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(54) **ULTRASOUND DIAGNOSTIC APPARATUS**

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(57) **ABSTRACT**

An ultrasound diagnostic apparatus configured in a manner connectable to an ultrasound probe includes a transmission unit configured to control supply of a transmission electric signal to transmit ultrasound from the ultrasound probe to a subject, a reception unit configured to acquire a reception signal which is based on reflected ultrasound received by the ultrasound probe, an ultrasound image generation unit configured to generate tomographic image data of the subject based on the reception signal, a movement reception unit configured to acquire movement information of the subject, a dynamic schematic view data generation unit configured to generate, based on the movement information, schematic view image data illustrating a movement of the subject in a schematic view, and a display processing unit configured to generate composite image data in which the tomographic image data and the dynamic schematic view image data are compounded based on time information.

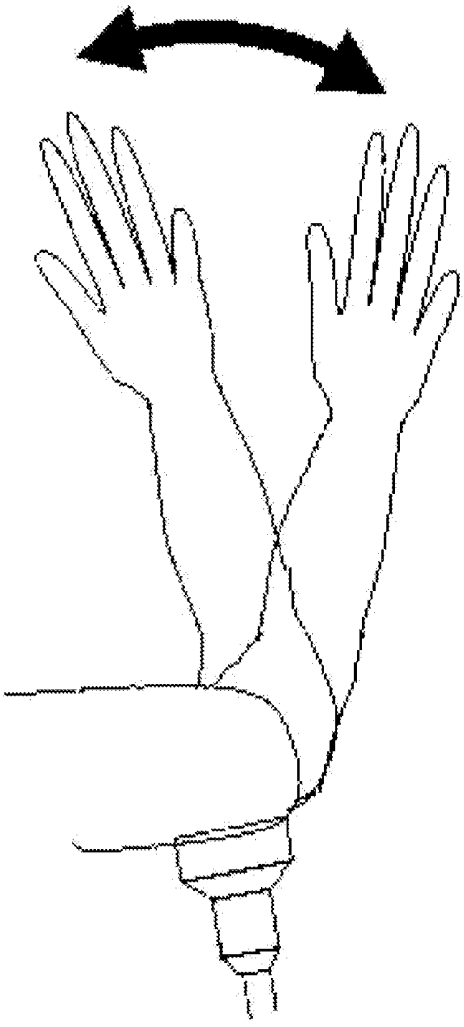


FIG. 1

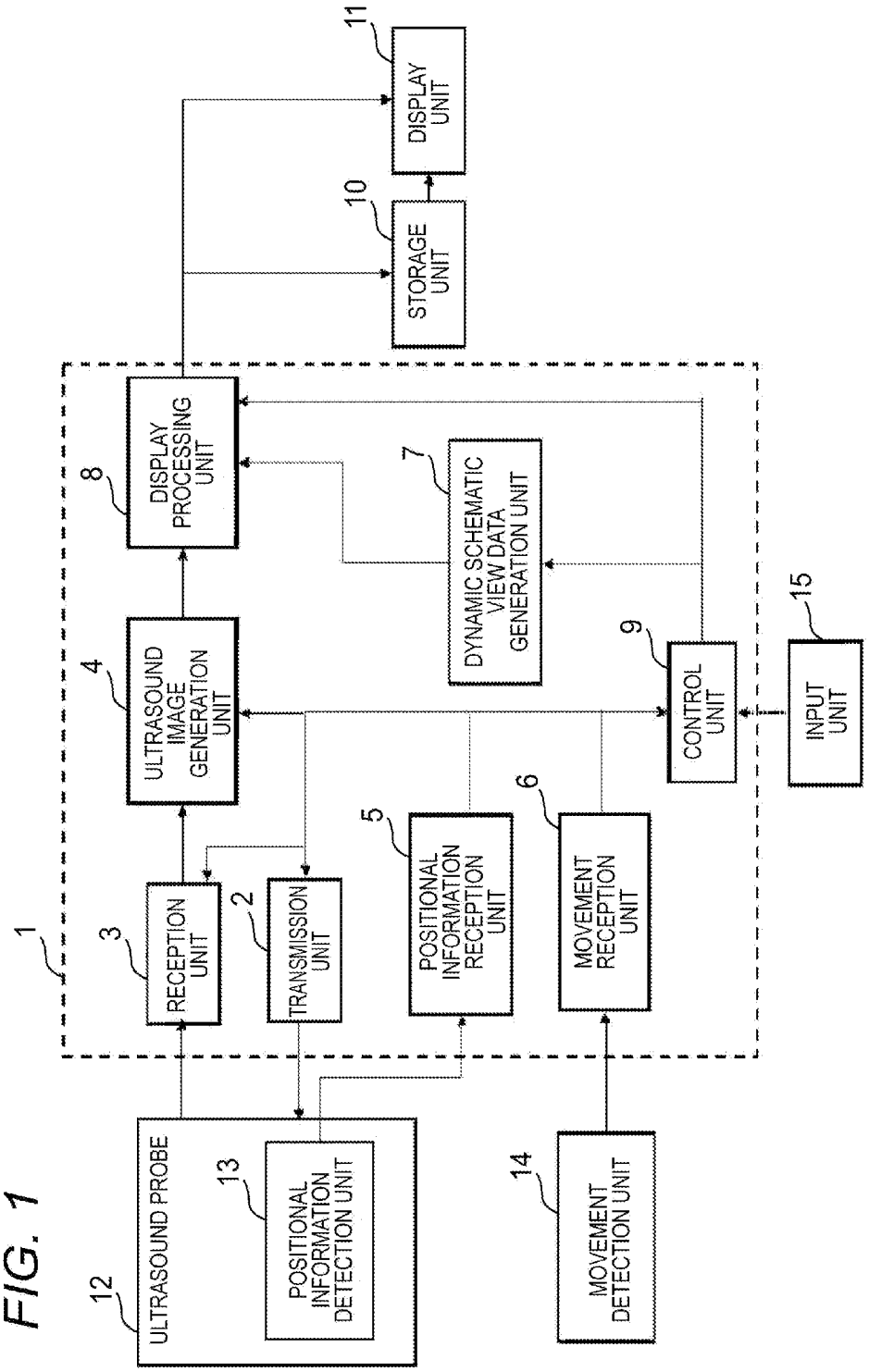

1
2
TRANSMISSION UNIT
3
RECEPTION UNIT
4
ULTRASOUND IMAGE GENERATION UNIT
5
POSITIONAL INFORMATION RECEPTION UNIT
6
MOVEMENT RECEPTION UNIT
7
DYNAMIC SCHEMATIC VIEW DATA GENERATION UNIT
8
DISPLAY PROCESSING UNIT
9
CONTROL UNIT
10
STORAGE UNIT
11
DISPLAY UNIT
12
ULTRASOUND PROBE
13
POSITIONAL INFORMATION DETECTION UNIT
14
MOVEMENT DETECTION UNIT
15
INPUT UNIT

FIG. 2

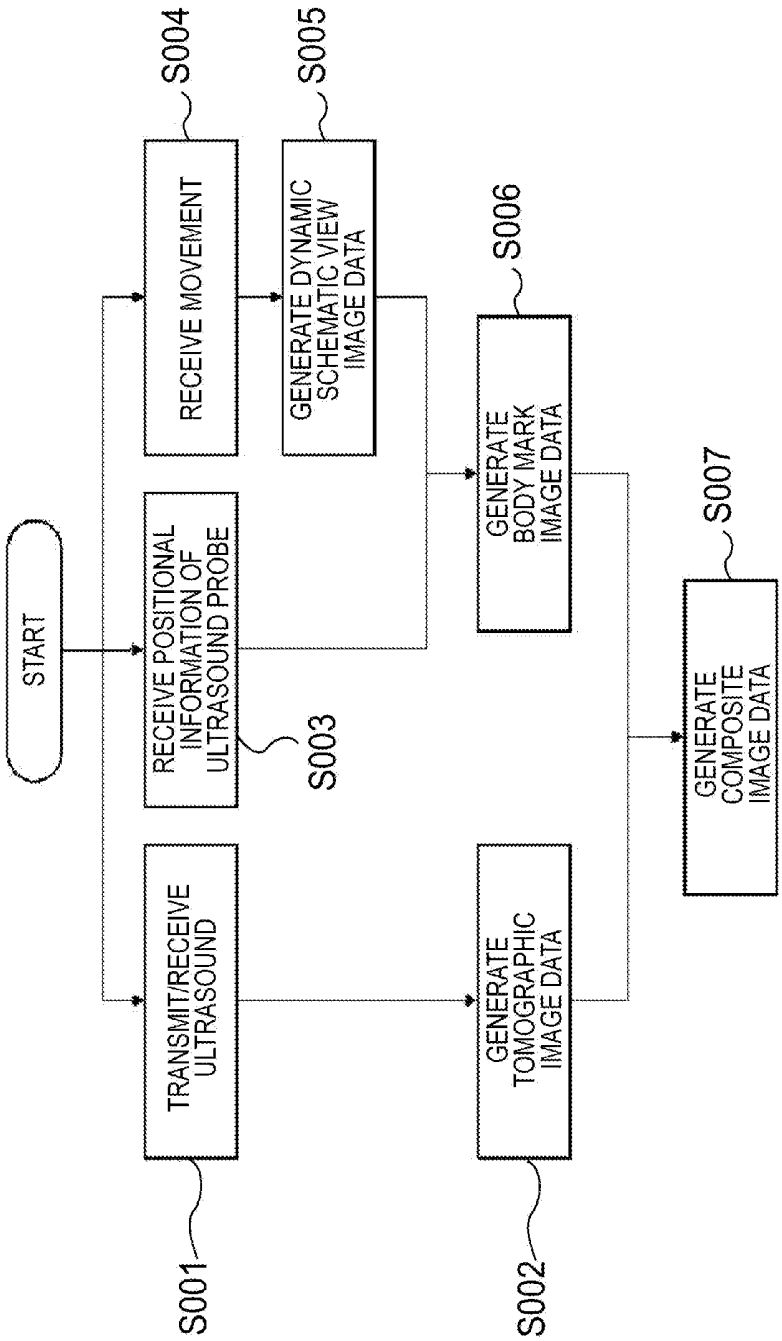

START
TRANSMIT/RECEIVE ULTRASOUND
RECEIVE POSITIONAL INFORMATION OF ULTRASOUND PROBE
RECEIVE MOVEMENT
GENERATE TOMOGRAPHIC IMAGE DATA
GENERATE DYNAMIC SCHEMATIC VIEW IMAGE DATA
GENERATE BODY MARK IMAGE DATA
GENERATE COMPOSITE IMAGE DATA
S001
S002
S003
S004
S005
S006
S007

