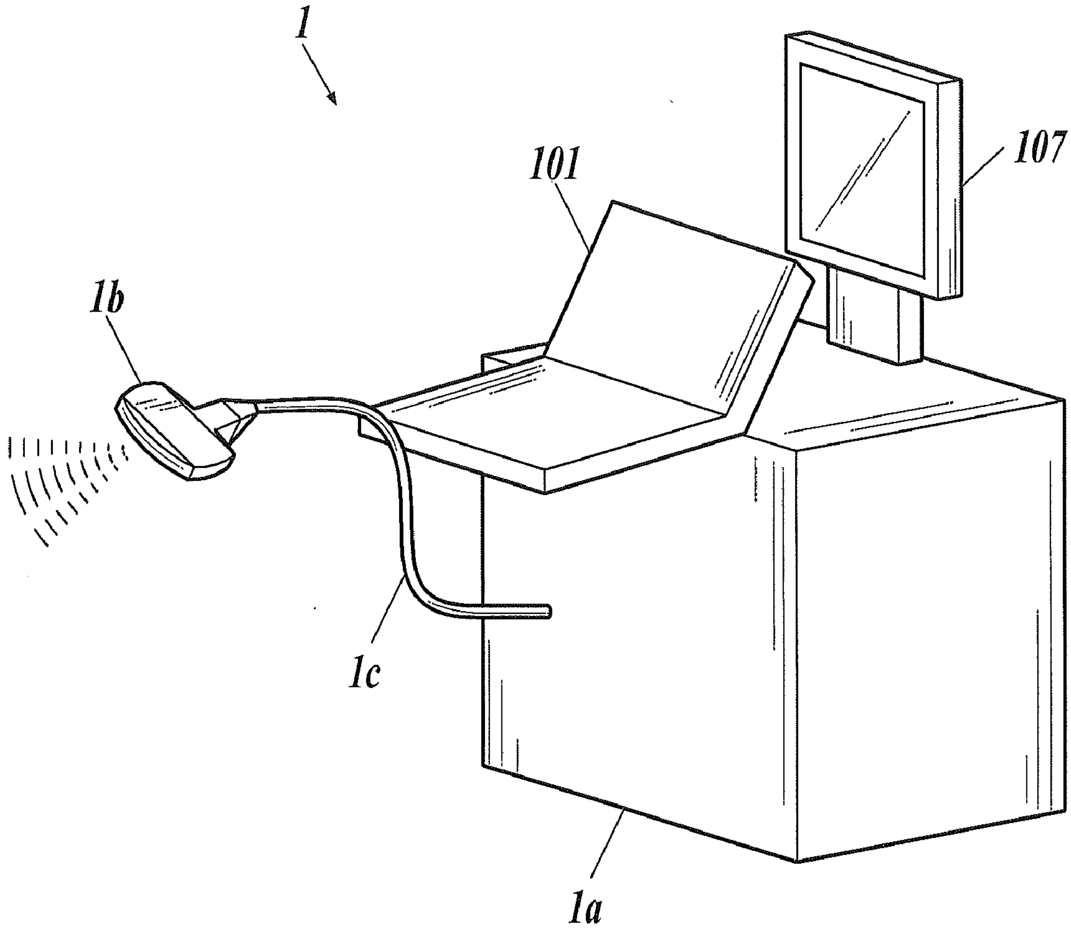


FIG. 1

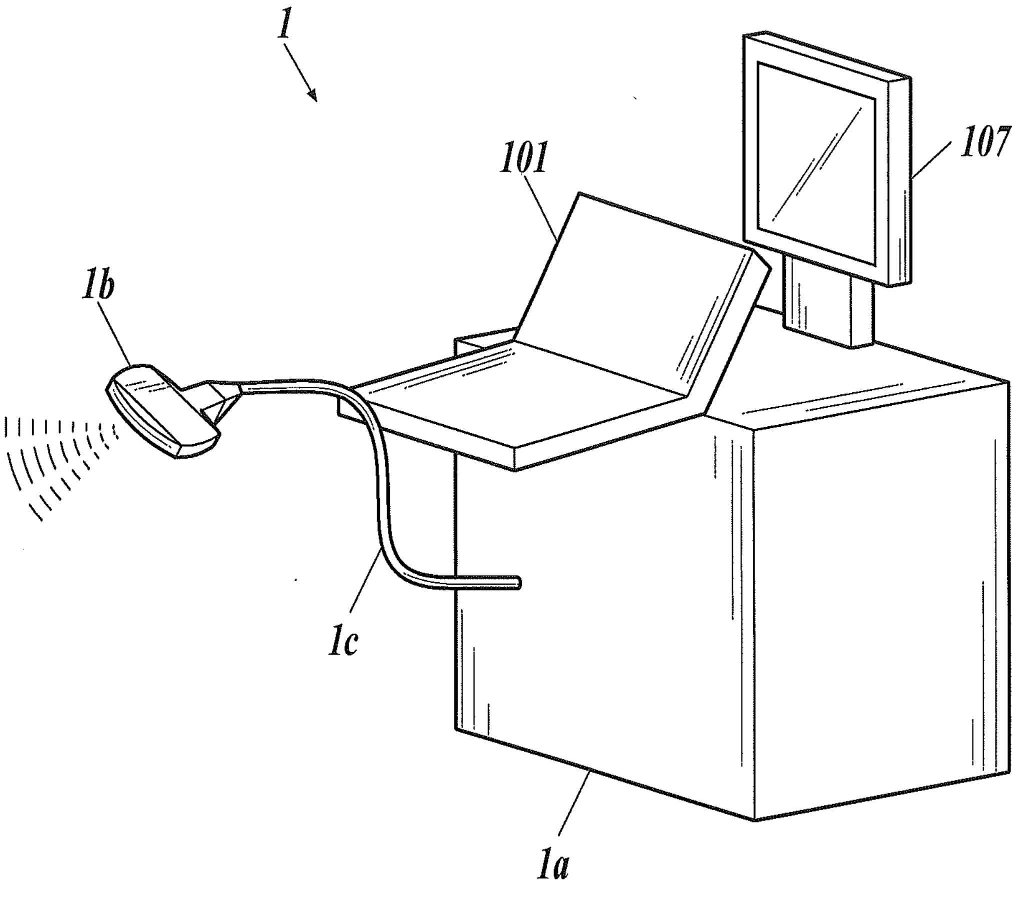


FIG. 2

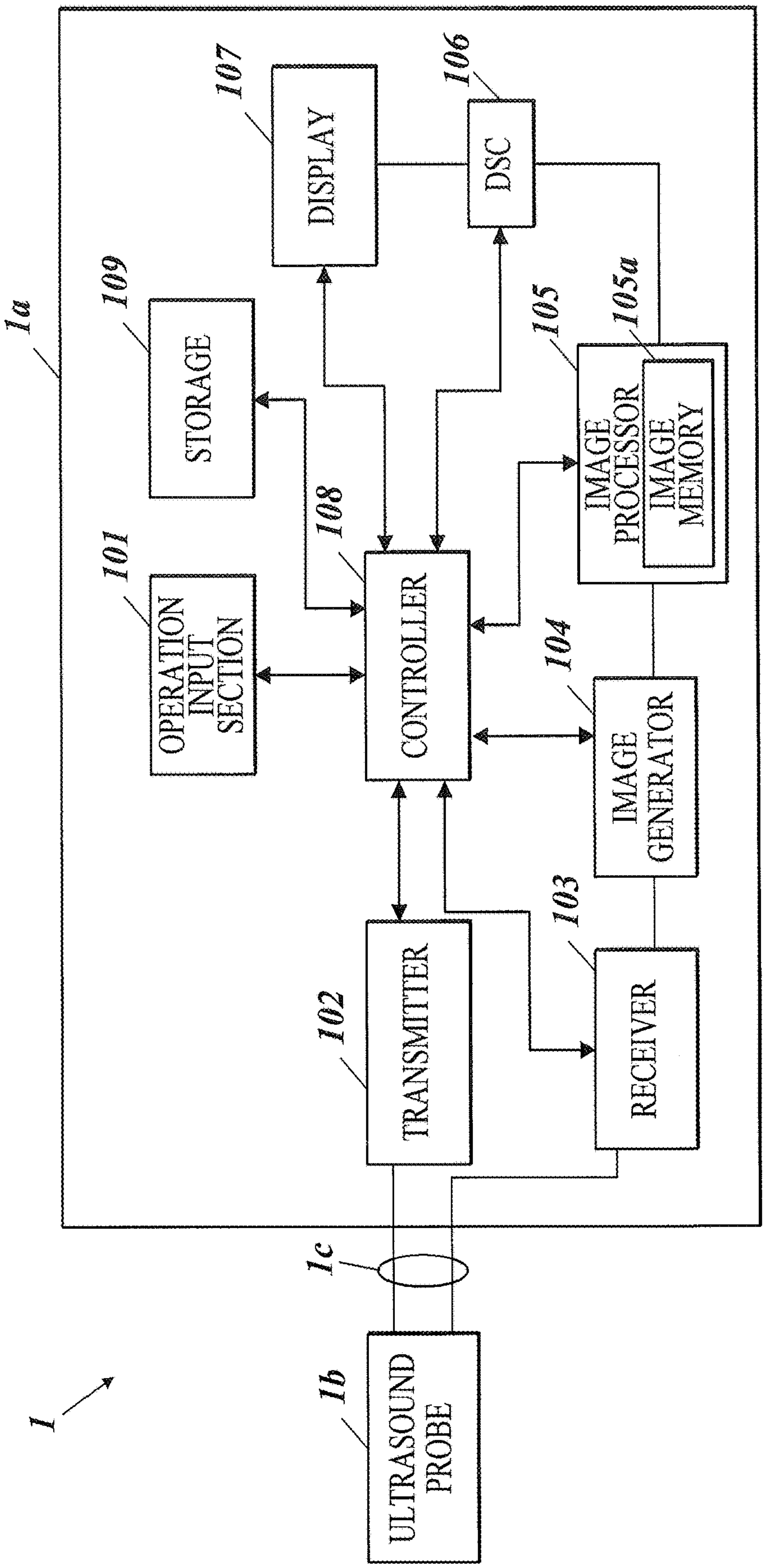

1
1a
1b
ULTRASOUND PROBE
1c
101
OPERATION INPUT SECTION
102
TRANSMITTER
103
RECEIVER
104
IMAGE GENERATOR
105
IMAGE PROCESSOR
105a
IMAGE MEMORY
106
DSC
107
DISPLAY
108
CONTROLLER
109
STORAGE

FIG.3

200

210 220 ...

