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NAKAMURA et al.(10) **Pub. No.: US 2012/0197127 A1**(43) **Pub. Date: Aug. 2, 2012**(54) **ULTRASOUND DIAGNOSTIC APPARATUS
AND ULTRASOUND IMAGE PRODUCING
METHOD**(75) Inventors: **Kenji NAKAMURA**, Kanagawa
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Tokyo (JP)(21) Appl. No.: **13/338,983**(22) Filed: **Dec. 28, 2011**(30) **Foreign Application Priority Data**

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Publication Classification(51) **Int. Cl.**
A61B 8/14 (2006.01)(52) **U.S. Cl.** **600/447**(57) **ABSTRACT**

An ultrasound diagnostic apparatus comprises a transducer array for transmitting ultrasonic beams to a subject, a multiplexer for sequentially selecting one channel of reception signal in every N number of channels of reception signals out of a plurality of channels of reception signals outputted from the transducer array which has received receiving ultrasonic echoes from the subject, a plurality of reception signal processors for sequentially processing an N number of channels of reception signals selected by the multiplexer to produce reception data, a beam former for performing beam forming on reception data sequentially produced by the plurality of reception signal processors and having time difference to produce sound ray signals, and an image producing unit for producing an ultrasound image based on the sound ray signals produced by the beam former.