FIG. 3

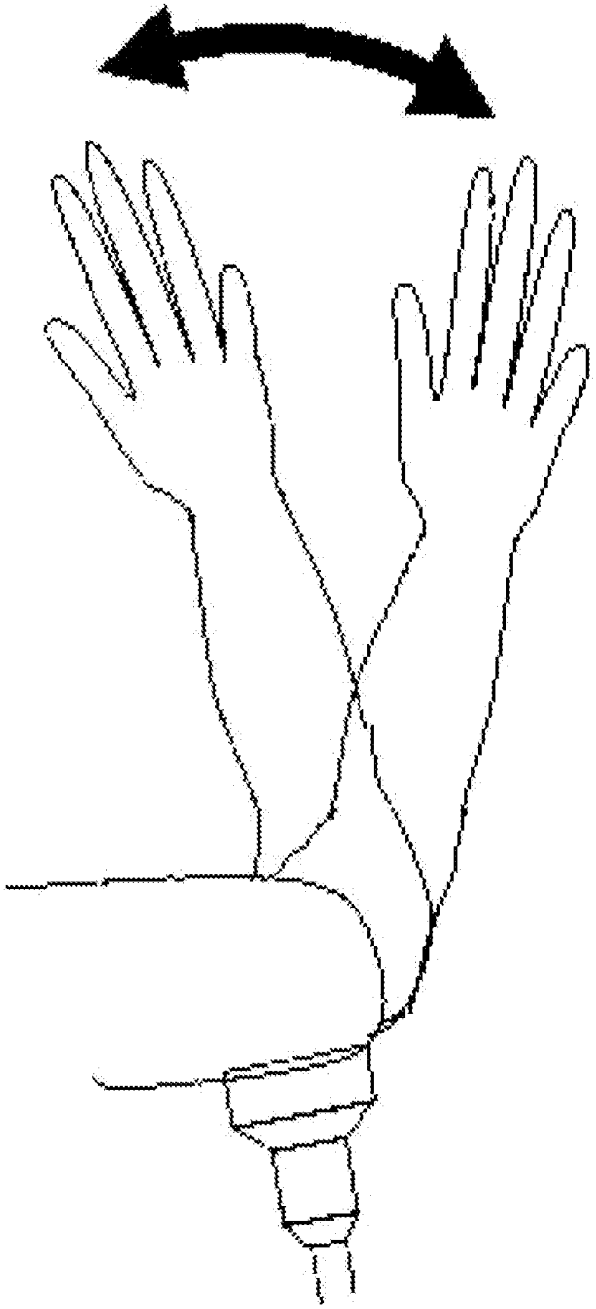


FIG. 4

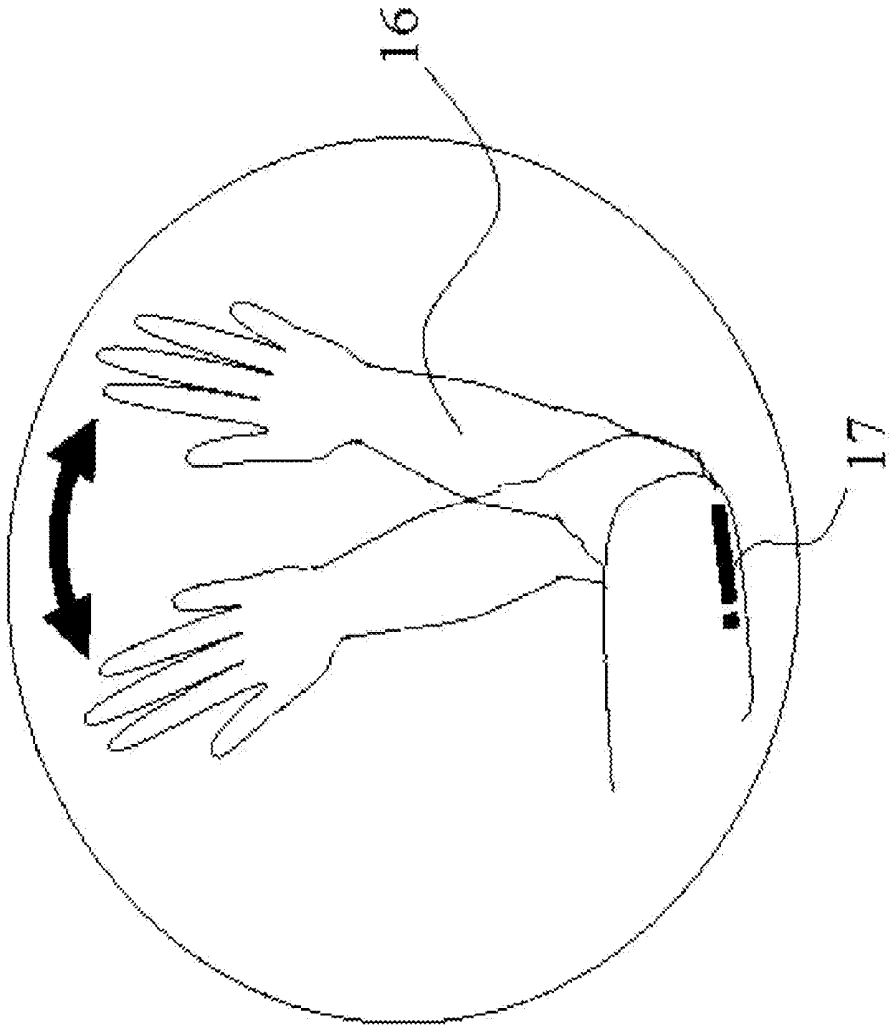


FIG. 5B

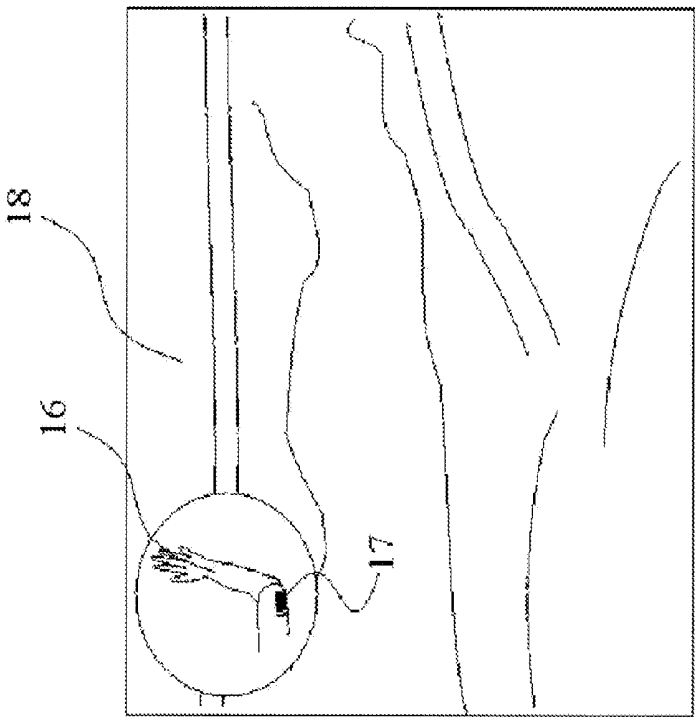
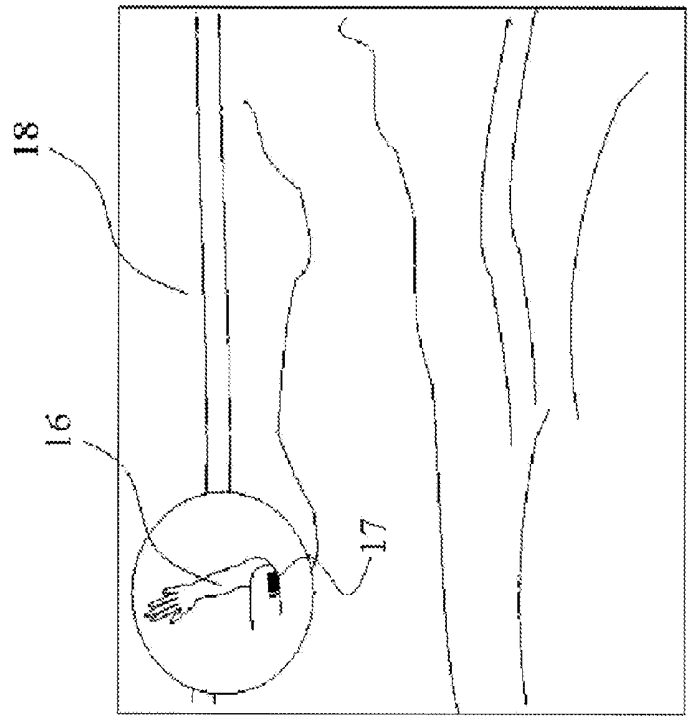


FIG. 5A



ULTRASOUND DIAGNOSTIC APPARATUS

[0001] The entire disclosure of Japanese Patent Application No. 2013-258913 filed on Dec. 16, 2013 including description, claims, drawings, and abstract are incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to an ultrasound diagnostic apparatus which is used in a medical field and which can be connected to an ultrasound probe.

[0004] 2. Description of the Related Art

[0005] An ultrasound diagnostic apparatus is connected to an ultrasound probe, transmits ultrasound while the ultrasound probe is applied to a surface of a subject such as an abdomen or a chest of a human body, receives reflected ultrasound reflected by the subject, and acquires an ultrasound diagnostic image. Here, a function to perform recording while displaying the ultrasound diagnostic image and a general schematic view of the subject and displaying a mark, which indicates a position of the ultrasound probe, therein in order to indicate that the acquired ultrasound diagnostic image is an image of when and where the ultrasound probe is applied on the subject has been known. A general schematic view of the subject in this case is a still image (see, for example, JP 04-166141 A and JP 2004-121488 A).