NAME: SHOULDER, TAG1:L18, TAG 2: FORMATTING, TAG 3; MAINTAINANCE:2[cm]	DEPTH [cm]						
	1	2	3	4	5	6	7
FREQUENCY[MHz]	15	12	10	8	8	6	6
TRAPEZOIDAL SCANNING	Off	Off	Off	Off	On	On	On
SOUND RAY DENSITY	5	4	3	3	2	2	2
DYNAMIC RANGE[dB]	75	70	70	65	60	60	55
TIME AVERAGE	STRONG	STRONG	MEDIUM	MEDIUM	MEDIUM	WEAK	WEAK
SCREEN LAYOUT	VERTICAL	VERTICAL	VERTICAL	HORIZONTAL	HORIZONTAL	HORIZONTAL	HORIZONTAL
OFFSETTGC1[dB]	5	−1	1	−4	−4	1	−3
≀	≀	≀	≀	≀	≀	≀	≀
OFFSETTGC8[dB]	−4	−4	−4	4	0	−5	3
OFFSET GAIN[dB]	5	−2	−3	−1	4	2	−2
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

FIG.4

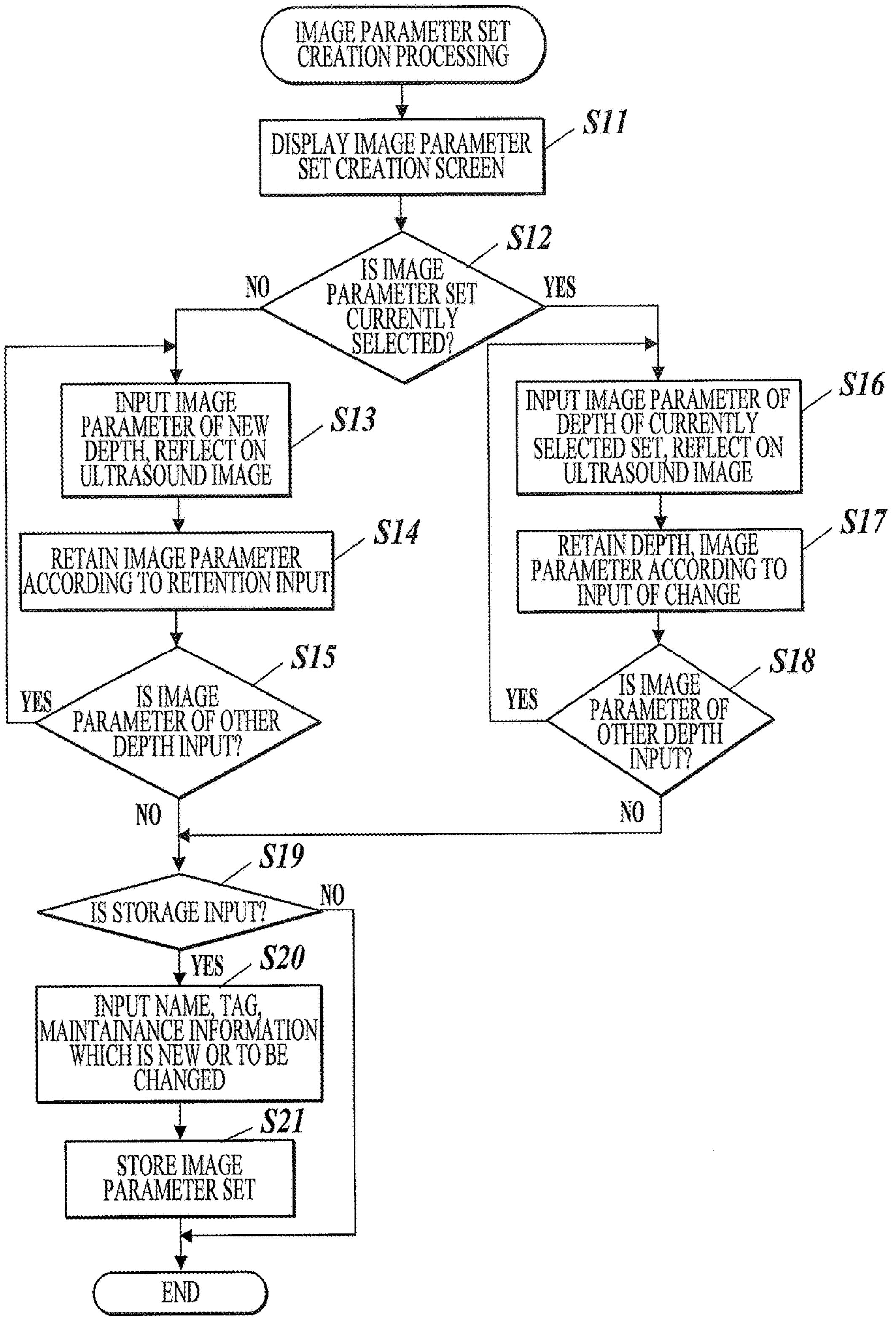


IMAGE PARAMETER SET CREATION PROCESSING
S11
DISPLAY IMAGE PARAMETER SET CREATION SCREEN
S12
IS IMAGE PARAMETER SET CURRENTLY SELECTED?
NO
YES
S13
INPUT IMAGE PARAMETER OF NEW DEPTH, REFLECT ON ULTRASOUND IMAGE
S14
RETAIN IMAGE PARAMETER ACCORDING TO RETENTION INPUT
S15
IS IMAGE PARAMETER OF OTHER DEPTH INPUT?
YES
NO
S16
INPUT IMAGE PARAMETER OF DEPTH OF CURRENTLY SELECTED SET, REFLECT ON ULTRASOUND IMAGE
S17
RETAIN DEPTH, IMAGE PARAMETER ACCORDING TO INPUT OF CHANGE
S18
IS IMAGE PARAMETER OF OTHER DEPTH INPUT?
YES
NO
S19
IS STORAGE INPUT?
NO
YES
S20
INPUT NAME, TAG, MAINTAINANCE INFORMATION WHICH IS NEW OR TO BE CHANGED
S21
STORE IMAGE PARAMETER SET
END

FIG. 5

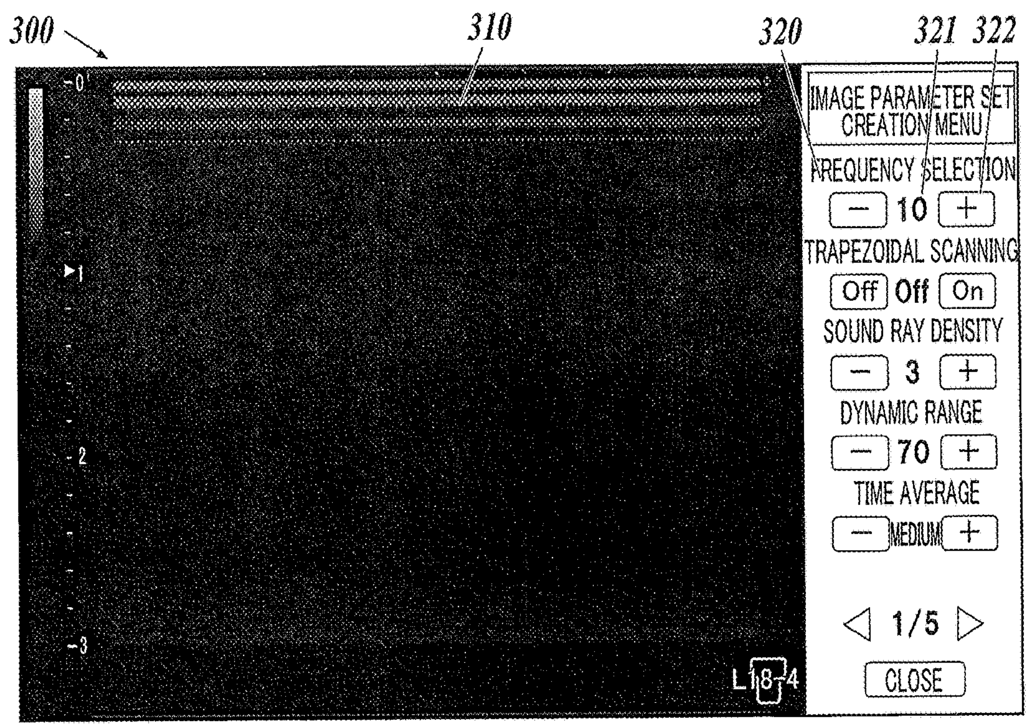

300
310
320
321
322
IMAGE PARAMETER SET CREATION MENU
FREQUENCY SELECTION
10
TRAPEZOIDAL SCANNING
Off
On
SOUND RAY DENSITY
3
DYNAMIC RANGE
70
TIME AVERAGE
MEDIUM
1/5
CLOSE
L18-4

FIG. 6

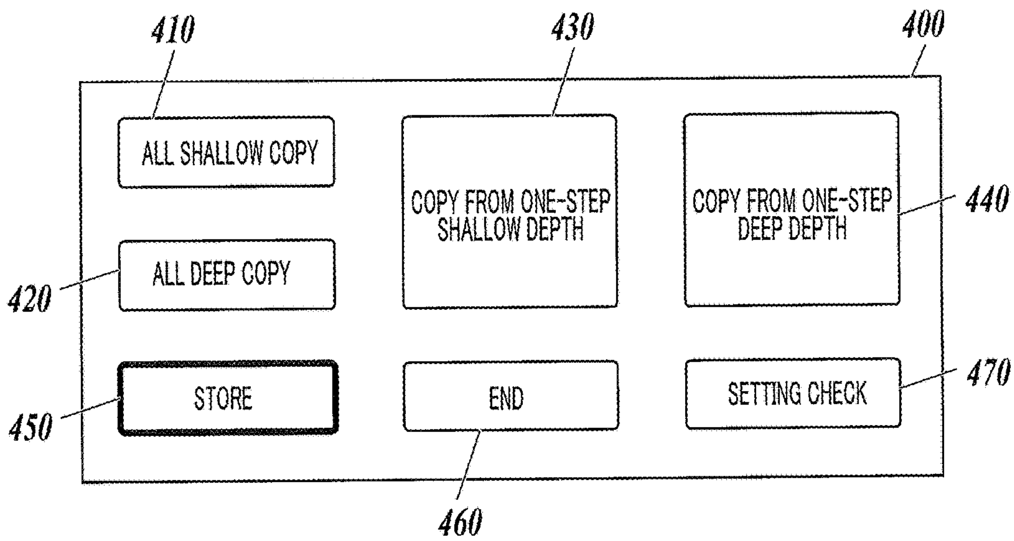

410
430
400
ALL SHALLOW COPY
COPY FROM ONE-STEP SHALLOW DEPTH
COPY FROM ONE-STEP DEEP DEPTH
440
420
ALL DEEP COPY
STORE
END
SETTING CHECK
470
450
460

FIG. 7

210

NAME: SHOULDER, TAG1:L18, TAG 2: FORMATTING, TAG 3:, MAINTAINANCE:2[cm]	DEPTH [cm]						
	1	2	3	4	5	6	7
FREQUENCY[MHz]	10	10	10	8	8	8	8
TRAPEZOIDAL SCANNING	Off	Off	Off	Off	Off	Off	Off
SOUND RAY DENSITY	3	3	3	3	3	3	3
DYNAMIC RANGE[dB]	70	70	70	65	65	65	65
TIME AVERAGE	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM
SCREEN LAYOUT	VERTICAL	VERTICAL	VERTICAL	HORIZONTAL	HORIZONTAL	HORIZONTAL	HORIZONTAL
OFFSETTGC1[dB]	1	1	1	−4	−4	−4	−4
~	~	~	~	~	~	~	~
OFFSETTGC8[dB]	−4	−4	−4	4	4	4	4
OFFSET GAIN[dB]	−3	−3	−3	−1	−1	−1	−1
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

FIG. 8

210

NAME: SHOULDER, TAG1:L18, TAG 2: FORMATTING, TAG 3:, MAINTAINANCE:2[cm]	DEPTH [cm]						
	1	2	3	4	5	6	7
FREQUENCY[MHz]	15	12	12	8	8	6	6
TRAPEZOIDAL SCANNING	Off	Off	Off	On	On	On	On
SOUND RAY DENSITY	5	4	4	2	2	2	2
DYNAMIC RANGE[dB]	75	70	70	60	60	60	55
TIME AVERAGE	STRONG	STRONG	STRONG	MEDIUM	MEDIUM	WEAK	WEAK
SCREEN LAYOUT	VERTICAL	VERTICAL	VERTICAL	HORIZONTAL	HORIZONTAL	HORIZONTAL	HORIZONTAL
OFFSETTGC1[dB]	5	−1	−1	−4	−4	1	−3
~	~	~	~	~	~	~	~
OFFSETTGC8[dB]	−4	−4	−4	0	0	−5	3
OFFSET GAIN[dB]	5	−2	−2	4	4	2	−2
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

