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(54) **ULTRASONIC IMAGE GENERATION SYSTEM AND ULTRASONIC WIRELESS PROBE**

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(57) **ABSTRACT**

An ultrasonic image generation system has a probe having an ultrasonic transducer configured to transmit and receive an ultrasonic signal, a processor configured to generate an ultrasonic image signal by processing a received signal of the ultrasonic transducer as well as to generate a drive signal that is supplied to the ultrasonic transducer, and a probe-side wireless communicator; and a terminal having a terminal-side wireless communicator configured to wirelessly communicate with the probe-side wireless communicator, a display configured to display an ultrasonic image based on the ultrasonic image signal, and an operation panel configured to input general measurement information, wherein the probe has a controller configured to determine control information necessary for generation of the drive signal and processing of the received signal from the general measurement information transmitted from the terminal.

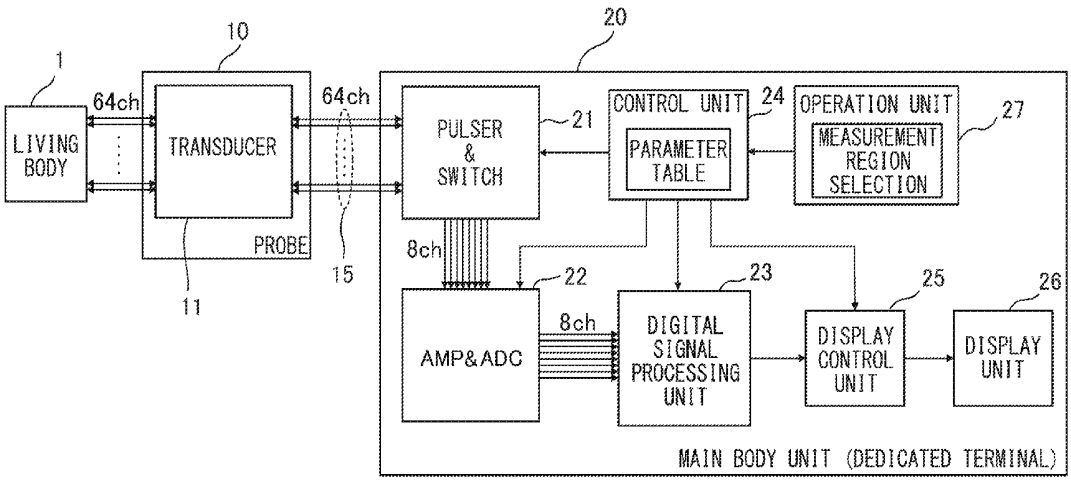


FIG. 1

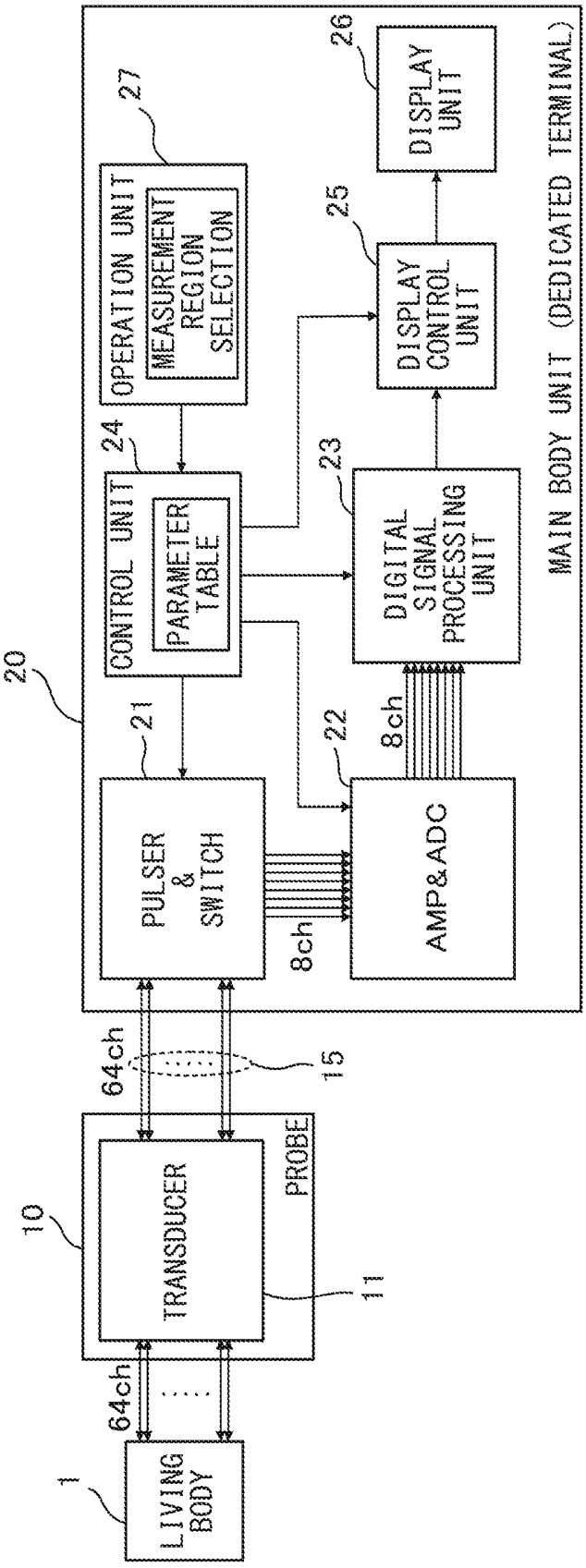
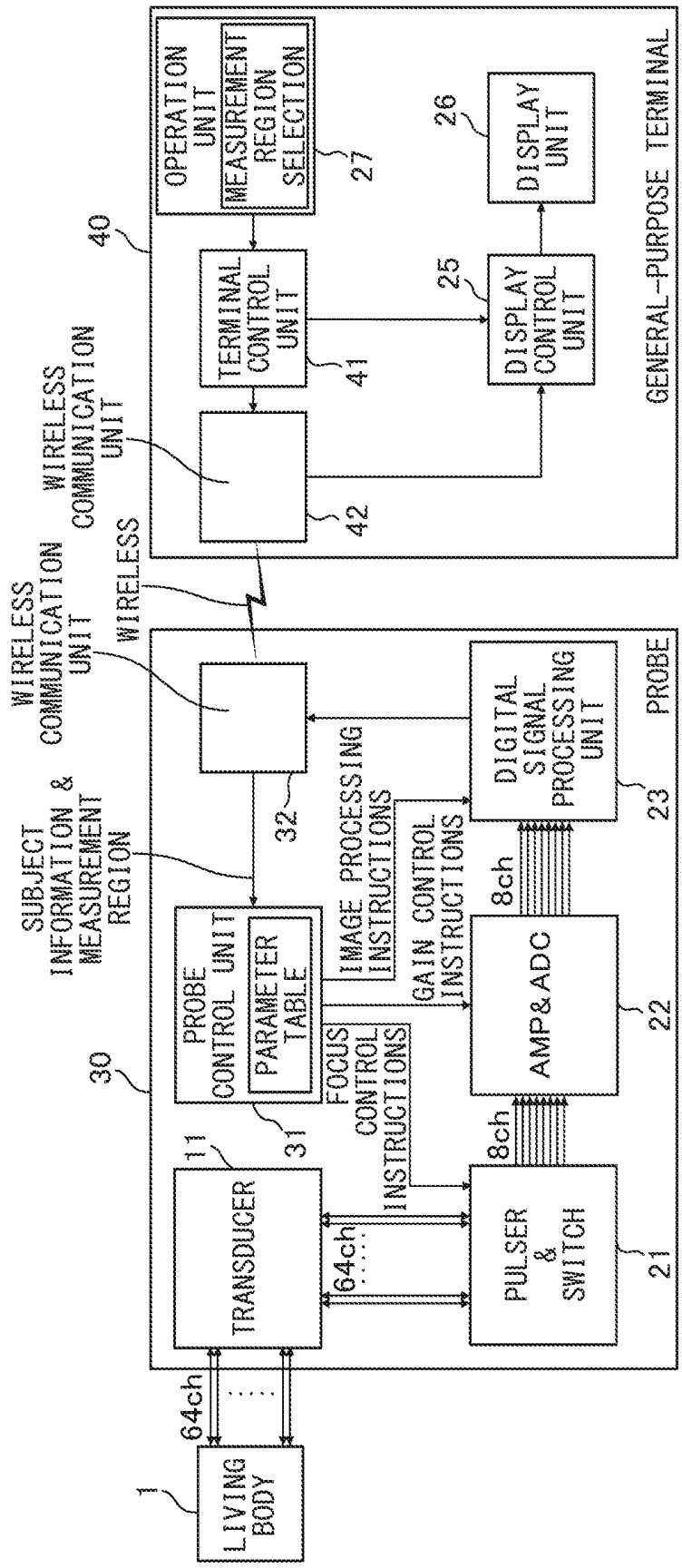