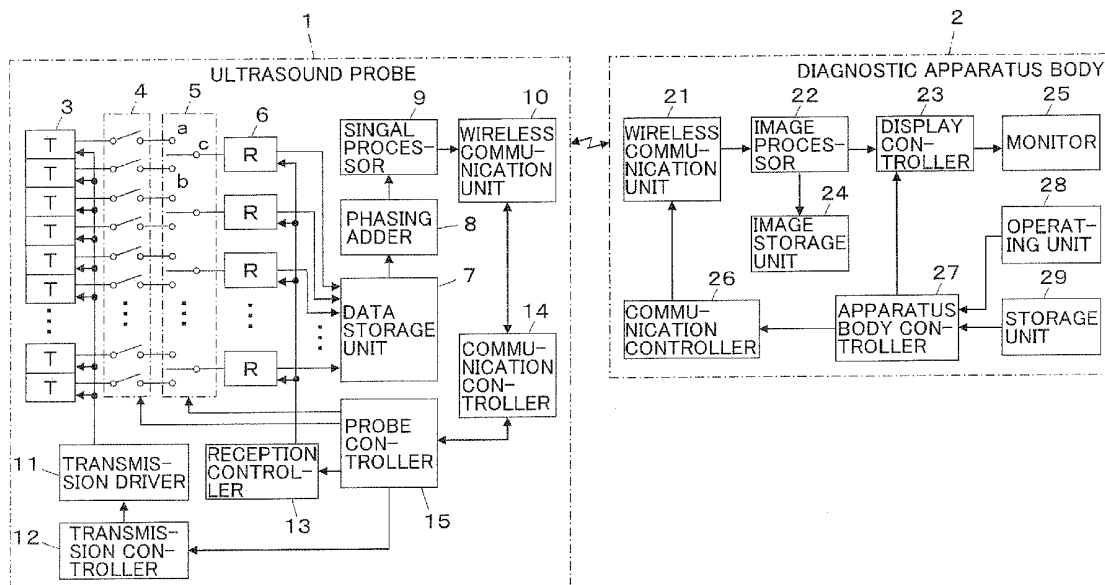


FIG. 1

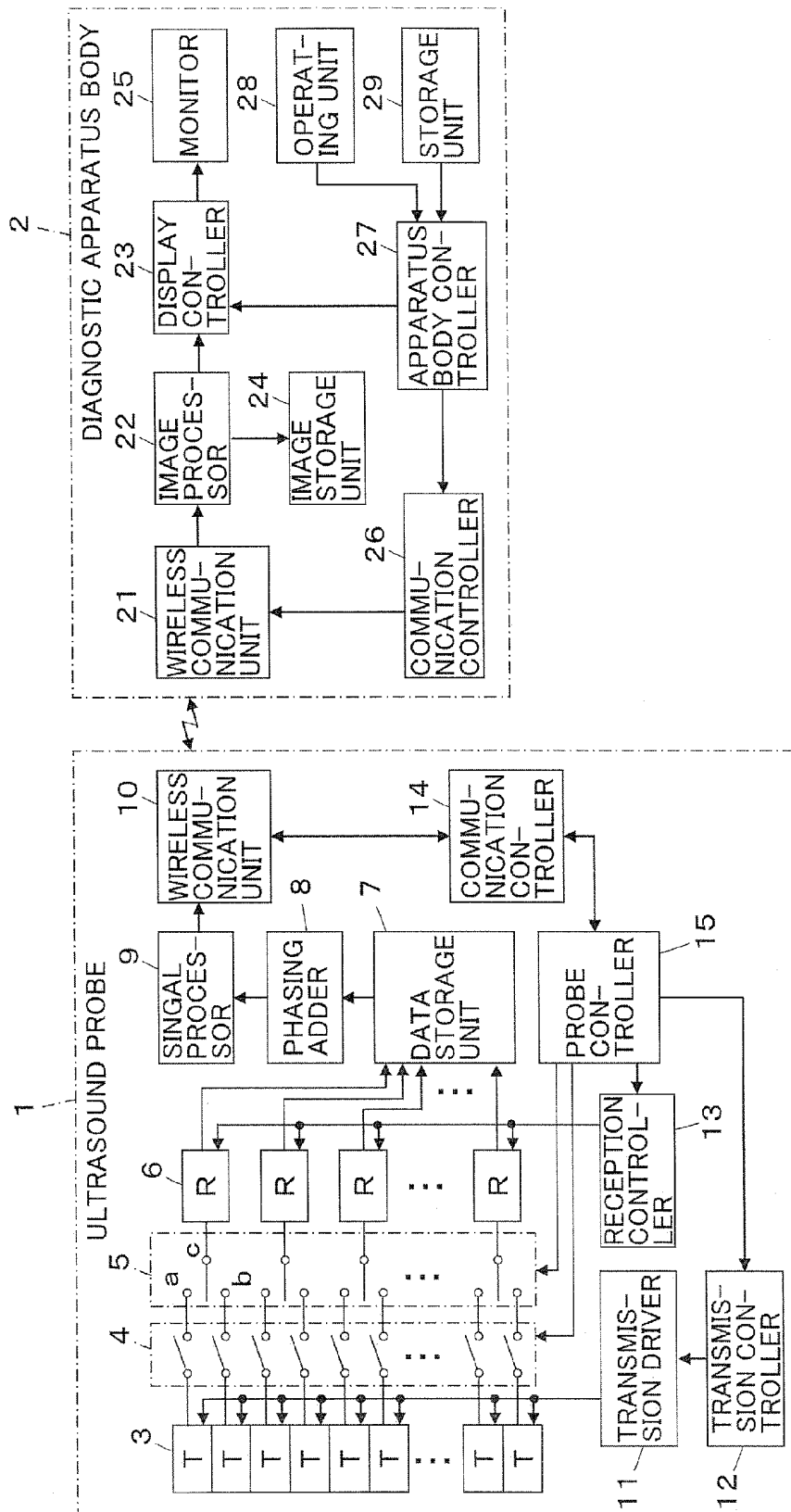