FIG. 9

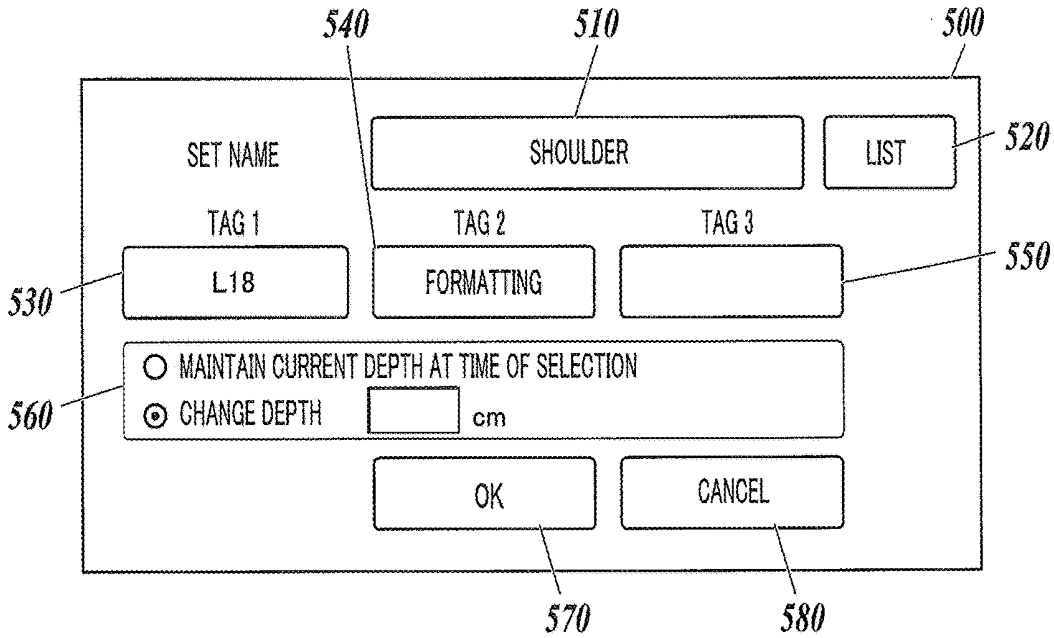

540
510
500
SET NAME
SHOULDER
LIST
520
TAG 1
TAG 2
TAG 3
530
L18
FORMATTING
550
MAINTAIN CURRENT DEPTH AT TIME OF SELECTION
560
CHANGE DEPTH
cm
OK
CANCEL
570
580

FIG. 10

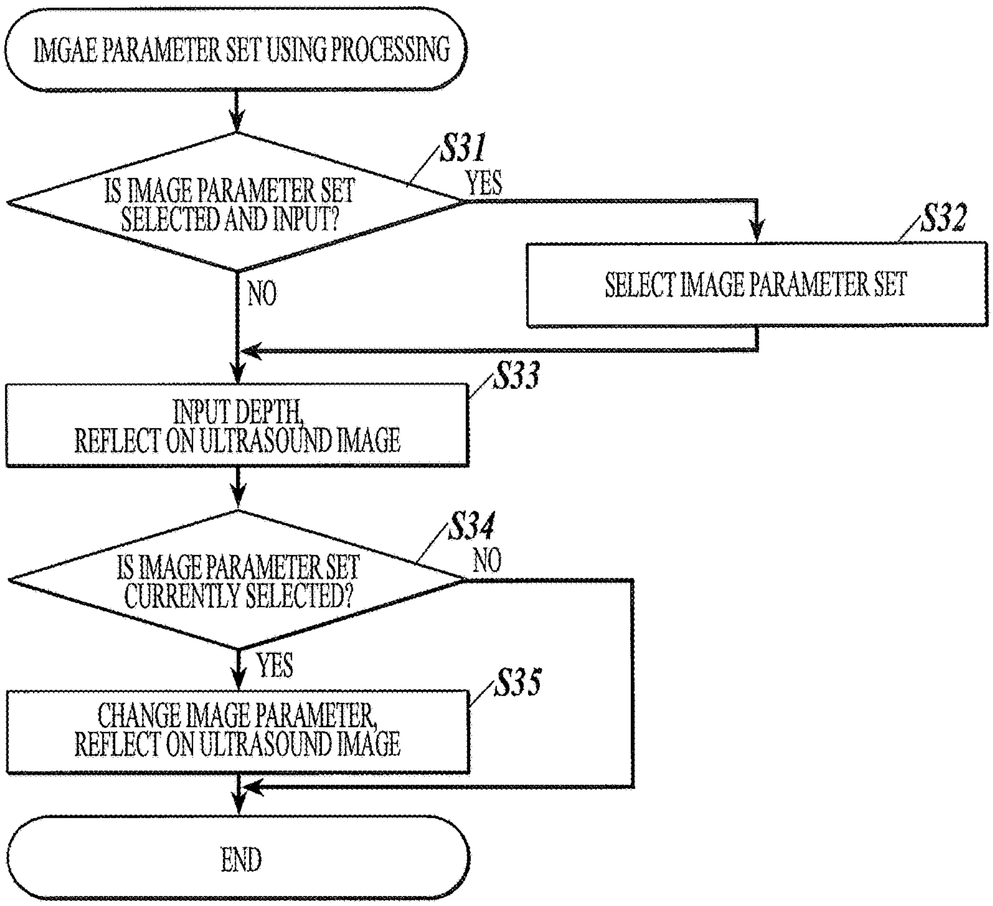

IMGAE PARAMETER SET USING PROCESSING
S31
IS IMAGE PARAMETER SET SELECTED AND INPUT?
YES
NO
S32
SELECT IMAGE PARAMETER SET
S33
INPUT DEPTH, REFLECT ON ULTRASOUND IMAGE
S34
IS IMAGE PARAMETER SET CURRENTLY SELECTED?
NO
YES
S35
CHANGE IMAGE PARAMETER, REFLECT ON ULTRASOUND IMAGE
END

FIG.11

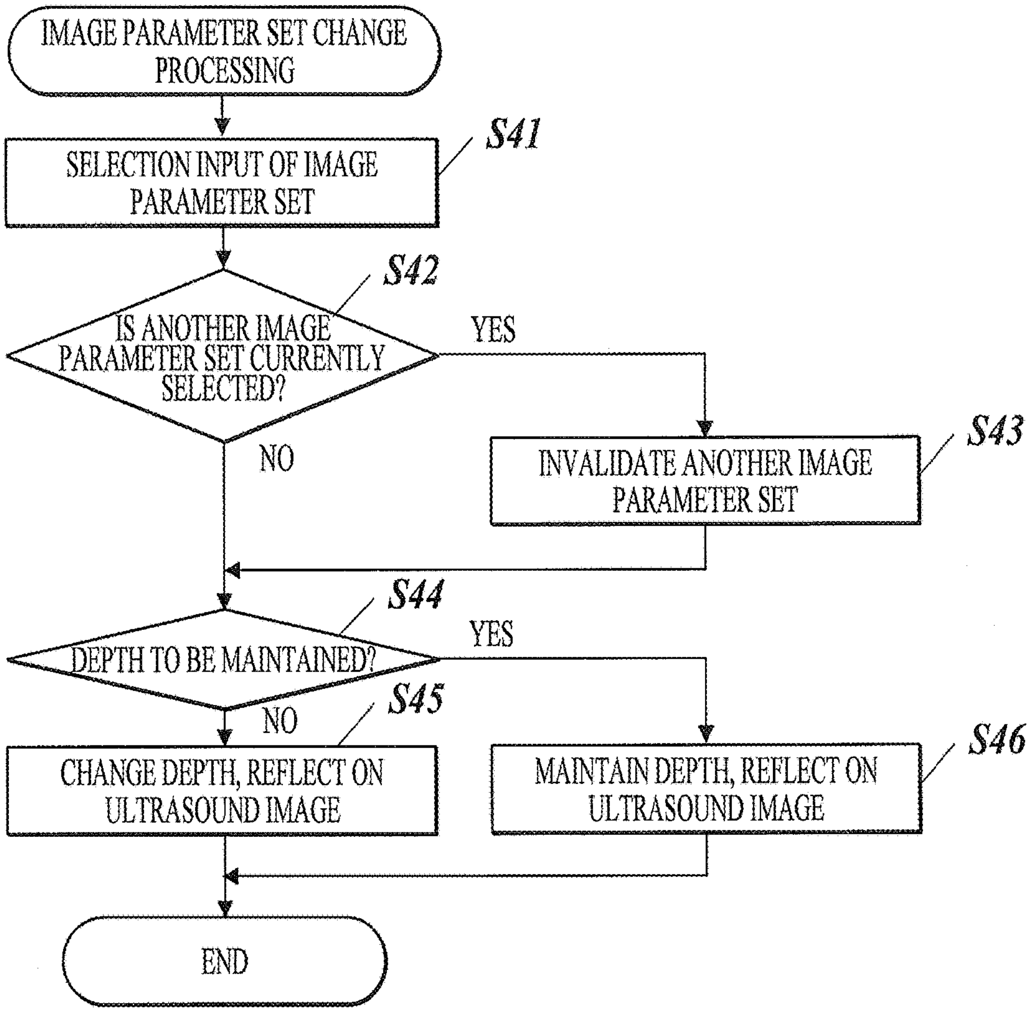


IMAGE PARAMETER SET CHANGE PROCESSING
S41
SELECTION INPUT OF IMAGE PARAMETER SET
S42
IS ANOTHER IMAGE PARAMETER SET CURRENTLY SELECTED?
YES
NO
S43
INVALIDATE ANOTHER IMAGE PARAMETER SET
S44
DEPTH TO BE MAINTAINED?
YES
NO
S45
CHANGE DEPTH, REFLECT ON ULTRASOUND IMAGE
S46
MAINTAIN DEPTH, REFLECT ON ULTRASOUND IMAGE
END