LIVING BODY
1
64ch
PROBE
TRANSDUCER
10
11
64ch
15
MAIN BODY UNIT (DEDICATED TERMINAL)
20
PULSER & SWITCH
21
8ch
AMP&ADC
22
DIGITAL SIGNAL PROCESSING UNIT
23
CONTROL UNIT
PARAMETER TABLE
24
OPERATION UNIT
MEASUREMENT REGION SELECTION
27
DISPLAY CONTROL UNIT
25
DISPLAY UNIT
26

FIG. 2


LIVING BODY
1
64ch
PROBE
TRANSDUCER
11
64ch
PULSER & SWITCH
21
8ch
AMP&ADC
22
8ch
DIGITAL SIGNAL PROCESSING UNIT
23
PROBE CONTROL UNIT
30
PARAMETER TABLE
31
32
WIRELESS COMMUNICATION UNIT
WIRELESS
WIRELESS COMMUNICATION UNIT
SUBJECT INFORMATION & MEASUREMENT REGION
IMAGE PROCESSING INSTRUCTIONS
GAIN CONTROL INSTRUCTIONS
FOCUS CONTROL INSTRUCTIONS
GENERAL-PURPOSE TERMINAL
40
OPERATION UNIT
MEASUREMENT REGION SELECTION
27
TERMINAL CONTROL UNIT
41
42
DISPLAY CONTROL UNIT
25
DISPLAY UNIT
26