[0006] Recently, for example, in an orthopedic field, there is a case of acquiring an ultrasound diagnostic image while making a subject change a state dynamically such as case of checking muscle or a skeleton of a predetermined part while moving an arm of a patient. However, in an apparatus of the related art which displays a position of an ultrasound probe on a general schematic view which is a still image, it has been difficult to understand how an ultrasound diagnostic image changes when and what kind of operation a subject performs.

SUMMARY OF THE INVENTION

[0007] An object of the present invention is to make it easier to recognize, when an ultrasound diagnostic image is acquired while a subject changes a state dynamically, a relationship between the acquired ultrasound diagnostic image and the dynamic change in state of the subject.

[0008] To achieve the abovementioned object, according to an aspect, an ultrasound diagnostic apparatus configured in a manner connectable to an ultrasound probe reflecting one aspect of the present invention comprises: a transmission unit configured to control supply of a transmission electric signal to transmit ultrasound from the ultrasound probe to a subject; a reception unit configured to acquire a reception signal which is based on reflected ultrasound received by the ultrasound probe; an ultrasound image generation unit configured to generate tomographic image data of the subject based on the reception signal; a movement reception unit configured to acquire movement information of the subject; a dynamic schematic view data generation unit configured to generate, based on the movement information, schematic view image data illustrating a movement of the subject in a schematic view; and a display processing unit configured to generate composite image data in which the tomographic image data and the dynamic schematic view image data are compounded based on time information.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The above and other objects, advantages and features of the present invention will become more fully understood from the detailed description given hereinbelow 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:

[0010] FIG. **1** is a view illustrating an example of a configuration of an ultrasound diagnostic apparatus in a first embodiment of the present invention;

[0011] FIG. **2** is a flowchart illustrating an example of an operation of the ultrasound diagnostic apparatus in the first embodiment of the present invention;

[0012] FIG. **3** is a view illustrating an example of movement information of a subject in the first embodiment of the present invention;

[0013] FIG. **4** is a view illustrating an example of a body mark image in the first embodiment of the present invention; and

[0014] FIG. **5**A and FIG. **5**B are views illustrating an example of a composite image in the first embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] Hereinafter, an embodiment which is an example of an ultrasound diagnostic apparatus 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 illustrated examples.

First Embodiment

[0016] FIG. **1** is a block diagram illustrating an example of a configuration of an ultrasound diagnostic apparatus according to the first embodiment of the present invention.

[0017] The ultrasound diagnostic apparatus **1** of the present embodiment includes a transmission unit **2**, a reception unit **3**, an ultrasound image generation unit **4**, a positional information reception unit **5**, a movement reception unit **6**, a dynamic schematic view data generation unit **7**, a display processing unit **8**, and a control unit **9**. Then the ultrasound diagnostic apparatus **1** is configured in a manner connectable to a storage unit **10**, a display unit **11**, an ultrasound probe **12**, a movement detection unit **14**, and an input unit **15**.

[0018] The ultrasound probe **12** includes a positional information detection unit **13** to detect positional information which is a position, an inclination, or a combination thereof of the ultrasound probe **12**.

Specifically, the positional information detection unit **13** is a gyro sensor, a sensor to detect an inclination of the ultrasound probe **12**, or the like.

[0019] The ultrasound probe **12** includes a vibrator to convert a transmission electric signal transmitted from the transmission unit **2** into ultrasound. The ultrasound emitted from the vibrator is transmitted to a subject while the ultrasound probe **12** is applied to a surface of the subject. Then, the ultrasound probe **12** receives reflected ultrasound reflected by the subject, converts the reflected ultrasound into a reception electric signal with the vibrator, and supplies the reception electric signal to the reception unit **3**. Note that the ultrasound probe **12** may include a plurality of vibrators arrayed in one-dimensional direction.

[0020] Also, the movement detection unit **14** detects a movement of the subject to be an object of an ultrasound diagnosis. Specifically, the movement detection unit **14** is, for example, a video camera which can take a motion picture or a sensor which is attached to the subject and detects speed, acceleration, a position, or an inclination. Also, these may be combined. The transmission unit **2** which is one of the configurations included in the ultrasound diagnostic apparatus **1** generates a transmission control signal to perform transmission control of the ultrasound transmitted from the ultrasound probe **12** to the subject. Then, the transmission unit **2** performs transmission processing to supply, to the ultrasound probe **12**, a transmission electric signal at high voltage which signal is generated at predetermined timing based on the transmission control signal. Note that the transmission processing performed by the transmission unit **2** at least means processing to generate the transmission control signal in the transmission unit **2** and to make the ultrasound probe **12** transmit the ultrasound. The transmission unit **2** includes a pulsar, a transmission beam former, and the like.