FIG. 12A

2cm

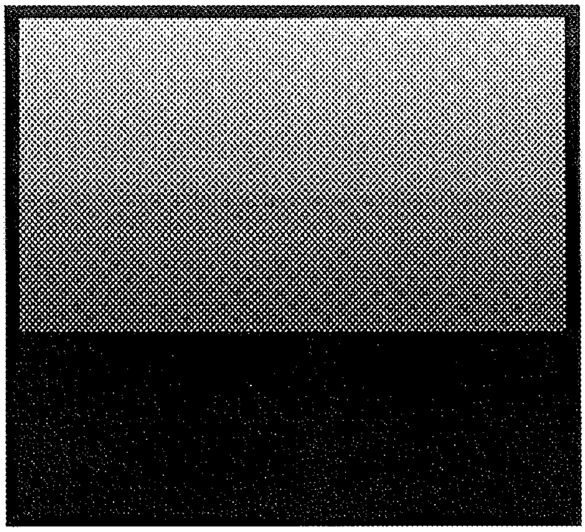


FIG. 12B

4cm

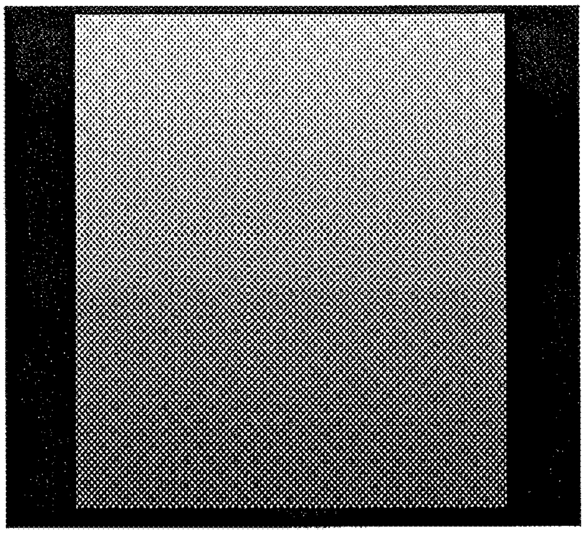


FIG. 12C

7cm

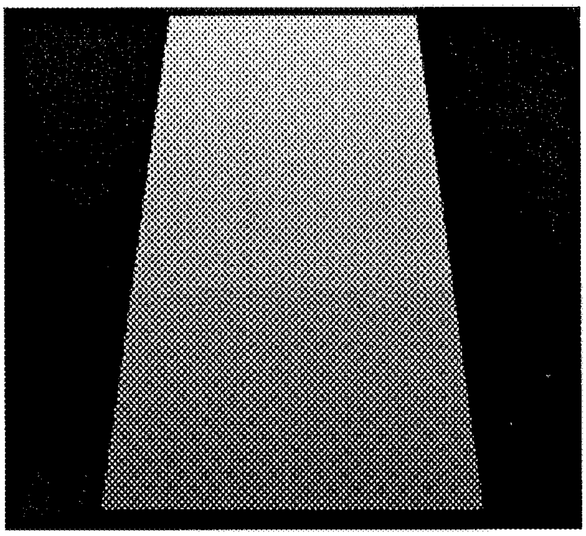


FIG.13A

3cm

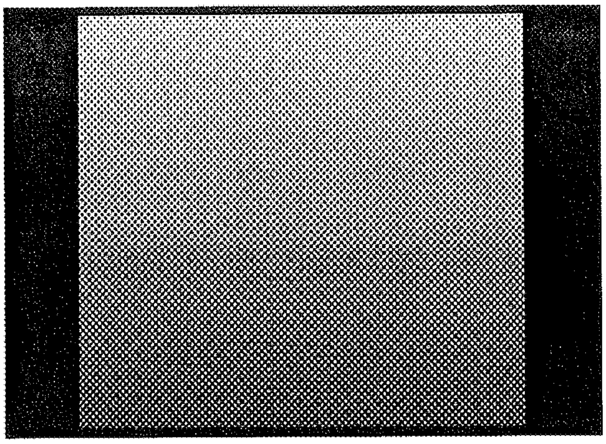


FIG.13B

3cm

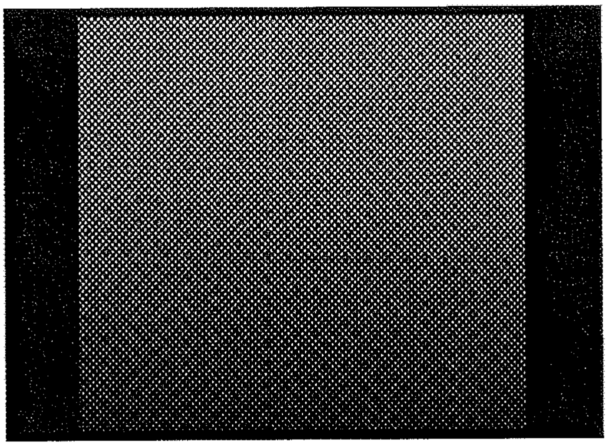
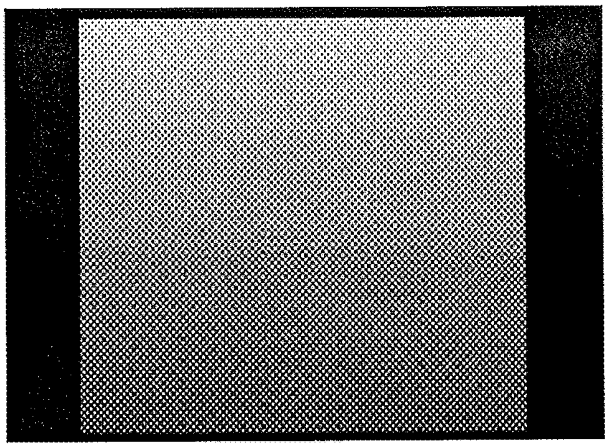


FIG.13C

3cm



ULTRASOUND DIAGNOSTIC DEVICE, IMAGE PARAMETER SETTING METHOD AND STORAGE MEDIUM

BACKGROUND

Cross-Reference to Related Application

[0001] The present application claims priority under 35 U.S.C. § 119 to Japanese Patent Application No. 2017-147649, filed on Jul. 31, 2017 and Japanese Patent Application No. 2018-005313, filed on Jan. 17, 2018, the entire contents of which are incorporated herein by reference.

1. Technological Field

[0002] The present invention relates to an ultrasound diagnostic device, an image parameter setting method and a storage medium.

2. Description of the Related Art

[0003] In ultrasound diagnosis, examination can be performed repeatedly since the heart beat or the movement of a fetus is obtained as an ultrasound image by an easy operation of putting the ultrasound probe against the body surface, and furthermore the patient is safe. There is known an ultrasound diagnostic device which is used for the ultrasound diagnosis and generates and displays the ultrasound image.

[0004] The ultrasound diagnostic device has many image parameters as setting information for generating ultrasound image data. It is possible to obtain good ultrasound image data by setting image parameters according to the depth, the site and the subject.

[0005] For example, there is known an ultrasound diagnostic device which changes the drive frequency of ultrasound waves to be transmitted according to the visual field depth and obtains a diagnostic image having an excellent resolution or a diagnostic image which is easy to see (see Japanese Patent No. 3947647).

[0006] There is also known an ultrasound diagnostic imaging system which forms a spatially-combined image by combining multiple different visual directions, the number of the different visual directions being changeable according to the change in image depth as an operation parameter (see Japanese Patent No. 4694692).

[0007] However, in the above conventional ultrasound diagnostic device and the ultrasound diagnostic imaging system, there has been a problem that, in a case where the depth is changed, changeable parameters are limited, and the brightness balance, contrast and followability are unintentionally changed or deteriorated in some cases due to a partial change in the image parameters and inconsistency with the image parameter which is not changed before and after the depth change. In order to correct them, the operating person needs to change the image parameters, which is a troublesome operation.

SUMMARY

[0008] An object of the present invention is to easily obtain good ultrasound image data according to a plurality of image parameters without the troublesome operation.

[0009] To achieve at least one of the abovementioned objects, according to a first aspect of the present invention, an ultrasound diagnostic device reflecting one aspect of the present invention includes: a transmitter which outputs a drive signal to an ultrasound probe that transmits and receives ultrasound waves; a receiver which obtains a reception signal from the ultrasound probe; a first hardware processor which generates ultrasound image data from the reception signal and performs image processing to the generated ultrasound image data; an operator which receives input of a depth of an ultrasound image to be displayed; and a second hardware processor which obtains a plurality of preset image parameters corresponding to the input depth, and controls the transmitter, the receiver and the first hardware processor to generate the ultrasound image data corresponding to the input depth according to the obtained plurality of image parameters.

[0010] According to a second aspect of the present invention, an image parameter setting method in an ultrasound diagnostic device including: a transmitter which outputs a drive signal to an ultrasound probe that transmits and receives ultrasound waves; a receiver which obtains a reception signal from the ultrasound probe; and a hardware processor which generates ultrasound image data from the reception signal and performs image processing to the generated ultrasound image data, the image parameter setting method reflecting one aspect of the present invention includes: a step of receiving input of a depth of an ultrasound image to be displayed; and a step of obtaining a plurality of preset image parameters corresponding to the input depth, and controlling the transmitter, the receiver and the hardware processor to generate the ultrasound image data corresponding to the input depth according to the obtained plurality of image parameters.

[0011] According to a third aspect of the present invention, a computer readable storage medium reflecting one aspect of the present invention stores a program for causing a computer to function as: a transmitter which outputs a drive signal to an ultrasound probe that transmits and receives ultrasound waves; a receiver which obtains a reception signal from the ultrasound probe; a first hardware processor which generates ultrasound image data from the reception signal and performs image processing to the generated ultrasound image data; an operator which receives input of a depth of an ultrasound image to be displayed; and a second hardware processor which obtains a plurality of preset image parameters corresponding to the input depth, and controls the transmitter, the receiver and the first hardware processor to generate the ultrasound image data corresponding to the input depth according to the obtained plurality of image parameters.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The advantages and features provided by one or more embodiments of the invention will become more fully understood from the detailed description given hereinafter and the appended drawings which are given by way of illustration only, and thus are not intended as a definition of the limits of the present invention, and wherein:

[0013] FIG. **1** is an outer appearance view of an ultrasound diagnostic device in an embodiment of the present invention;

[0014] FIG. **2** is a block diagram showing the functional configuration of the ultrasound diagnostic device;

[0015] FIG. **3** is a view showing an example of an image parameter set group;

[0016] FIG. **4** is a flowchart showing image parameter set creation processing;

[0017] FIG. **5** is a view showing an image parameter set creation screen;

[0018] FIG. **6** is a view showing an image parameter copy window;

[0019] FIG. **7** is a view showing an image parameter set of all shallow copy and all deep copy;

[0020] FIG. **8** is a view showing an image parameter set of one-step shallow copy and one-step deep copy;

[0021] FIG. **9** is a view showing a storage dialog;

[0022] FIG. **10** is a flowchart showing image parameter set using processing;

[0023] FIG. **11** is a flowchart showing image parameter set change processing;

[0024] FIG. **12**A is a view showing a B-mode image of the depth 2 [cm] of a first image parameter set;

[0025] FIG. **12**B is a view showing a B-mode image of the depth 4 [cm] of a first image parameter set;

[0026] FIG. **12**C is a view showing a B-mode image of the depth 7 [cm] of a first image parameter set;

[0027] FIG. **13**A is a view showing a B-mode image of the depth 3 [cm] of a first image parameter set;

[0028] FIG. **13**B is a view showing a B-mode image of the depth 3 [cm] for which the observation site of the first image parameter set is changed; and

[0029] FIG. **13**C is a view showing a B-mode image of the depth 3 [cm] of a second image parameter set.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0030] Hereinafter, one or more embodiments of the present invention will be described in detail with reference to the drawings. However, the scope of the invention is not limited to the disclosed embodiments.

[0031] The embodiment will be described with reference to FIG. **1** to FIG. **13**C. First, the device configuration in the embodiment will be described with reference to FIG. **1** and FIG. **2**. FIG. **1** is an outer appearance view of an ultrasound diagnostic device **1** in the embodiment. FIG. **2** is a block diagram showing the functional configuration of the ultrasound diagnostic device **1**.

[0032] As shown in FIG. **1** and FIG. **2**, the ultrasound diagnostic device **1** in the embodiment includes an ultrasound diagnostic device main body **1***a* and an ultrasound probe **1***b*. The ultrasound probe **1***b* transmits ultrasound waves (transmission ultrasound waves) to a subject such as a living body not shown in the drawings, and receives reflected waves of the ultrasound waves (reflected ultrasound waves) which were reflected in the subject. The ultrasound diagnostic device main body **1***a* is connected to the ultrasound probe **1***b* via a cable **1***c*, causes the ultrasound probe **1***b* to transmit the transmission ultrasound waves to the subject by transmitting drive signals of electrical signals to the ultrasound probe **1***b*, and performs imaging of the internal state of the subject as an ultrasound image on the basis of the reception signals which are electrical signals generated in the ultrasound probe **1***b* according to the reflected ultrasound waves from inside the subject received by the ultrasound probe **1***b*.