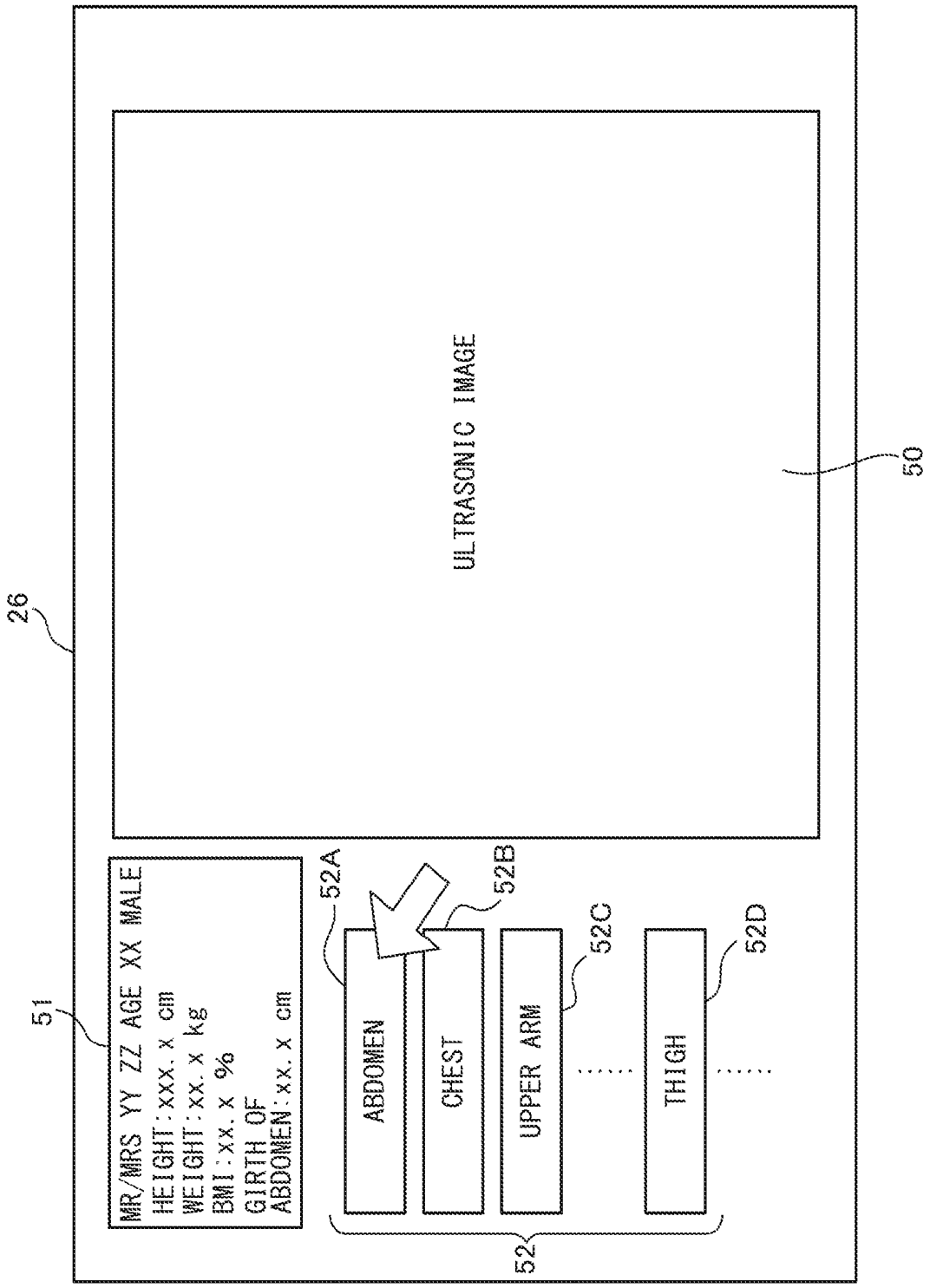

26
ULTRASONIC IMAGE
50
MR/MRS YY ZZ AGE XX MALE
HEIGHT: xxx.x cm
WEIGHT: xx.x kg
BMI: xx.x %
GIRTH OF
ABDOMEN: xx.x cm
51
52A
52B
52C
52D
ABDOMEN
CHEST
UPPER ARM
THIGH
52

FIG. 3

FIG. 4

MEASUREMENT REGION

GENERAL MEASUREMENT INFORMATION					CONTROL INFORMATION			
	SEX	BMI	GIRTH OF ABDOMEN	AGE	GAIN	FOCUS POSITION	NUMBER OF FOCUS POINTS	IMAGE PROCESSING
ABDOMEN	MALE	—	80cm OR MORE	—	LARGE	DEEP PART	THREE POINTS	PATTERN A
			60cm OR MORE		MIDDLE			
			LESS THAN 60cm		SMALL			
			:		:			
	FEMALE	—	80cm OR MORE	—	LARGE			PATTERN B
			60cm OR MORE		MIDDLE			
			LESS THAN 60cm		SMALL			
			:		:			
CHEST	MALE	—	—	FIFTY OR OLDER	SMALL	DEEP PART	TWO POINTS	PATTERN C
				:	:			
	FEMALE	—	—	THIRTIES	MIDDLE			
				:	:			
UPPER ARM	MALE	20.0 OR LESS	—	SIXTY OR OLDER	SMALL	SHALLOW PART	ONE POINT	PATTERN D
		:	:	:				
	FEMALE	:	:	:				PATTERN E
THIGH	MALE	22.0 OR LESS	—	TWENTIES	LARGE	SHALLOW PART ~DEEP PART	TWO POINTS	PATTERN F
		22.0 OR MORE		FORTIES	MIDDLE			
		:		:	:			
	FEMALE	30.0 OR MORE	—	THIRTIES	MIDDLE			
		:		:	:			

ULTRASONIC IMAGE GENERATION SYSTEM AND ULTRASONIC WIRELESS PROBE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation application of International Application PCT/JP2016/056113 filed on Feb. 29, 2016, the entire contents of which are incorporated herein by reference.

FIELD

[0002] The present invention relates to an ultrasonic image generation system and an ultrasonic wireless probe.