FIG. 2

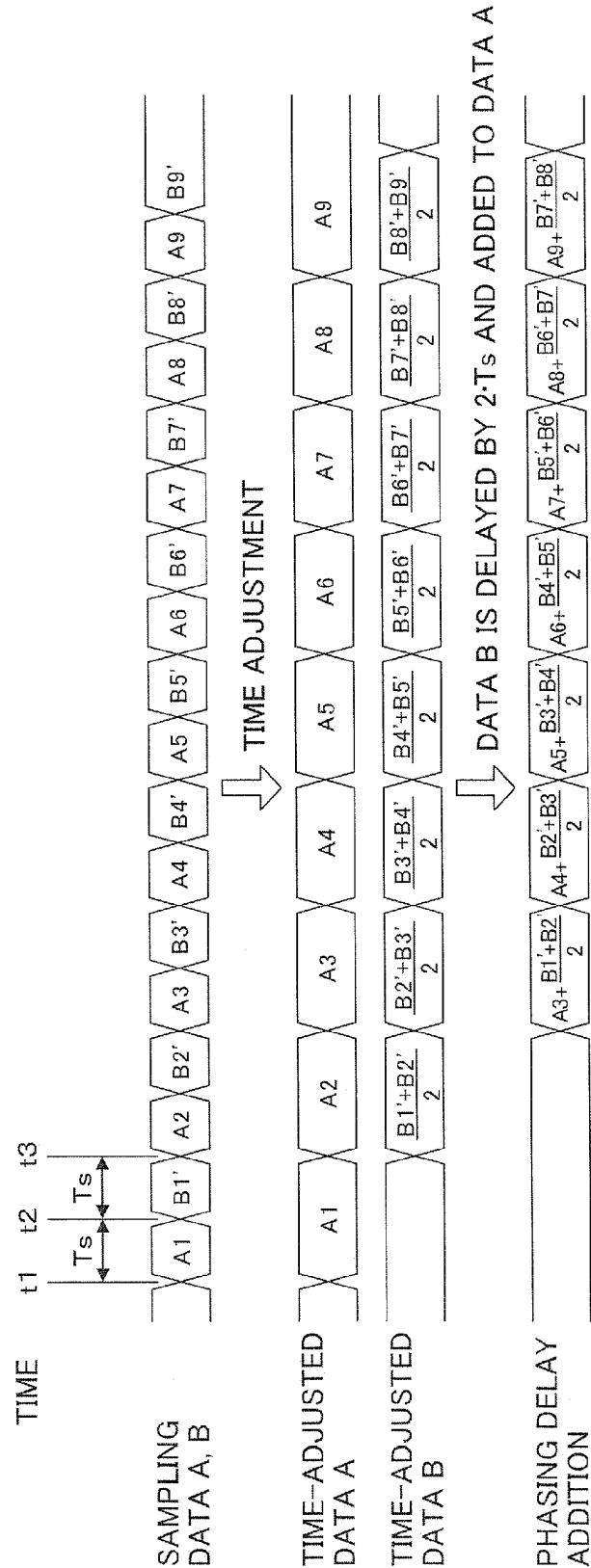


FIG. 3

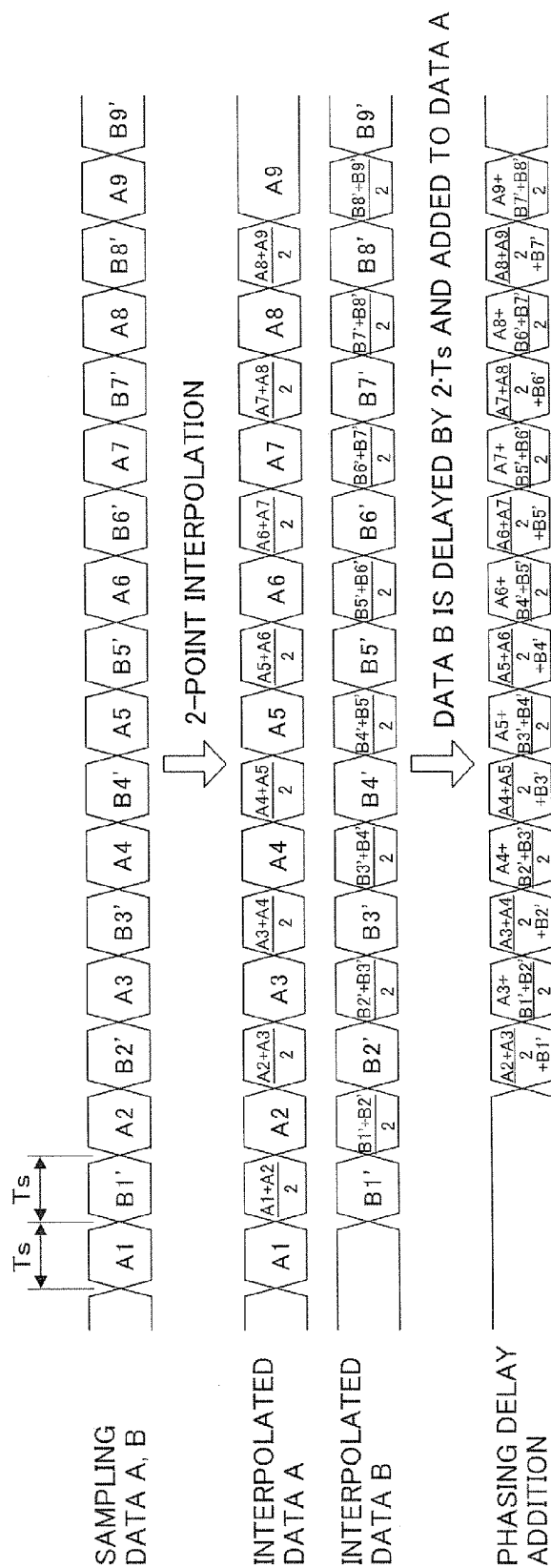