[0033] The ultrasound probe **1***b* includes a plurality of oscillators formed of piezoelectric elements, the oscillators being arranged in one-dimensional array in azimuth direction. In the embodiment, for example, there is used the ultrasound probe **1***b* including 192 oscillators. The oscillators may be arranged in two-dimensional array. The number of the oscillators may be arbitrarily set. Though the embodiment adopts an electronic scanning probe of the linear scanning type for the ultrasound probe **1***b*, either of the electronic scanning type or the machine scanning type may be adopted. Any type of the linear scanning type, sector scanning type and convex scanning type may be adopted, and the ultrasound probe **1***b* may be exchanged with a different type of ultrasound probe **1***b*.

[0034] As shown in FIG. **2**, the ultrasound diagnostic device main body **1***a* includes, for example, an operation input section **101** as an operator, a transmitter **102**, a receiver **103**, an image generator **104**, an image processor **105**, a DSC (Digital Scan Converter) **106**, a display **107**, a controller **108** and a storage **109**.

[0035] The operation input section **101** includes, for example, various switches, buttons, a dial, a track ball, a mouse, a keyboard and the like for performing a command by an operating person (doctor, technician or the like) instructing start of diagnosis and for inputting data such as personal information of the subject. The operation input section **101** outputs the operation signal to the controller **108**. The operation input section **101** further includes a touch panel provided on a display screen of the display **107**.

[0036] The transmitter **102** is a circuit which causes the ultrasound probe **1***b* to generate transmission ultrasound waves by supplying drive signals which are electrical signals via the cable **1***c* to the ultrasound probe **1***b* in accordance with control by the controller **108**. The transmitter **102** includes, for example, a clock generation circuit, a delay circuit and a pulse generation circuit. The clock generation circuit is a circuit for generating clock signals for determining the transmission timing of the drive signals and transmission frequency. The delay circuit is a circuit for setting the delay time for each individual path corresponding to the oscillator for the transmission timing of the drive signals and delaying the transmission of the drive signals by the set delay time to focus the transmission beams formed of the transmission ultrasound waves. The pulse generation circuit is a circuit for generating pulse signals as drive signals at predetermined periods. The transmitter **102** formed as descried above generates, for example, transmission ultrasound waves by driving a part of (for example 64) consecutive oscillators among a plurality of (for example, 192) oscillators arranged in the ultrasound probe **1***b*. The transmitter **102** performs scanning by shifting, in the azimuth direction, the oscillators which drive at each generation of the transmission ultrasound waves.

[0037] The receiver **103** is a circuit which receives reception signals which are electrical signals via the cable **1***c* from the ultrasound probe **1***b* in accordance with the control by the controller **108**. The receiver **103** includes, for example, an amplifier, an A/D converting circuit and a phasing addition circuit. The amplifier is a circuit for amplifying the reception signals at a preset amplifying rate for each individual path corresponding to the oscillator. The A/D converting circuit is a circuit for performing A/D conversion of the amplified reception signals. The phasing addition circuit is a circuit for aligning the time phases by providing the delay times for the reception signals subjected to the A/D conversion for the respective individual paths corresponding to the respective oscillators, and adding the aligned time phases (phasing addition) to generate sound ray data.

[0038] The image generator **104** generates B-mode image data by performing envelop detection processing, log compression and the like to the sound ray data from the receiver **103** and adjusting the dynamic range and the gain to perform brightness conversion, in accordance with control by the controller **108**. That is, the B-mode image data represents the strength of the reception signal by brightness. The image generator **104** can generate ultrasound image data of an image mode other than the B-mode. The image generator **104** can generate, for example, ultrasound image data by at least one of a B-mode, an A-mode, an M-mode, a color Doppler mode, a power Doppler mode, a CW (Continuous Wave) mode and an Elastography mode.

[0039] The image processor **105** includes an image memory **105***a* formed of a semiconductor memory such as a DRAM (Dynamic Random Access Memory). In accordance with control by the controller **108**, the image processor **105** can perform various types of image processing to the B-mode image data output from the image generator **104**, and stores B-mode image data which is subjected to or not subjected to the image processing in the image memory **105***a* by the unit of frame. Especially, the image processor **105** performs image processing of providing a gain value by after-mentioned TGC (Time Gain Compensation) of a normal operation, offset TGC, gain of a normal operation and offset gain to B-mode image data output from the image generator **104**. The TGC is a function of correcting and adjusting the amplification degree (gain) of the received ultrasound waves with respect to the time corresponding to the distance at a certain interval. The image data by the unit of frame may be referred to as ultrasound image data or frame image data. The image processor **105** transmits frame image data stored in the image memory **105***a* to the DSC **106** in accordance with control by the controller **108**.

[0040] In accordance with control by the controller **108**, the DSC **106** converts the frame image data received from the image processor **105** into an image signal for the display **107** and outputs the converted signal to the display **107**.

[0041] As the display **107**, there can be applied a display device such as an LCD (Liquid Crystal Display), a CRT (Cathode-Ray Tube) display, an organic EL (Electronic Luminescence) display, an inorganic EL display and plasma display. The display **107** performs display of an image on the display screen in accordance with the image signal output from the DSC **106** in accordance with control by the controller **108**.

[0042] The controller **108** includes, for example, a CPU (Central Processing Unit), a ROM (Read Only Memory) and a RAM (Random Access Memory), reads out various processing programs such as a system program or the like stored in the ROM and loads them onto the RAM, and integrally controls the operations of the sections of the ultrasound diagnostic device **1** in accordance with the loaded programs. The ROM is formed of a nonvolatile memory or the like such as a semiconductor, and stores a system program corresponding to the ultrasound diagnostic device **1**, various processing programs executable on the system program, various types of data and the like such as a gamma table. Especially, the various programs include, for example, an image parameter set creation program for executing image parameter set creation processing, an image parameter set using program for executing the image parameter set using processing, an image parameter set changing program for executing the image parameter set change processing and the like. These programs are stored in a form of computer readable program code, and the CPU sequentially executes the operation according to the program code. The RAM forms a working area for temporarily storing various programs executed by the CPU and data according to these programs.

[0043] The storage **109** is formed of a large-capacity storage medium such as an HDD (Hard Disk Drive), for example, and stores ultrasound image data, an after-mentioned image parameter set group **200**, various types of setting information and the like so as to be linked with patient information.

[0044] Next, with reference to FIG. **3**, the configuration of the image parameter set group **200** stored in the storage **109** will be described. FIG. **3** is a view showing an example of the image parameter set group **200**.

[0045] The image parameter set group **200** has a plurality of image parameter sets as tables for storing setting values of a plurality of image parameters corresponding to a plurality of depths. As shown in FIG. **3**, the image parameter set group **200** has image parameter sets **210**, **220** . . . which are provided by the observation site and the use such as ultrasound diagnosis.

[0046] The image parameter set **210** has a name, tag **1**, tag **2**, tag **3** and maintenance information of the image parameter set. The name, tag **1**, tag **2** and tag **3** function as identification information of the image parameter set **210**. Thus, for example, a same name may be provided to a plurality of image parameter sets, and a different tag may be provided to each image parameter set. Though up to three tags can be registered here, the number of tags is not limited to this. The image parameter set may have an identification number.

[0047] The name is a name of image parameter set, and may be an observation site, for example. The tags may be freely set by an operating person to be the type of the ultrasound probe **1***b* in the ultrasound diagnosis using the image parameter set, the field of the ultrasound diagnosis and the like. The name and tags are also used for keyword search and tag search of the image parameter set.

[0048] The maintenance information is information on whether to maintain the last depth when the image parameter set to be changed is selected in a state in which the image parameter set is not selected or another image parameter set is selected, and information on the depth after change in a case where the depth is not maintained (the depth is changed). The maintenance information is, for example, "On (in a case of maintaining the depth)" and "x ([cm], x: arbitrary depth value (in a case of not maintaining the depth))".

[0049] The image parameter set **210** contains setting values of (transmission) frequency, trapezoidal scanning, sound ray density, dynamic range, time average, screen layout, offset TGC 1 to 8, offset gain and the like as image parameters of the B-mode corresponding to a plurality of depths (for example, 1 to 7 [cm] (1 [cm] interval)). Though not shown in the drawings, the image parameter set **210** has setting values of image parameters corresponding to the plurality of depths (for example, 1 to 7 [cm]) also for other modes such as an M-mode.

[0050] The (transmission) frequency is the frequency [MHz] of the transmission ultrasound waves. The trapezoidal scanning is information indicating whether to perform trapezoidal scanning of generating trapezoidal B-mode image data by changing the angle of the sound ray of each oscillator using the linear ultrasound probe **1***b*. The sound ray density is information indicating the density of sound ray of the transmission ultrasound waves emitted from the ultrasound probe **1***b*.

[0051] The dynamic range is information indicating the dB amount to be assigned to the brightness tone of generated image data among the brightness of sound ray data exceeding 100 dB. The time average is the amount indicating the number of temporal consecutive frames of B-mode image (each pixel value) to have arithmetic average or weighting average in the live B-mode image. The time average in the embodiment is represented as strong, medium and weak. The screen layout is information indicating whether to perform vertical display or horizontal display in a case of double-screen display.

[0052] The offset TGC 1 to 8 is information indicating the gain value (brightness value) [dB] to be added to each area as offset which is the correction value to the time corresponding to the distance of each area that is obtained by dividing the B-mode image into eight areas in the depth direction. For example, in the embodiment, the TGC by a normal operation and the offset TGC is a same area. The number of areas of offset TGC and normal TGC is not limited to eight. In a case where the TGC of normal operation is done to increase or decrease the brightness value of each area of the displayed B-mode image by input of the operating person, if the offset TGC is valid, the brightness value of normal TGC+offset TGC is added to each pixel value of each corresponding area of the B-mode image.

[0053] The offset gain is information indicating the gain value (brightness value) [dB] to be added as offset to the entire area of the B-mode image. In a case where gain adjustment of normal operation is done to increase or decrease the brightness value of each area of the displayed B-mode image by input of normal gain by the operating person, if the offset gain is valid, normal gain adjustment value+offset gain brightness value are added to each pixel value of the entire area of the B-mode image.

[0054] In the image parameter set **210**, the setting value of trapezoidal scanning of image parameter is invalid (off) when the depth is shallow, and the setting value is valid (on) when the depth is deep. The setting value of trapezoidal scanning of image parameter may be configured so that the angle of sound ray is small when the depth is shallow and the angle of sound ray is large when the depth is deep.

[0055] In the image parameter set **210**, the setting value of sound ray density of image parameter is high when the depth is shallow and the setting value is low when the depth is deep. In the image parameter set **210**, the setting value of time average of image parameter is strong when the depth is shallow and the setting value is weak when the depth is deep.

[0056] In the image parameter set **210**, the setting value of dynamic range of image parameter is high when the depth is shallow and the setting value is low when the depth is deep. In the image parameter set **210**, the setting value of screen layout of the image parameter is vertical when the depth is shallow and the setting value is horizontal when the depth is deep.

[0057] In the image parameter set **210**, the trapezoidal scanning is valid when the depth is deep. When the trapezoidal scanning is valid, image quality is lowered since the sound ray interval is broadened in the deep part. In order to complement this, the sound ray density is made high in the deep part. However, when the sound ray density is made high, the frame rate is lowered and followability is lowered, and thus, the time average is made weak in the deep part. By making the depth deep and the time average weak, SNR (signal noise ratio) is lowered, and thus, the dynamic range is lowered. In accordance with this, the gain (offset TGC and offset gain) is changed. In such a way, in the image parameter set **210**, image parameters are set so that good ultrasound image data is obtained by mutual cooperation of setting information of a plurality of image parameters.

[0058] The image parameters of B-mode of the image parameter set **210** are not limited to these, and may be other image parameters such as transmission waveform, transmission opening, transmission focus, reception frequency, image processing and signal processing. The transmission waveform is a drive signal waveform, for example. The transmission opening is the number of channels of oscillator of the transmission opening of the ultrasound probe **1***b*. The transmission focus is the focusing distance of the ultrasound probe **1***b*. The reception frequency is the frequency [MHz] of the reception ultrasound waves (reflected ultrasound waves, echoes). The image processing is information on image processing of edge enhancement and strengthening or weakening the smoothing, for example. The signal processing is information on signal processing such as characteristic coefficient of the dynamic filter, for example.