BACKGROUND

[0003] An ultrasonic image generation system that generates an ultrasonic image representing a state of the inside of a living body by irradiating the living body with an ultrasonic wave and detecting the reflected wave is widely used. A common ultrasonic image generation system has a main body unit and an ultrasonic transducer (hereinafter, referred to as an ultrasonic unit) connected to the main body unit by a cable. The main body unit generates a drive signal of the ultrasonic unit and transmits the generated drive signal to the ultrasonic unit via the cable. The ultrasonic unit outputs an ultrasonic wave in accordance with the drive signal, generates a reflected ultrasonic wave signal by capturing the reflected ultrasonic wave, and transmits the reflected ultrasonic wave signal to the main body unit. The main body unit generates an ultrasonic image by processing the received reflected ultrasonic wave signal and displays the ultrasonic image on a display.

[0004] In recent years, an ultrasonic image generation system is expected to be turned into a mobile device and reduction in size, reduction in cost, and improvement of operability have been sought. The ultrasonic unit, which is grasped by the hand and contacts with a living body portion, is connected to the main body unit by a cable, and therefore the operation thereof is restrained. Thus, it has been proposed to improve operability by eliminating the cable and carried out data communication by wireless communication, in other words, by turning data communication into wireless communication. However, since the amount of data to be transferred in the communication between the ultrasonic unit and the main body unit is large, it is difficult to communicate a large amount of data in a short time by wireless communication, to reduce the size of the ultrasonic image generation system and to improve operability of the ultrasonic image generation system.

[0005] Further, in general, the ultrasonic image generation system is a dedicated device and the cost is high. Thus, it is desired to reduce the cost by making use of a general-purpose terminal, such as a PC, a PC tablet, and a smartphone. However, a dedicated device aims at improvement of operability by providing a lot of mechanical knobs and switches, and therefore there has been such a problem that it is difficult to implement the same operability as that of a dedicated device by a general-purpose terminal. Further, since the cable is compatible with a special I/F, the ultrasonic image generation system is a dedicated terminal.

RELATED DOCUMENTS

[0006] [Patent Document 1] Japanese Laid Open Patent Document No. 2012-187244

[0007] [Patent Document 2] Japanese Laid Open Patent Document No. 2010-57562

[0008] [Patent Document 3] U.S. Patent Application No. 2003/0139664

SUMMARY

[0009] An ultrasonic image generation system of a first aspect has a probe unit and a terminal. The probe unit has an ultrasonic unit configured to transmit and receive an ultrasonic signal, a drive control/signal processing unit configured to generate an ultrasonic image signal by processing a received signal of the ultrasonic unit as well as to generate a drive signal that is supplied to the ultrasonic unit, and a probe-side wireless communication unit. The terminal has a terminal-side wireless communication unit configured to wirelessly communicate with the probe-side wireless communication unit, a display unit configured to display an ultrasonic image based on the ultrasonic image signal, and an operation unit configured to input general measurement information. The probe unit has a control information determination unit configured to determine control information necessary for the generation of a drive signal and the processing of a received signal from general measurement information transmitted from the terminal.

[0010] The object and advantages of the embodiments will be realized and attained by means of the elements and combination particularly pointed out in the claims.

[0011] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are not restrictive of the invention.

BRIEF DESCRIPTION OF DRAWINGS

[0012] FIG. **1** is a block diagram illustrating a configuration of a common ultrasonic image generation system.

[0013] FIG. **2** is a block diagram illustrating a configuration of an ultrasonic image generation system of an embodiment.

[0014] FIG. **3** is a diagram illustrating a display example of a display unit of a general-purpose terminal.

[0015] FIG. **4** is a diagram illustrating a parameter setting table of general measurement information and control information.

DESCRIPTION OF EMBODIMENTS

[0016] Before explaining an ultrasonic image generation system of an embodiment, a common ultrasonic image generation system is explained.

[0017] FIG. **1** is a block diagram illustrating a configuration of a common ultrasonic image generation system.

[0018] The common ultrasonic image generation system has a probe **10**, a main body unit **20**, and a cable **15** that connects the probe **10** and the main body unit **20**. The probe **10** and the main body unit **20** are connected by the cable **15** and communication is performed between the main body unit **20** and the probe **10** and at the same time, a power source is supplied from the main body unit **20** to the probe **10**.

[0019] The probe **10** is held by a measurer of the ultrasonic image generation system and is in contact with the surface of a living body **1**, which is the target of measurement, and thereby, the inside of the living body **1** is measured by ultrasonic waves. The probe **10** has a transducer **11** that converts a high-voltage pulse signal received via the cable into a sound wave, outputs the sound wave to the living body **1**, and converts the sound wave reflected at the boundary between muscle and fat, whose acoustic impedances are different, within the living body **1** into an electric signal.