FIG. 4

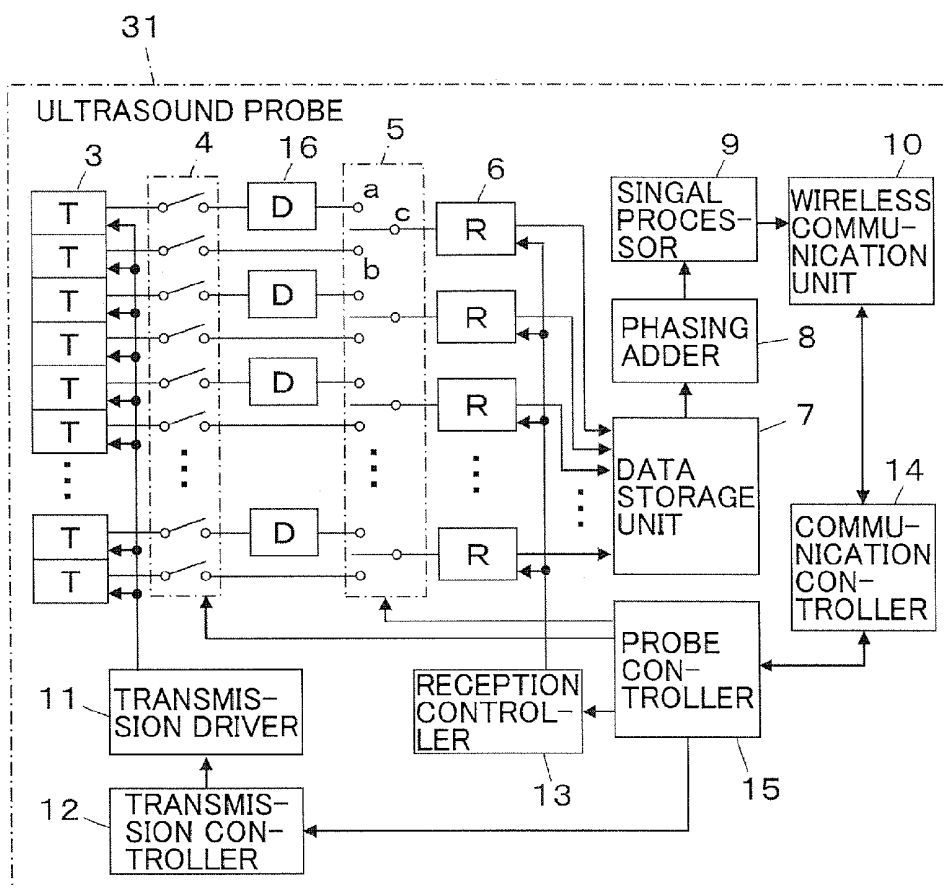
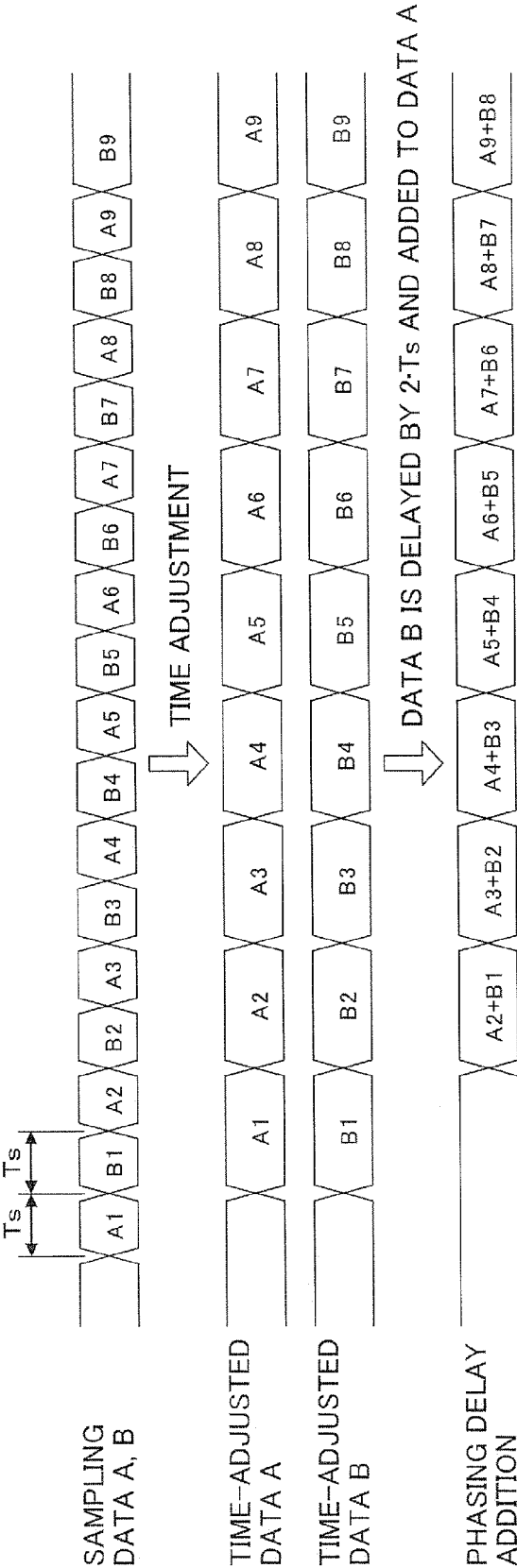