[0021] The reception unit **3** receives a reception electric signal from the ultrasound probe **12**, performs processing, which is necessary for construction or the like of ultrasound tomographic image data, such as amplification or detection of the reception electric signal, and performs reception processing to generate a reception signal. Note that the reception processing performed by the reception unit **3** at least means processing in which the reception unit **3** acquires the reception signal which is based on the reflected ultrasound. For example, in a case where the plurality of vibrators is arrayed in the one-dimensional direction, the reception unit **3** generates the reception signal by performing amplification and A/D conversion of the reception electric signal converted by the ultrasound probe **12**. Then, by giving appropriate delay to the reflected ultrasound received by each of the vibrators and by performing adding, only ultrasound from a predetermined position or direction is detected. By performing the transmission processing by the transmission unit **2** and the reception processing by the reception unit **3**, a plurality of reception signals corresponding to one image frame is acquired. By repeating these pieces of processing for a plurality of times, a plurality of reception signals corresponding to a plurality of image frames is acquired. The reception unit **3** includes an amplifier, an A/D converter, a reception beam former, and the like.

[0022] Note that a part of the functions of the transmission unit **2** and the reception unit **3** may be provided on a side of the ultrasound probe **12**. For example, the following configuration can be considered. That is, in the ultrasound probe **12**, a transmission electric signal is generated based on a transmission control signal which is output from the transmission unit **2** and which is for generating a transmission electric signal. Then, the transmission electric signal is converted into ultrasound and received reflected ultrasound is converted into a reception electric signal, and then, a reception signal is generated in the ultrasound probe **12** based on the reception electric signal and the reception unit **3** receives the reception signal.

[0023] Generally, the transmission unit **2** performs the transmission processing repeatedly and continuously and generates a reception signal successively. Thus, the following processing is performed successively relative to the generated reception signal.

[0024] The ultrasound image generation unit **4** receives the reception signal generated in the reception unit **3**, analyzes amplitude of the reception signal, converts the reception signal into a luminance signal corresponding to signal intensity thereof, performs coordinate transformation or the like of the luminance signal in such a manner that the luminance signal corresponds to an orthogonal coordinate system, and successively constructs tomographic image data (B mode image data) which is an ultrasound image. The ultrasound image generation unit **4** includes, for example, various filters, a detector, a logarithmic amplifier, a scan converter, a different signal/image processor, and the like. Note that since the reception signal is digitalized, the conversion of the reception signal into a luminance signal corresponding to signal intensity of the reception signal may be realized not by the above-described hardware but by software.

[0025] The positional information reception unit **5** is connected to the positional information detection unit **13** included in the ultrasound probe **12** and receives positional information of the ultrasound probe **12** which information is detected by the positional information detection unit **13**. The movement reception unit **6** is connected to the movement detection unit **14** and receives information of a movement of the subject which movement is detected by the movement detection unit **14**.

[0026] Based on the information of the movement of the subject which information is received by the movement reception unit **6**, the dynamic schematic view data generation unit **7** generates schematic view image data illustrating the movement of the subject in a schematic view. Moreover, based on the positional information of the ultrasound probe **12** which information is received by the positional information reception unit **5**, the dynamic schematic view data generation unit **7** generates, in the schematic view image data illustrating the movement of the subject in a schematic view, body mark image data which simultaneously illustrates a position or an inclination of the ultrasound probe **12**.

[0027] The display processing unit **8** generates composite image data in which the tomographic image data generated by the ultrasound image generation unit **4**, the schematic view image data or the body mark image data generated by the dynamic schematic view data generation unit **7**, and the like are compounded. Then, the display processing unit **8** performs processing to store the composite image data into the storage unit **10** or to display the composite image data onto the display unit **11**.

[0028] The control unit **9** includes, for example, an arithmetic processor including a memory and controls an operation of each configuration.

[0029] The storage unit **10** is an electronic storage medium such as a memory and stores the composite image data generated by the display processing unit **8**. The storage unit **10** may be embedded in the ultrasound diagnostic apparatus **1**.

[0030] The display unit **11** is, for example, a display and displays the composite image data generated by the display processing unit **8**. Also, the composite image data stored in the storage unit **10** may be displayed. The display unit **11** may be included integrally as one chassis in the ultrasound diagnostic apparatus **1**.

[0031] The input unit **15** is a keyboard, a mouse, a trackball, or the like. The input unit **15** receives an input from an operator of the ultrasound diagnostic apparatus **1** and inputs, into the control unit **9**, an instruction which is based on the input from the operator.

[0032] Typically, a part or the whole of a function of each function block included in the ultrasound diagnostic apparatus **1** can be realized as an LSI which is an integrated circuit. Note that here, the LSI is used but may be referred to as an IC, a system LSI, a super LSI, or an ultra LSI depending on a degree of integration. Also, a method of circuit integration is not limited to the LSI and may be realized by a special circuit or a general processor. A field programmable gate array (FPGA) or a reconfigurable processor in which connection or setting of a circuit cell inside an LSI can be reconfigured may be used. Also, a part of the whole of a function of each function block may be executed by software. In this case, the software is stored in one or more storage media, optical disks, or hard disks. The storage media are, for example, ROMs. The software is executed by the arithmetic processor.

[0033] Next, an operation of the ultrasound diagnostic apparatus **1** including such a configuration described above will be described with reference to FIG. **2**. FIG. **2** is a flowchart illustrating an example of the operation of the ultrasound diagnostic apparatus **1** in the first embodiment of the present invention.