[0020] The main body unit **20** has a pulser & switch **21**, an AMP & ADC **22**, a digital signal processing unit **23**, a control unit **24**, a display control unit **25**, a display unit **26**, and an operation unit **27**. The pulser & switch **21** generates a high-voltage pulse signal that is supplied to the transducer **11**, and selects the electric signal of the reflected sound wave by a switch circuit and outputs the electric signal to the AMP & ADC **22**. The pulser & switch circuit **21** performs, in response to the control signal from the control unit **24**, processing to bring into focus the signals transmitted simultaneously in a plurality of channels within the living body by changing the amount of delay for each channel. After amplifying the electric signal by the amplifier (AMP) in response to the control signal from the control unit **24**, the AMP & ADC **22** converts the electric signal into a digital signal by the ADC (Analog-to-Digital Converter) and outputs the digital signal to the digital signal processing unit **23**. Here, an example is illustrated, in which the number of input/output channels of the transducer **11** is sixty-four and the number of channels of the AMP & ADC **22** is eight, but these numbers are optional and the width and resolution of an ultrasonic image that is obtained are determined by the channel interval and the number of channels of the transducer **11**. The pulser & switch **12** performs simultaneous pulser transmission corresponding to the number of channels of the ADC.

[0021] The digital signal processing unit **23** converts the digital signal from the AMP & ADC **22** into luminance information by making use of the control signal from the control unit **24**, and performs gain correction or the like that takes into consideration the attenuation within the living body and generates an ultrasonic image signal. By the above processing, an ultrasonic image signal can be obtained by carried out transmission and reception while shifting the sixty-four channels one by one and processing the received signals. The display control unit **25** receives an ultrasonic image signal from the digital signal processing unit **23** and performs control so as to display an ultrasonic image on the display unit **26**.

[0022] The control unit **24** receives general measurement information, which is input by a measurer making use of the operation unit **27**, for example, measurement regions, sex, age, height, weight (or BMI), and so on, of a subject of measurement. The operation unit **27** may be a touch panel. The control unit **24** has a parameter table and determines control information suitable to the general measurement information by making use of the table. The control information includes gain, focus position, number of focus points, image processing pattern to be used, and so on. The control unit **24** controls the pulser & switch circuit **21**, the AMP & ADC **22**, the digital signal processing unit **23**, and the display control unit **25** based on the control information. As described previously, the pulser & switch circuit **21** performs the processing to bring into focus the signals transmitted simultaneously in a plurality of channels within the living body by changing the amount of delay for each channel, and the focus position and the number of focus points are used for the control by the control unit **24**. Further, the gain is used for gain adjustment in the AMP & ADC **22** and the image processing pattern is used for determination of an image processing method that is used in the digital signal processing unit **23**. Furthermore, the control information is used by the display control unit **25** in order to display an appropriate ultrasonic image on the display unit **26**. The general measurement information is supplied to the display control unit **25** and displayed on the display unit **26** to check a subject of measurement.

[0023] The configuration of the above-described common ultrasonic image generation system is widely known, and therefore further explanation is omitted.

[0024] FIG. **2** is a block diagram illustrating a configuration of an ultrasonic image generation system of the embodiment.

[0025] The ultrasonic image generation system of the embodiment differs from the common apparatus in FIG. **1** in that a general-purpose terminal **40** is employed in place of the main body unit **20**, that part of the components of the main body unit **20** are moved to the probe side, and that the general-purpose terminal **40** and the probe are connected by wireless communication, not by a cable. Thus, the components in common between FIG. **1** and FIG. **2** are indicated by attaching the same reference symbols and explanation thereof is omitted.

[0026] The ultrasonic image generation system of the embodiment has a probe **30** and the general-purpose terminal **40**. The probe **30** and the general-purpose terminal **40** are capable of communication by wireless communication. Because no cable is provided, a power source is not supplied to the probe **30**, and therefore the probe **30** has a battery and each unit is driven by a battery. The battery may be a primary battery or a rechargeable secondary battery.