FIG. 5



ULTRASOUND DIAGNOSTIC APPARATUS AND ULTRASOUND IMAGE PRODUCING METHOD

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an ultrasound diagnostic apparatus and an ultrasound image producing method and particularly to reduction in electric power consumption by an ultrasound diagnostic apparatus for giving a diagnosis based on an ultrasound image produced by transmission and reception of ultrasonic waves from a transducer array of an ultrasound probe.

[0002] Conventionally, ultrasound diagnostic apparatus using ultrasound images are employed in the medical field. In general, this type of ultrasound diagnostic apparatus includes an ultrasound probe equipped with a built-in transducer array and an apparatus body connected to the ultrasound probe. The ultrasound probe transmits ultrasonic waves toward a subject and receives ultrasonic echoes from the subject. The received signals are then electrically processed in the apparatus body to generate an ultrasound image.

[0003] In recent years, there have been developed portable ultrasound diagnostic apparatus that can be brought to a bed or transported to a site for emergency medical care. This type of ultrasound diagnostic apparatus uses a battery for power supply, and, therefore, the power consumption of the apparatus greatly affects the time length of continuous use thereof. Since the amount of heat generated inside the apparatus increases with the power consumption, the dimensions of the apparatus needs to be increased as a measure to release heat, reducing the benefit of portability.

[0004] In particular, in a wireless probe connected wirelessly to the apparatus body, since transmission and reception circuits for transmitting ultrasonic waves from the transducers and receiving ultrasound echoes need to be housed in a compact probe, a great reduction in power consumption is demanded in these circuits.

[0005] Reduction in the number of mounted transmission and reception circuits would accordingly save on power consumption but when the number of simultaneous apertures also decreases with the number of transmission and reception circuits, high quality images are no longer to be obtained.

[0006] JP 2000-139912 A describes an ultrasound diagnostic apparatus wherein, in order to enable signal reception with broad apertures even when small-angle deflection is effected, the signals from a plurality of adjacent transducers are unequally added up to reduce the number of reception signals, followed by digital conversion and phasing delay addition by a beam former.

SUMMARY OF THE INVENTION

[0007] However, the apparatus described in JP 2000-139912 A still requires signal processors in a number corresponding to the reduced number of the reception signals, making it difficult to save on power consumption in the probe.

[0008] An object of the present invention is to provide an ultrasound diagnostic apparatus and an ultrasound image producing method that enable saving on power consumption while obtaining high quality images.