[0034] First, the ultrasound probe **12** is arranged on a surface of the subject and the ultrasound diagnostic apparatus **1** transmits/receives ultrasound (step S**001**). Specifically, an example in which the ultrasound probe **12** is arranged on a shoulder of a human body will be described. The ultrasound diagnostic apparatus **1** successively acquires a reception signal including a cross-sectional surface of a muscle or a bone of the shoulder by the transmission processing and the reception processing respectively by the transmission unit **2** and the reception unit **3** and acquires a plurality of reception signals corresponding to one image frame. Moreover, the acquisition is repeated and reception signals corresponding to a plurality of image frames in a predetermined period of time are acquired.

[0035] Next, the ultrasound image generation unit **4** receives the plurality of reception signals acquired in step S**001**, analyzes amplitude of the reception signals, converts each of the reception signals into a luminance signal corresponding to signal intensity thereof, performs coordinate transformation or the like of the luminance signals in such a manner that the luminance signals correspond to an orthogonal coordinate system, and successively constructs tomographic image data including a cross-sectional surface of a muscle or a bone of the shoulder. Here, time at which acquisition of a plurality of reception signals corresponding to one image frame is completed is recorded into a memory or the like as time information associated with the one image frame (step S**002**).

[0036] On the other hand, the positional information reception unit **5** acquires, from the positional information detection unit **13**, positional information which is a position, an inclination, or a combination thereof of the ultrasound probe **12**. Here, time at which the positional information is acquired is recorded into the memory or the like as time information associated with the positional information (step S**003**).

[0037] Moreover, by a video camera which is the movement detection unit **14**, a certain range including the shoulder of the human body which is the subject is shot. The movement reception unit **6** acquires movement information of a movement of the human body including the shoulder which is the subject shot by the video camera. Here, a period of time in which the movement is performed is recorded into the memory or the like as time information associated with the movement information (step S**004**).

[0038] Next, based on the movement information acquired in step S**004**, the dynamic schematic view data generation unit **7** generates schematic view image data which illustrates, in a schematic view, the movement of the human body including the shoulder of a person who is the subject (step S**005**). Specifically, motion picture information acquired from the video camera is received by the movement reception unit **6** and the dynamic schematic view data generation unit **7** compares changes in color and/or luminance value data of an image between the frames, analyzes the changes of the image between the frames, and extracts an outline of a dynamic image. Then, image data of a background and that of the other static part or image data of a part in which a movement is equal to or less than a predetermined value is deleted and motion picture data which is outline data of a dynamic image extracted from the motion picture information is generated as dynamic schematic view data. FIG. **3** is a view illustrating an example of the motion picture of when the ultrasound probe **12** is applied to the shoulder and a movement to move a right arm to a left side (inward rotation) and a movement to move the right arm to a right side (outward rotation) are performed with an elbow as a supporting point. A state in which a person who is the subject is seen from a head side is illustrated. In an image shot by the video camera, a background or the like is shot along with the human body. From the motion picture, luminance value data of the image is analyzed and an outline of the moving arm and that of the shoulder and the human body connected thereto are extracted as a schematic view of the human body.

[0039] Here, the display processing unit **8** displays, on the display unit **11**, the dynamic schematic view data generated in step S**005**. Here, the image to be displayed may be displayed as a screen in which the dynamic schematic view data and the tomographic image data generated in step S**002** are compounded. Then, by using the input unit **15**, an operator of the ultrasound diagnostic apparatus **1** specifies, in the dynamic schematic view data, a part on the screen which part corresponds to a region to which the ultrasound probe **12** is applied. The display processing unit **8** receives an input of the specified part, generates body mark image data which displays a schematic view of the ultrasound probe **12** on the specified part, and displays the body mark image data onto the display unit **11** (step S**006**). As a method to specify, in the dynamic schematic view data, a region to which the ultrasound probe **12** is applied, an outline of the ultrasound probe **12** may be extracted from color and/or luminance value data of the image in each frame of the motion picture information shot by the video camera and a position to which the ultrasound probe **12** is applied may be automatically superimposed on the dynamic schematic view data. Here, by comparison with data of color and/or shape of the ultrasound probe **12** recorded into the memory or the like in advance, the ultrasound probe **12** is detected from the image. Moreover, the positional information reception unit **5** receives angle information of an inclination detection sensor from the positional information detection unit **13** in the ultrasound probe **12** The display processing unit **8** generates data based on the angle information in such a manner that an angle of the schematic view of the ultrasound probe **12** in the body mark image data becomes identical to an angle of the ultrasound probe **12** actually applied to the subject. Also, based on positional information of the ultrasound probe **12** which information is acquired at

time identical to the time information associated with the movement information of the motion picture of the dynamic schematic view data, a position or an angle of the schematic view of the ultrasound probe **12** changes along with a change in time of the dynamic schematic view data. FIG. **4** is a view illustrating an example of displaying the body mark image data on the display unit **11**. A schematic view of the human body **16** is a display based on the dynamic schematic view data and is a motion picture. The view repeats inward rotation and outward rotation with the lapse of time. When a position or an angle in an ultrasound probe schematic view **17** displayed on the schematic view of the human body **16** changes with the lapse of time, the position or the angle changes on the schematic view of the human body **16**.