[0027] The probe **30** has a probe control unit **31** and a wireless communication unit **32**, in addition to the transducer **11**, the pulser & switch **21**, the AMP & ADC **22**, and the digital signal processing unit **23**. The general-purpose terminal **40** has a terminal control unit **41** and a wireless communication unit **42**, in addition to the display control unit **25**, the display unit **26**, and the operation unit **27**. The function of the control unit **24** in FIG. **1** is implemented by the probe control unit **31** and the terminal control unit **41**. The parameter table to determine control information suitable to the general measurement information is provided to the probe control unit **31**. The terminal control unit **41** only performs simple processing in relation to the input of general measurement information.

[0028] The wireless communication unit **32** and the wireless communication unit **42** each have a short-range wireless communication function (for example, BLUETOOTH (registered trademark)) and are capable of wirelessly communicating with each other (wireless communication). No cable is connected to the probe as described above, and therefore operability improves.

[0029] As the general-purpose terminal **40**, any terminal can be used as long as having a display function, an input function, and a wireless communication function and for example, the terminal is used by installing application software for an ultrasonic image generation system to a PC tablet, a PC, a smartphone, and so on.

[0030] As above, in the ultrasonic image generation system of the embodiment, in order to implement wireless communication, first, the pulser & switch **21**, which is the function on the side of the main body in the conventional system, is arranged on the side of the probe **30**. Thus, the high-voltage pulse signal between the transducer and the pulser & switch, which is conventionally transferred by a cable, and the data of the reflected wave from the living body are transferred on the same substrate, and therefore a cable may be eliminated. Further, by arranging the AMP & ADC **22** and the digital signal processing unit **23** on the side of the probe side **30**, the data of the reflected wave may be turned into image data by digital signal processing on the side of the probe **30**. Thus, the size of data that is communicated is compressed, and therefore the data may be wirelessly transferred to the general-purpose terminal **40** with ease.

[0031] The pulser & switch **21**, the AMP & ADC **22**, and the digital signal processing unit **23** are arranged on the side of the probe **30** and only the already-existing functions of the general-purpose, such as the display function, the input function, and the wireless communication function, are used, and therefore the general-purpose terminal **40** may be implemented by general-purpose components. Thus, the cost and size of the apparatus may be reduced.

[0032] FIG. **3** is a diagram illustrating a display example of the display unit of the general-purpose terminal.

[0033] On the display unit **26** of the general-purpose terminal **40**, an acquired ultrasonic image **50**, subject information **51**, such as name, age, sex, height, weight, BMI (Body Mass Index), and girth of abdomen of a subject, and measurement-target regions **52** (abdomen **52**A, chest **52**B, upper arm **52**C, thigh **52**D, and so on) are displayed. The subject information **51** and the measurement-target regions **52** are input by a measurer by making use of the operation unit **27** while checking the display contents on the display unit **26**. However, when a general-purpose terminal compatible with the measurer is used, information stored in advance in the general-purpose terminal may be used. Further, when the display unit **26** is a touch panel which has a touch screen function, the operation unit **27** is not necessary and the information may be input by touching the display unit **26**.

[0034] The terminal control unit **41** transmits the input measurement regions and subject information (may be only the information necessary for measurement) to the probe control unit **31** via the wireless communication unit **42** and the wireless communication unit **32**. The probe control unit **31** determines control information in accordance with the parameter table based on the received information and controls the pulser & switch **21**, the AMP & ADC **22**, and the digital signal processing unit **23**. Thus, the load to set parameters in the general-purpose terminal **40** is reduced, and operability may be maintained.

[0035] FIG. **4** is a diagram illustrating a parameter setting table of general measurement information and control information. The general measurement information includes measurement regions (abdomen, chest, upper arm, thigh, and so on), sex, BMI (weight/(height)^2), and age, and the control information includes gain, focus position, number of focus points, and image processing pattern.

[0036] For example, when the girth of the abdomen of a subject is large, the depth of measurement of the abdomen is greater, and therefore it is necessary to appropriately adjust the image luminance by increasing the gain of the reflected wave data at the deep part by taking into consideration the attenuation within the body and an appropriate gain is set to the table. Further, the focus point position changes in accordance with the depth of measurement, and therefore it is necessary to change the amount of delay of the pulser & switch circuit **21** and it is supposed to improve image quality by providing a plurality of focus points in accordance with the depth. Thus, an appropriate focus position and an appropriate number of focus points are set to the table. In addition to the above, it is considered to change the measurement range for each measurement region or to change the image processing pattern of the filter processing and the like in accordance with an image with features, and therefore an appropriate image processing pattern is set to the table for each measurement region.