[0059] The image parameter sets **220** . . . have setting values of a plurality of image parameters corresponding to a plurality of depths for a plurality of image modes such as the B-mode and the M-mode similarly to the image parameter set **210**.

[0060] Especially, the "sound ray density", the "time average" and the like are used as image parameters not only in the B-mode but also in the color Doppler mode, power Doppler mode and elastography mode. Thus, in the color Doppler mode, power Doppler mode and elastography mode, the setting information such as "sound ray density" and "time average" is set, and stored in the image parameter set of the image mode. The image parameters such as "sound ray density" and "time average" have the action and effect similar to those of the B-mode also in the color Doppler mode, power Doppler mode and elastography mode.

[0061] As an image parameter of the image mode other than the B-mode, the "repeat transmission number" is used in the color Doppler mode. Thus, in the color Doppler mode, the setting information of "repeat transmission number" is set and stored in the image parameter set of the color Doppler mode. Specifically, the sensitivity is improved by increasing the setting value of "repeat transmission number" when the depth is shallow, and the frame rate is secured by decreasing the setting value of "repeat transmission number" when the depth is deep.

[0062] Next, with reference to FIG. **4** to FIG. **13**C, the operation of the ultrasound diagnostic device **1** will be described. FIG. **4** is a flowchart showing image parameter set creation processing. FIG. **5** is a view showing an image parameter set creation screen **300**. FIG. **6** is a view showing an image parameter copy window **400**. FIG. **7** is a view showing an image parameter set **210** of all shallow copy and all deep copy. FIG. **8** is a view showing an image parameter set **210** of one-step shallow copy and one-step deep copy. FIG. **9** is a view showing a storage dialog **500**. FIG. **10** is a flowchart showing image parameter set using processing. FIG. **11** is a flowchart showing image parameter set change processing. FIG. **12**A is a view showing a B-mode image of the depth 2 [cm] of the image parameter set **210**. FIG. **12**B is a view showing a B-mode image of the depth 4 [cm] of the image parameter set **210**. FIG. **12**C is a view showing a B-mode image of the depth 7 [cm] of the image parameter set **210**. FIG. **13**A is a view showing a B-mode image of the depth 3 [cm] of the image parameter set **210**. FIG. **13**B is a view showing a B-mode image of the depth 3 [cm] for which the observation site of the image parameter set **210** is changed. FIG. **13**C is a view showing a B-mode image of the depth 3 [cm] of the image parameter set **220**.

[0063] First, with reference to FIG. **4**, the image parameter set creation processing executed in the ultrasound diagnostic device **1** will be described. The image parameter set creation processing is processing of newly creating or changing the image parameter set and storing the image parameter set while the operating person such as a doctor is checking the display contents of the image parameter set in the live ultrasound image (live image). A technician or the like as a subject lies on a bed in advance in the examination room provided with the ultrasound diagnostic device **1**.

[0064] In the ultrasound diagnostic device **1**, according to the input of live image display instruction to display the live ultrasound image (live image) in an arbitrary image mode (for example, B-mode) from the operating person via the operation input section **101**, the controller **108** causes the transmitter **102** to output the drive signal for live image display to the ultrasound probe **1***b* put on the subject to emit the transmission ultrasound waves, causes the receiver **103** to receive the reception signal corresponding to the reflected ultrasound waves (echoes) from the ultrasound probe **1***b* to cause the image generator **104** to generate ultrasound image data, causes the image processor **105** to perform image processing, and causes the display **107** to display the ultrasound image of the live image of the subject via the DSC **106**. At this time, in the ultrasound diagnostic device **1**, by executing after-mentioned image parameter set using processing or image parameter set change processing, the operating person may select and input the image parameter set of a desired image mode among the image parameter set group **200** so as to display the live image corresponding to the selected image parameter set.

[0065] In the ultrasound diagnostic device **1**, for example, in response to the trigger that the operating person inputs the desired image mode (for example, B-mode) and execution instruction of the image parameter set creation processing via the operation input section **101**, the controller **108** executes the image parameter set creation processing in accordance with the image parameter set creation program stored in the ROM.

[0066] As shown in FIG. **4**, first, the controller **108** causes the display **107** to display the image parameter set creation screen of the desired image mode which is instructed and input (step S**11**). In step S**11**, for example, the image parameter set creation screen **300** of B-mode shown in FIG. **5** is displayed. The image parameter set creation screen **300** has a live image display area **310** and an image parameter input area **320**. The live image display area **310** is a display area of the live image. The image parameter input area **320** is the input area of the setting values of a plurality of image parameters. The image parameter input area **320** has, for example, an image parameter value display area **321** to display the setting value and a value input button **322** to receive the input of setting value for each of the plurality of image parameters.

[0067] The controller **108** determines whether the image parameter set is currently selected by the operating person's input before the image parameter set creation processing (step S**12**). If the image parameter set is not currently selected (step S**12**: NO), as the new image parameter set creation, the controller **108** receives input of a new depth and setting values of a plurality of image parameters in the desired image mode corresponding to the depth via the operation input section **101** and reflects input information (depth, setting values of image parameters in the image mode) on the live image which is currently displayed (step S**13**). For example, on the image parameter set creation screen **300**, the depth is changed by dial input of the operation input section **101**, and each time the value input button **322** is touched and input, the controller **108** appropriately controls the transmitter **102**, the receiver **103**, the image generator **104**, the image processor **105** and the like according to the input depth and image parameters, to display the live image corresponding to the input depth and the image parameters in the live image display area **310**.

[0068] The controller **108** retains the depth and the plurality of image parameters input in step S**13** according to the retention input from the operating person via the operation input section **101** (step S**14**). The controller **108** determines whether the operating person inputs an image parameter of any other depth via the operation input section **101** (step S**15**). If there is input of an image parameter of any other depth (step S**15**: YES), the processing proceeds to step S**13**.

[0069] If the image parameter set is currently selected (step S**12**: YES), as image parameter set change, the controller **108** reads out the currently-selected image parameter set of the desired image mode from the storage **109** via the operation input section **101**, receives input of the depth to be changed in the image parameter set which is currently selected and setting values of a plurality of image parameters in the desired image mode corresponding to the depth, and reflects the input information (depth, setting values of image parameters in the image mode) on the live image which is currently displayed (step S**16**). For example, on the image parameter set creation screen **300**, the depth is changed by dial input of the operation input section **101**, and the setting value of each of the image parameters in the image parameter set which is currently selected is displayed in the image parameter value display area **321**, and each time the value input button **322** is touched and input, the controller **108** displays the live image corresponding to the input depth and the image parameter in the live image display area **310** similarly to step S**13**.

[0070] The controller **108** retains the depth input in step S**13** and the plurality of image parameters according to the retention input from the operating person via the operation input section **101** (step S**17**). The controller **108** determines whether there is input of an image parameter of any other depth in the image parameter set which is currently selected from the operating person via the operation input section **101** (step S**18**). If there is input of image parameter of other depth (step S**18**: YES), the processing proceeds to step S**16**.

[0071] Though the setting values of the plurality of image parameters are input for each depth in steps S**16** to S**18**, there is a case where a same setting value is set to a plurality of image parameters at different depths. Thus, in step S**16**, the image parameter copy window **400** shown in FIG. **6** may be displayed on the display **107** so that a same setting value is copied to the plurality of image parameters at different depths.

[0072] The image parameter copy window **400** has an all shallow copy button **410**, an all deep copy button **420**, a one-step shallow copy button **430**, a one-step deep copy button **440**, a storage button **450**, an end button **460** and a setting check button **470**.

[0073] The all shallow copy button **410** is a button for receiving execution input to copy the setting values of the plurality of image parameters at the currently-selected depth to the setting values of the plurality of image parameters at all the depths which are shallower than the currently-selected depth. For example, in the image parameter set **210** in FIG. **3**, when the all shallow copy button **410** is touch-input while the depth 3 [cm] is selected, as shown in FIG. **7**, the setting values of the plurality of image parameters at the depth 3 [cm] are retained so as to be copied to the setting values of the plurality of image parameters at the depths 1 and 2 [cm] which are shallower than 3 [cm].

[0074] The all deep copy button **420** is a button for receiving execution input to copy the setting values of the plurality of image parameters at the currently-selected depth to the setting values of the plurality of image parameters at all the depths which are deeper than the currently-selected depth. For example, in the image parameter set **210** in FIG. **3**, when the all shallow copy button **410** is touch-input while the depth 4 [cm] is selected, as shown in FIG. **7**, the setting values of the plurality of image parameters at the depth 4 [cm] are retained so as to be copied to the setting values of the plurality of image parameters at the depths 5, 6 and 7 [cm] which are deeper than 4 [cm].

[0075] The one-step shallow copy button **430** is a button for receiving execution input to copy the setting values of the plurality of image parameters at the depth which is one-step shallower than the currently-selected depth to the setting values of the plurality of image parameters at the currently-selected depth. For example, in the image parameter set **210** in FIG. **3**, when the one-step shallow copy button **430** is touch-input while the depth 3 [cm] is selected, as shown in FIG. **8**, the setting values of the plurality of image parameters at the depth 2 [cm] which is one-step shallower than the depth 3 [cm] are retained so as to be copied to the setting values of the plurality of image parameters at the depth 3 [cm].

[0076] The one-step deep copy button **440** is a button for receiving execution input to copy the setting values of the plurality of image parameters at the depth which is one-step deeper than the currently-selected depth to the setting values of the plurality of image parameters at the currently-selected depth. For example, in the image parameter set **210** in FIG. **3**, when the one-step deep copy button **440** is touch-input while the depth 4 [cm] is selected, as shown in FIG. **8**, the setting values of the plurality of image parameters at the depth 5 [cm] which is one-step deeper than the depth 4 [cm] are retained so as to be copied to the setting values of the plurality of image parameters at the depth 4 [cm].

[0077] The storage button **450** is a button for receiving execution input of storage of the input image parameter set. The end button **460** is a button for receiving execution input of end of the image parameter set creation processing. The setting check button **470** is a button for receiving execution input of display of the image parameter retained in step S17 to the display **107** for check.

[0078] In step S**16**, the controller **108** may cause the display **107** to display the table of the image parameter set which is currently selected so as to receive change input of the setting values of the image parameters in the table of the image parameter set which is displayed. Similarly, in step S13, the operating person may input setting values of the image parameters via the operation input section **101** in the table of the image parameter set displayed on the display **107**.

[0079] Returning to FIG. **4**, if there is no input of image parameter at any other depth (step S**15**: NO) or (step S**18**: NO), the controller **108** determines whether the operating person inputs execution of storage via the operation input section **101** (step S**19**). In step S**19** after step S**18**, for example, the above determination is made by whether the storage button **450** is touch-input or not. If the execution of storage is not input (step S**19**: NO), the image parameter set creation processing ends.

[0080] If execution of storage is input (step S**19**: YES), the controller **108** receives input of the name, tags and maintenance information of the image parameter set to be newly created or changed from the operating person via the operation input section **101** (step S20). In step S20, for example, the storage dialog **500** shown in FIG. **9** is displayed, and the input is performed via the storage dialog **500**. The storage dialog **500** has a name input field **510**, tag input fields **530**, **540** and **550**, a maintenance information input field **560**, an OK button **570** and a cancel button **580**.