[0040] Next, the display processing unit **8** generates composite image data in which the tomographic image data generated in step S**002** and the body mark image data generated in step S**006** are compounded (step S**007**). Here, body mark image data which is based on dynamic schematic view data and positional information of the ultrasound probe **12** which are acquired at the time identical to time information associated with one image frame of the tomographic image data is compounded. FIG. **5**A and FIG. **5**B are views illustrating an example of displaying the composite image data on the display unit **11**. FIG. **5**A is a view of when the right arm is rotated inward and FIG. **5**B is a view of when the right arm is rotated outward. On the display unit **11**, an image in which a tomographic image **18** and the body mark image are compounded is displayed.

[0041] Then, the ultrasound diagnostic apparatus **1** displays the composite image data generated in step S**007** on the display unit **11** and/or stores the data into the storage unit **10**. The control unit **9** may read the data stored in the storage unit **10** and may display the read data on the display unit **11**. According to such a configuration, the following can be visually recognized as a motion picture. That is, an ultrasound diagnostic image of which position of the subject is what kind of image when the subject is in what kind of movement state.

Modification of First Embodiment

[0042] In the first embodiment, in step S**005**, schematic view image data is generated by analyzing luminance value data of an image and extracting an outline of a dynamic image in motion picture information acquired by the video camera. However, a plurality of patterns of schematic view data of a motion picture of a subject may be stored in a memory and a pattern may be selected by an operator on an input unit **15** or a pattern similar to a generated dynamic schematic view may be selected automatically. Here, for example, a sensor to detect speed, acceleration, a position, or an inclination may be attached to an arm, a fingertip, or the like of the subject as a movement detection unit **14** and a movement reception unit **6** may detect a movement of the arm in respect to a lapse of time, and thus, a dynamic schematic view data generation unit **7** may generate dynamic schematic view data in which a movement speed or an angle of a motion picture pattern selected by the operator is made identical to a movement speed or an angle of the actual arm. That is, in step S**004**, acquisition of movement information of a movement of a human body is performed not by the video camera but by the sensor to detect speed, acceleration, a position, or an inclination. Other operations and configurations of an ultrasound diagnostic apparatus **1** are similar to those of the first embodiment, and thus, description thereof is omitted.

[0043] Application to an ultrasound diagnostic apparatus or the like, which is used when a dynamic change of an ultrasound diagnostic image is observed with an observed region being moved, is possible.

[0044] According to an embodiment of the present invention, since a movement reception unit configured to acquire movement information of a subject, a dynamic schematic view data generation unit configured to generate schematic view image data illustrating a movement of the subject in a schematic view based on the movement information, and a display processing unit configured to generate composite image data in which tomographic image data and the dynamic schematic view image data are compounded based on time information are included, the ultrasound diagnostic image can be visually recognized along with the movement of the subject.

[0045] Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustrated and example only and is not to be taken by way of limitation, the scope of the present invention being interpreted by terms of the appended claims.

What is claimed is:

1. An ultrasound diagnostic apparatus configured in a manner connectable to an ultrasound probe, comprising:

a transmission unit configured to control supply of a transmission electric signal to transmit ultrasound from the ultrasound probe to a subject;

a reception unit configured to acquire a reception signal which is based on reflected ultrasound received by the ultrasound probe;

an ultrasound image generation unit configured to generate tomographic image data of the subject based on the reception signal;

a movement reception unit configured to acquire movement information of the subject;

a dynamic schematic view data generation unit configured to generate, based on the movement information, schematic view image data illustrating a movement of the subject in a schematic view; and

a display processing unit configured to generate composite image data in which the tomographic image data and the dynamic schematic view image data are compounded based on time information.

2. The ultrasound diagnostic apparatus according to claim **1**, wherein the dynamic schematic view data generation unit extracts an outline of the subject and generates the schematic view image data based on the movement information.

3. The ultrasound diagnostic apparatus according to claim **2**, wherein the dynamic schematic view data generation unit generates the schematic view image data based on predetermined schematic view data stored in advance and the movement information.

4. The ultrasound diagnostic apparatus according to claim **1**, further comprising a positional information reception unit configured to receive positional information of the ultrasound probe,

wherein the dynamic schematic view data generation unit generates, based on the positional information, body mark image data in which the schematic view image data and the positional information of the ultrasound probe are compounded.

* * * * *

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[标]申请(专利权)人(译)	柯尼卡株式会社		
申请(专利权)人(译)	柯尼卡美能达INC.		
当前申请(专利权)人(译)	柯尼卡美能达INC.		
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发明人	YOSHITOMI, HIDENORI		
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优先权	2013258913 2013-12-16 JP		
外部链接	Espacenet USPTO		

摘要(译)

以可连接到超声探头的方式配置的超声诊断设备包括：发送单元，被配置为控制发送电信号的供应以将超声从超声探头发送到对象;接收单元，被配置为获取基于的接收信号。超声探头接收的反射超声，基于接收信号生成对象的断层图像数据的超声图像生成单元，被配置为获取对象的运动信息的运动接收单元，动态示意图数据生成单元，被配置为基于移动信息生成示意图，该示意图图像数据示意性地示出了对象在示意图中的移动;以及显示处理单元，被配置为生成合成图像数据，其中基于断层图像数据和动态示意图图像数据被合成。准时信息。