[0037] In the embodiment, the side of the probe **30**, not the side of the general-purpose terminal **40**, is caused to have the table of the image optimization parameters, and therefore it is only required to update the table information on the probe at the time of updating the table information, and no task is required for the side of the general-purpose terminal **40**. Thus, measurement may be carried out with the same parameters also when a different general-purpose terminal is used.

[0038] As above, the embodiment is explained, but all the examples and conditions described here are described for the purpose of aiding understanding of the invention and the concepts of the invention to be applied to the art. Particularly, the examples and conditions described are not intended to limit the scope of the invention and the configurations of such examples in the specification do not indicate the superiority and inferiority of the invention. The embodiment of the invention is described in detail, but it should be understood that the various changes, substitutions, and alterations can be made without departing the sprit and scope of the invention.

CITATION LIST

[0039] **11** transducer
[0040] **21** pulser & switch
[0041] **22** AMP & ADC
[0042] **23** digital signal processing unit
[0043] **25** display control unit
[0044] **26** display unit
[0045] **27** operation unit
[0046] **30** probe
[0047] **31** probe control unit
[0048] **32** wireless communication unit
[0049] **40** general-purpose terminal
[0050] **41** terminal control unit
[0051] **42** wireless communication unit

What is claimed is:

1. An ultrasonic image generation system comprising:

a probe including an ultrasonic transducer configured to transmit and receive an ultrasonic signal, a processor configured to generate an ultrasonic image signal by processing a received signal of the ultrasonic transducer as well as to generate a drive signal that is supplied to the ultrasonic transducer, and a probe-side wireless communicator; and

a terminal including a terminal-side wireless communicator configured to wirelessly communicate with the probe-side wireless communicator, a display configured to display an ultrasonic image based on the

ultrasonic image signal, and an operation panel configured to input general measurement information, wherein

the probe includes a controller configured to determine control information necessary for generation of the drive signal and processing of the received signal from the general measurement information transmitted from the terminal.

2. The ultrasonic image generation system according to claim **1**, wherein

the controller includes a table in which the general measurement information and the control information are associated with each other.

3. The ultrasonic image generation system according to claim **1**, wherein

the general measurement information includes measurement-target region, sex, and BMI, and

the control information includes gain, focus position, number of focus points, and image processing pattern.

4. The ultrasonic image generation system according to claim **2**, wherein

the general measurement information includes measurement-target region, sex, and BMI, and

the control information includes gain, focus position, number of focus points, and image processing pattern.

5. An ultrasonic wireless probe comprising:

an ultrasonic transducer configured to transmit and receive an ultrasonic signal;

a processor configured to generate an ultrasonic image signal by processing a received signal of the ultrasonic transducer as well as to generate a drive signal that is supplied to the ultrasonic transducer;

a wireless communicator; and

a controller configured to determine control information necessary for generation of the drive signal and processing of the received signal from general measurement information received by the wireless communicator, wherein

the ultrasonic image signal is transmitted from the wireless communicator.

* * * * *

专利名称(译)	超声波图像生成系统和超声波无线探头		
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申请号	US15/863488	申请日	2018-01-05
[标]申请(专利权)人(译)	株式会社索思未来		
申请(专利权)人(译)	SOCIONEXT INC.		
当前申请(专利权)人(译)	SOCIONEXT INC.		
[标]发明人	TAKAGI HIROAKI YONEDA NAOTO ADACHI NAOTO TAMAMURA MASAYA INOUE AMANE		
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摘要(译)

超声图像生成系统具有探头，该探头具有被配置为发送和接收超声信号的超声换能器，处理器被配置为通过处理超声换能器的接收信号来生成超声图像信号以及生成所提供的驱动信号。超声换能器和探头侧无线通信器;终端侧无线通信器，其被配置为与探测器侧无线通信器无线通信;显示器，被配置为基于超声图像信号显示超声图像;以及操作面板，被配置为输入一般测量信息，其中，探针具有控制器，该控制器被配置为确定产生驱动信号所需的控制信息和从终端发送的一般测量信息处理接收信号。