[0081] The name input field **510** is an input field of the name of image parameter set to be newly created or changed. The tag input fields **530**, **540** and **550** are input field of tags **1**, **2** and **3** of the image parameter set to be newly created or changed. The maintenance information input field **560** is an input field including radio buttons for receiving input of whether to maintain the last depth and the depth after change in a case of not maintaining (that is, changing) the depth at the time of newly selecting the image parameter set to be newly created or changed. In a case of proceeding through step S16, the name, tags **1**, **2** and **3** and maintenance information of the currently-selected image parameter set read out in step S**16** are displayed as default so as to be able to be changed and input in the name input field **510**, the tag input fields **530**, **540** and **550** and maintenance input field **560**.

[0082] The OK button **570** is a button for receiving execution input of storage and overwriting of input information in the name input field **510**, the tag input fields **530**, **540** and **550** and the maintenance information input field **560**. The cancel button **580** is a button for receiving execution input of cancellation of input (storage) in the name input field **510**, the tag input fields **530**, **540** and **550** and the maintenance information input field **560**.

[0083] The controller **108** stores the image parameter set which includes a plurality of image parameters at a plurality of depths retained in step S14 or S17 in the storage **109** so as to be associated with the name, tags **1**, **2** and **3** and the maintenance information input in step S**20** (step S**21**), and ends the image parameter set creation processing. In step S**21**, the stored image parameter set may be displayed on the display **107**.

[0084] In steps S16 to 18 in the image parameter set creation processing, the operating person may specify (specify by input via the operation input section **101**) the image parameter to be changed or to be maintained (not changed) in the image parameter set which is currently selected, and input and change only the setting information of the image parameter to be changed.

[0085] Next, with reference to FIG. **10**, the image parameter set using processing executed in the ultrasound diagnostic device **1** will be described. The image parameter set using processing is processing of selecting the image parameter set from the image parameter set group **200** and reflecting the selected image parameter set in the live image. A patient as the subject lies on a bed in advance in the examination room provided with the ultrasound diagnostic device **1**.

[0086] Similarly to the image parameter set creation processing, in the ultrasound diagnostic device **1**, the live image of a desired image mode (for example, B-mode) which is input is generated and displayed on the display **107** according to the input from the operating person via the operation input section **101**.

[0087] In the ultrasound diagnostic device **1**, for example, in response to a trigger that the operating person inputs the desired image mode and execution instruction of image parameter set using processing via the operation input section **101**, the controller **108** executes the image parameter set using processing in accordance with the image parameter set using program stored in the ROM.

[0088] As shown in FIG. **10**, first, the controller **108** receives the selection input of the image parameter set of the image mode which is instructed and input from the operating person via the operation input section **101**, and determines whether the image parameter set is selected and input (step S**31**). In step S**31**, for example, the controller **108** displays the search screen of the image parameter set on the display **107**, receives input of the image mode, the keyword of name and tags of the image parameter set from the operating person via the operation input section **101**, searches in the image parameter set group **200** of the storage **109** with the input image mode, keyword and tags, displays the image parameter sets as the search results, and receives the selection input of one image parameter set among the search results from the operating person. In step S**31**, the operation input section **101** may receive selection of one image parameter set via physical keys or buttons (displayed buttons) of the touch panel to which a plurality of image parameter sets are assigned.

[0089] If the image parameter set is selected and input (step S**31**: YES), the controller **108** selects (sets) the image parameter set which was selected and input in step S**31** (step S**32**). After step S**32**, or if the image parameter set is not selected and input (step S**31**: NO), the controller **108** receives input of the depth from the operating person via the operation input section **101**, according to the input depth, appropriately controls the transmitter **102**, the receiver **103**, the image generator **104**, the image processor **105** and the like to display the live image on the display **107** corresponding to the input depth of the image mode which was instructed and input (step S**33**).

[0090] The controller **108** determines whether the image parameter set is currently selected (valid) in step S**32** (step S**34**). If the image parameter set is not currently selected (step S**34**: NO), the image parameter set using processing ends. If the image parameter set is currently selected (step S**34**: YES), according to the depth input in step S**33** and the image parameter set selected in step S**32**, the controller **108** appropriately controls the transmitter **102**, the receiver **103**, the image generator **104**, the image processor **105** and the like to cause the display **107** to display the live image corresponding to the input depth and the image parameters of the image mode which was instructed and input (step S**35**), and ends the image parameter set using processing.

[0091] Next, with reference to FIG. **11**, the image parameter set change processing executed in the ultrasound diagnostic device **1** will be described. The image parameter set change processing is processing of changing the image parameter set selected from the image parameter set group **200** and reflecting it on the live image. The image parameter set using processing (or image parameter set change processing) of the desired image mode is executed in advance.

[0092] In the ultrasound diagnostic device **1**, for example, in response to a trigger that the operating person inputs the execution instruction of image parameter set change processing of the desired image mode via the operation input section **101**, the controller **108** executes the image parameter set change processing in accordance with the image parameter set changing program stored in the ROM.

[0093] As shown in FIG. **11**, first, similarly to step S**31** in FIG. **10**, the controller **108** receives the selection input of the image parameter set of the image mode which is instructed and input from the operating person via the operation input section **101**, and selects the image parameter set which is selected and input (step S**41**). The controller **108** determines whether another image parameter set has been selected immediate before step S**41** (step S**42**). If another image parameter set has been selected (step S**42**: YES), the controller **108** invalidate the another image parameter set which has been selected (step S**43**).

[0094] If another image parameter set has not been selected (step S**42**: NO) or after execution of step S**43**, the controller **108** refers to maintenance information of the image parameter set selected in step S**41**, and determines whether to maintain the depth (step S**44**). If the depth is not maintained (step S**44**: NO), according to the depth of maintenance information referred to in step S**44** and the image parameter set which is currently selected, the controller **108** appropriately controls the transmitter **102**, the receiver **103**, the image generator **104**, the image processor **105** and the like to cause the display **107** to display the live image corresponding to the depth and the image parameter of the image mode which was instructed and input (step S**45**), and ends the image parameter set change processing.

[0095] If the depth is maintained (step S**44**: YES), according to the depth which was selected immediately before in the another image parameter set and the image parameter set which is currently selected, the controller **108** appropriately controls the transmitter **102**, the receiver **103**, the image generator **104**, the image processor **105** and the like to cause the display **107** to display the live image corresponding to the depth and the image parameter which is currently selected of the image mode which was instructed and input (step S**46**), and ends the image parameter set change processing.

[0096] Here, the description will be made for an example in which the image parameter set using processing is repeatedly executed so that the live image of the B-mode image is displayed, the image parameter set **210** is selected, and the depth is changed while using the image parameter set **210**. In the first image parameter set using processing, when the image parameter set **210** is selected in step S**32** and the depth 2 [cm] is input in step S**33**, for example, in step S**35**, a rectangular B-mode image at the depth 2 [cm] shown in FIG. **12**A is displayed.

[0097] In the second image parameter set using processing, when the selection input is not performed in step S**32** (same image parameter set **210** is used) and the depth 4 [cm] is input in step S**33**, for example, a rectangular B-mode image at the depth 4 [cm] shown in FIG. **12**B is displayed in step S**35**.

[0098] In the third image parameter set using processing, when the selection input is not performed in step S**32** (same image parameter set **210** is used) and the depth 7 [cm] is input in step S**33**, for example, a trapezoidal B-mode image at the depth 7 [cm] shown in FIG. **12**C is displayed in step S**35**.

[0099] Here, the description will be made for an example in which the image parameter set using processing and the image parameter set change processing are executed so that the live image of the B-mode image is displayed, the image parameter set **210** is changed to the image parameter set **220**, and the depth is maintained. In the image parameter set using processing, when the image parameter set **210** is selected in step S**32** and the depth 3 [cm] is input in step S**33**, for example, in step S**35**, a rectangular B-mode image at the depth 3 [cm] shown in FIG. **13**A is displayed.

[0100] In a case where the ultrasound probe **1***b* is moved in order to change the observation site, for example, the rectangular B-mode image at the depth 3 [cm] shown in FIG. **13**B is displayed. However, the B-mode image in FIG. **13**B is highly attenuation image, and thus, it cannot be observed. Thus, the image parameter set change processing is executed, the image parameter set **220** is input in step S**41**, and when the depth 3 [cm] is maintained in step S**44**, for example, in step S**46**, the rectangular B-mode image at the depth 3 [cm] shown in FIG. **13**C is displayed, leading to the B-mode image with attenuation corresponding to the observation site. Here, the image parameter set **220** corresponds to the observation site after change and the maintenance information is On.

[0101] As described above, according to the embodiment, the ultrasound diagnostic device **1** includes: a transmitter **102** which outputs a drive signal to an ultrasound probe **1***b* transmitting and receiving ultrasound waves; a receiver **103** which obtains a reception signal from the ultrasound probe **1***b*; an image generator **104** which generates ultrasound image data from the reception signal; an image processor **105** which performs image processing to the generated ultrasound image data; an operation input section **101** which receives input of a depth of the ultrasound image to be displayed; and a controller **108** which obtains a plurality of image parameters which is set in advance corresponding to the input depth, and, according to the obtained plurality of image parameters, controls the transmitter **102**, the receiver **103**, the image generator **104** and the image processor **105** to generate the ultrasound image data corresponding to the input depth.

[0102] Thus, it is possible to change a plurality of image parameters according to the change of depth, and easily obtain good ultrasound image data corresponding to the plurality of image parameters without troublesome operation.

[0103] The plurality of image parameters is image parameters corresponding to at least one image mode among a B-mode, an M-mode, a color Doppler mode, a power Doppler mode, a CW mode and an Elastography mode. Thus, it is possible to change the plurality of image parameters according to the change in depth for various image modes.

[0104] The controller **108** obtains a plurality of image parameters corresponding to the input depth from the image parameter sets **210**, **220** . . . which are tables having a plurality of preset image parameters corresponding to a plurality of depths stored in the storage **109**. Thus, by using the image parameter sets, it is possible to easily control image parameters and improve visibility in checking the setting values of the respective image parameters for each depth.

[0105] The storage **109** stores a plurality of types of image parameter sets **210**, **220** . . . (image parameter set group **200**). The operation input section **101** receives input of the depth of the ultrasound image data to be generated and selection input of one image parameter set from the plurality of types of image parameter sets. The controller **108** obtains the plurality of image parameters corresponding to the input depth from the image parameter set which was selected and input. Thus, it is possible to apply the optimum image parameters corresponding to the condition such as the type of the ultrasound probe **1***b*, the site and the subject to the ultrasound image data.

[0106] The operation input section **101** receives selection of one image parameter set via physical keys or buttons (displayed buttons) of a touch panel to which a plurality of image parameter sets are assigned. Thus, it is possible to simply select and switch the image parameter set.

[0107] When a selection input of changing the image parameter set is performed by the operation input section **101**, the controller **108** maintains the depth before selection input according to the maintenance information, and obtains a plurality of image parameters corresponding to the depth before the selection input in the image parameter set which was selected and input. Thus, only the image parameters are changed, and it is not necessary to perform setting again due to the depth becoming an unintended value.

[0108] The operation input section **101** receives input of setting values of a plurality of image parameters for each depth of the image parameter set. The controller **108** stores the image parameter set corresponding to the setting values of the plurality of image parameters for each input depth in the storage **109**. Thus, the operating person can freely customize the image parameter set and obtain ultrasound image data corresponding to the operating person's preference.

[0109] According to the setting values of a plurality of image parameters of the input depth, the controller **108** controls the transmitter **102**, the receiver **103**, the image generator **104** and the image processor **105** to generate the ultrasound image data corresponding to the input depth and cause the display **107** to display the generated data. Thus, it is possible to freely customize the image parameter set while visually checking whether a desired ultrasound image is obtained.

[0110] One of the plurality of image parameters is trapezoidal scanning, and the setting value is set in the image parameter set so that the trapezoidal scanning is invalid or the angle is small when the depth is shallow, and the trapezoidal scanning is valid or the angle is large when the depth is deep. When the depth is shallow, the area is located out of the display area even if the trapezoidal scanning is performed, and the effect of view expansion cannot be obtained. Thus, the image quality can be improved by invalidating the trapezoidal scanning or reducing the angle and increasing the density between the scanning lines. On the other hand, when the depth is deep, it is possible to improve the effect of view expansion by validating the trapezoidal scanning or increasing the angle and having the expanded view area by the trapezoidal scanning within the display area.

[0111] One of the plurality of image parameters is a sound ray density, and the setting value is set to the image parameter set so that the sound ray density is high when the depth is shallow and the sound ray density is low when the depth is deep. When the sound ray density becomes higher, the frame rate is lowered though the image quality is high. When the sound ray density becomes lower, the frame rate is improved though the image quality is lowered. The frame rate is improved when the depth is shallow, and the frame rate is lowered when the depth is deep. This leads to a good solution to these trade-off relationships.

[0112] One of the plurality of image parameters is a time average, and the setting value is set to the image parameter set so that the time average is strong when the depth is shallow and the time average is weak when the depth is deep. When the depth is shallow, the frame rate is improved and followability is improved. When the depth is deep, the frame rate is lowered and followability is lowered. The followability is lowered when the time average becomes stronger, and the followability is improved when the time average becomes weaker. This leads to a good solution to these trade-off relationships.

[0113] One of the plurality of image parameters is a dynamic range, and the setting value is set to the image parameter set so that the dynamic range is high when the depth is shallow and the dynamic range is low when the depth is deep. The SNR is high at the shallow part of the ultrasound image, and the SNR is low at the deep part of the ultrasound image. Thus, it is possible to make the dynamic range higher in order to display from a strong signal to a weak signal when the SNR is high, and it is possible to make the dynamic range lower in order to display a weak signal with a high brightness when the SNR is low.

[0114] One of the plurality of image parameters is a screen layout setting in double-screen display, and the setting value is set to the image parameter set so that the screen layout setting is vertical when the depth is shallow and the screen layout is horizontal when the depth is deep. The ultrasound image is horizontally long when the depth is shallow, and the ultrasound image is vertically long when the depth is deep. Thus, it is possible to use vertical screen layout in the direction of the horizontally long ultrasound image when the depth is shallow, and use horizontal screen layout in the direction of the vertically long ultrasound image when the depth is deep.

[0115] One of the plurality of image parameters is offset TGC. The controller **108** causes the image processor **105** to provide the addition value of the gain of offset TGC of input depth and the gain of normal TGC to the ultrasound image data corresponding to the input depth. Thus, it is possible to correct ununiformity in image brightness changing in the depth direction by the offset TGC while maintaining conventional use of TGC of normal operation.

[0116] One of the plurality of image parameters is offset gain. The controller **108** causes the image processor **105** to provide the addition value of the offset gain of input depth and the gain by normal operation to the ultrasound image data corresponding to the input depth. Thus, it is possible to suppress the depth change and the brightness change by the image parameter set while maintaining conventional use of gain at the time of normal operation.

[0117] The description in the above embodiment is an example of an ultrasound diagnostic device, an image parameter setting method and a storage medium which are preferred according to the present invention, and the present invention is not limited to this example.

[0118] For example, though the image parameter set group **200** is stored in the storage **109** of the ultrasound diagnostic device **1** in the embodiment, the present invention is not limited to this. For example, the ultrasound diagnostic device **1** may include a reading/writing section of an external media such as a USB (Universal Serial Bus) memory and an SD (Secure Digital) card so that the image parameter set group **200** can be stored in the external media. The external media storing the image parameter set group **200** is connected to another ultrasound diagnostic device, and the image parameter set group **200** is copied to the storage of the another ultrasound diagnostic device to be used.

[0119] When the image parameter set to be used in the image parameter set group **200** is not selected, the plurality of image parameters may reflect preset setting values in the ultrasound image. The preset values are information group having setting values of a plurality of image parameters (including the depth in this case), body mark information and text information for each image mode such as the B-mode and a shared image mode.

[0120] At the same time as predetermined preset selection, it may be set whether to validate a predetermine image parameter set.

[0121] In the configuration of displaying a table of the image parameter set, a difference between setting values may be emphasized by coloring or the like when there is a difference which is a predetermined threshold or more between a setting value of an image parameter at one depth and a setting value of an image parameter at a depth next to the one depth (for example, the depth which is one-step shallower or deeper than the one depth).

[0122] Though the image parameter set is in a form of table in the embodiment, the present invention is not limited to this. The image parameter set may be anything as long as the setting value of the image parameter can be changed for each depth, and the image parameter set may be a function of the image parameter to which the depth is input. Furthermore, there may be a plurality of functions for a same image parameter.

[0123] The image parameter set includes setting values of a plurality of image parameters of a plurality of image modes. When a part of one image parameter set is copied to create another image parameter set, setting values of a plurality of image parameters of image modes which are a part of the one image parameter set may be copied to the another image parameter set.

[0124] Though the description has been made for creation, use and change of the image parameter set which is other than the depth and corresponding to the depth, the above contents of the embodiment may be used for a parameter other than the depth, the parameter serving as an opportunity to change the image parameter set.

[0125] As for the detailed configurations and detailed operations of the components forming the ultrasound diagnostic device **1** in the embodiment, modifications can be appropriately made within the scope of the present invention.

[0126] Although embodiments of the present invention have been described and illustrated in detail, the disclosed embodiments are made for purposes of illustration and example only and not limitation. The scope of the present invention should be interpreted by terms of the appended claims.

[0127] The entire disclosure of Japanese patent Application No. 2017-147649, filed on 31 Jul. 2017, and No. 2018-005313, filed on 17 Jan. 2018, are incorporated herein by reference in its entirety.

What is claimed is:

1. An ultrasound diagnostic device, comprising:

a transmitter which outputs a drive signal to an ultrasound probe that transmits and receives ultrasound waves;

a receiver which obtains a reception signal from the ultrasound probe;

a first hardware processor which generates ultrasound image data from the reception signal and performs image processing to the generated ultrasound image data;

an operator which receives input of a depth of an ultrasound image to be displayed; and

a second hardware processor which obtains a plurality of preset image parameters corresponding to the input depth, and controls the transmitter, the receiver and the first hardware processor to generate the ultrasound image data corresponding to the input depth according to the obtained plurality of image parameters.

2. The ultrasound diagnostic device according to claim **1**, wherein the plurality of image parameters are image parameters corresponding to at least one image mode among a B-mode, an M-mode, a color Doppler mode, a power Doppler mode, a CW mode and an Elastography mode.

3. The ultrasound diagnostic device according to claim **1**, wherein the second hardware processor obtains the plurality of image parameters corresponding to the input depth from an image parameter set which is stored in a storage and has a plurality of preset image parameters corresponding to a plurality of depths.

4. The ultrasound diagnostic device according to claim **3**, wherein

the storage stores a plurality of types of image parameter sets,

the operator receives input of a depth of ultrasound image data to be generated and selection input of an image parameter set from among the plurality of types of image parameter sets, and

the second hardware processor obtains the plurality of image parameters corresponding to the input depth from the image parameter set which is selected and input.

5. The ultrasound diagnostic device according to claim **3**, wherein the operator receives selection of an image parameter set via a key or a button of a touch panel to which a plurality of image parameter sets are assigned.

6. The ultrasound diagnostic device according to claim **3**, wherein, when the operator receives selection input of changing the image parameter set, the second hardware processor maintains the depth before the selection input, and obtains a plurality of image parameters corresponding to the depth before the selection input in the image parameter set which is selected and input.

7. The ultrasound diagnostic device according to claim **3**, wherein,

the operator receives input of setting values of a plurality of image parameters for each depth in the image parameter set, and

the second hardware processor stores the image parameter set corresponding to the input setting values of the plurality of image parameters for each depth in the storage.

8. The ultrasound diagnostic device according to claim **7**, wherein, according to the plurality of input image parameters for each depth, the second hardware processor controls the transmitter, the receiver and the first hardware processor to generate the ultrasound image data corresponding to the input depth and display the generated ultrasound image data on a display.

9. The ultrasound diagnostic device according to claim **1**, wherein one of the plurality of image parameters is trapezoidal scanning, and a setting value is set such that the trapezoidal scanning is invalid or an angle is small when the depth is shallow and the trapezoidal scanning is valid or the angle is large when the depth is deep.

10. The ultrasound diagnostic device according to claim **1**, wherein one of the plurality of image parameters is a sound ray density, and a setting value is set such that the sound ray density is high when the depth is shallow and the sound ray density is low when the depth is deep.

11. The ultrasound diagnostic device according to claim **1**, wherein one of the plurality of image parameters is a time average, and a setting value is set such that the time average is strong when the depth is shallow and the time average is weak when the depth is deep.

12. The ultrasound diagnostic device according to claim **1**, wherein one of the plurality of image parameters is a dynamic range, and a setting value is set such that the dynamic range is high when the depth is shallow and the dynamic range is low when the depth is deep.

13. The ultrasound diagnostic device according to claim **1**, wherein one of the plurality of image parameters is a screen layout setting, and a setting value is set such that the screen layout setting is vertical when the depth is shallow and the screen layout setting is horizontal when the depth is deep.

14. The ultrasound diagnostic device according to claim **1**, wherein one of the plurality of image parameters is offset TGC, and the second hardware processor controls the first hardware processor to provide a value obtained by adding a gain of offset TGC of the input depth and a gain of normal TGC to the ultrasound image data corresponding to the input depth.

15. The ultrasound diagnostic device according to claim **1**, wherein one of the plurality of image parameters is an offset gain, and the second hardware processor controls the first hardware processor to provide a value obtained by adding an offset gain of the input depth and a gain by a normal operation to the ultrasound image data corresponding to the input depth.

16. An image parameter setting method in an ultrasound diagnostic device including: a transmitter which outputs a drive signal to an ultrasound probe that transmits and receives ultrasound waves; a receiver which obtains a reception signal from the ultrasound probe; and a hardware processor which generates ultrasound image data from the reception signal and performs image processing to the generated ultrasound image data, the method comprising:

a step of receiving input of a depth of an ultrasound image to be displayed; and

a step of obtaining a plurality of preset image parameters corresponding to the input depth, and controlling the transmitter, the receiver and the hardware processor to generate the ultrasound image data corresponding to the input depth according to the obtained plurality of image parameters.

17. A computer readable storage medium storing a program for causing a computer to function as:

a transmitter which outputs a drive signal to an ultrasound probe that transmits and receives ultrasound waves;

a receiver which obtains a reception signal from the ultrasound probe;

a first hardware processor which generates ultrasound image data from the reception signal and performs image processing to the generated ultrasound image data;

an operator which receives input of a depth of an ultrasound image to be displayed; and

a second hardware processor which obtains a plurality of preset image parameters corresponding to the input depth, and controls the transmitter, the receiver and the first hardware processor to generate the ultrasound image data corresponding to the input depth according to the obtained plurality of image parameters.

* * * * *

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专利名称(译)	超声诊断装置，图像参数设定方法和存储介质		
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摘要(译)

一种超声波诊断装置，包括：发送器，其将驱动信号输出到发送和接收超声波的超声波探头;接收器，其从超声探头获得接收信号;第一硬件处理器，从接收信号生成超声图像数据，并对生成的超声图像数据进行图像处理;接收输入要显示的超声波图像的深度的操作者;第二硬件处理器，获取与输入深度对应的多个预设图像参数，并控制发送器，接收器和第一硬件处理器根据获取的多个图像参数生成与输入深度对应的超声图像数据。