[0009] An ultrasound diagnostic apparatus according to the present invention comprises:

[0010] a transducer array for transmitting ultrasonic beams to a subject and receiving ultrasonic echoes from the subject;

[0011] a multiplexer for sequentially selecting one channel of reception signal in every N number of channels of reception signals out of a plurality of channels of reception signals outputted from the transducer array which has received receiving ultrasonic echoes from the subject;

[0012] a plurality of reception signal processors for sequentially processing an N number of channels of reception signals selected by the multiplexer to produce reception data;

[0013] a beam former for performing beam forming on reception data sequentially produced by the plurality of reception signal processors and having time difference to produce sound ray signals; and

[0014] an image producing unit for producing an ultrasound image based on the sound ray signals produced by the beam former.

[0015] An ultrasound diagnostic method according to the present invention comprises the steps of:

[0016] transmitting an ultrasonic beam from a transducer array to a subject;

[0017] sequentially selecting one channel of reception signal in every N number of channels of reception signals out of a plurality of channels of reception signals outputted from the transducer array which has received receiving ultrasonic echoes from the subject;

[0018] producing reception data by sequentially processing a selected N number of channels of reception signals;

[0019] beam forming reception data sequentially produced and having time difference to produce sound ray signals; and

[0020] producing an ultrasound image based on the produced sound ray signals.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] FIG. 1 is a block diagram illustrating a configuration of an ultrasound diagnostic apparatus according to Embodiment 1 of the invention.

[0022] FIG. 2 is a timing chart illustrating how signal processing is performed in Embodiment 1.

[0023] FIG. 3 is a timing chart illustrating how signal processing is performed in Embodiment 2.

[0024] FIG. 4 is a block diagram illustrating a configuration of an ultrasound probe used in an ultrasound diagnostic apparatus according to Embodiment 3.

[0025] FIG. 5 is a timing chart illustrating how signal processing is performed in Embodiment 3.

DETAILED DESCRIPTION OF THE INVENTION

[0026] Embodiments of the present invention will be described below based on the appended drawings.

Embodiment 1

[0027] FIG. 1 illustrates a configuration of an ultrasound diagnostic apparatus according to Embodiment 1 of the invention. The ultrasound diagnostic apparatus comprises an ultrasound probe 1 and a diagnostic apparatus body 2 that is connected to the ultrasound probe 1 via wireless communication.

[0028] The ultrasound probe 1 includes a plurality of ultrasound transducers 3 constituting a plurality of channels of a one-dimensional or two-dimensional transducer array, and a plurality of reception signal processors 6 is connected to the transducers 3 via a reception signal connecting section 4 and a multiplexer 5. A data storage unit 7 is connected to the reception signal processors 6, and a wireless communication

unit 10 is connected to the data storage unit 7 via a phasing adder 8 and a signal processor 9 in sequence. Also, a transmission controller 12 is connected to the transducers 3 via a transmission driver 11, a reception controller 13 is connected to the reception signal processors 6, and a communication controller 14 is connected to the wireless communication unit 10. Further, a probe controller 15 is connected to the transmission controller 12, the reception controller 13, and the communication controller 14.

[0029] The transducers 3 each transmit ultrasonic waves according to driving signals supplied from the transmission driver 11 and receive ultrasonic echoes from the subject to output reception signals. Each of the transducers 3 is composed of an oscillator including, for example, a piezoelectric body made of a piezoelectric ceramic typified by PZT (lead zirconate titanate) or a piezoelectric polymer typified by PVDF (polyvinylidene fluoride) and an electrode provided on each end of the piezoelectric body.

[0030] When the electrodes of each of the oscillators are supplied with a pulsed voltage or a continuous-wave voltage, the piezoelectric body expands and contracts to cause the oscillator to produce pulsed or continuous ultrasonic waves. These ultrasonic waves are combined to form an ultrasonic beam. Upon reception of propagating ultrasonic waves, the piezoelectric body of each oscillator expands and contracts to produce an electric signal, which is then outputted as an ultrasonic reception signal.

[0031] The transmission driver 11 includes, for example, a plurality of pulsers and adjusts the delay amounts of driving signals for the respective transducers 3 based on a transmission delay pattern selected by the transmission controller 12 so that the ultrasonic waves transmitted from the transducers 3 form a broad ultrasonic beam covering an area of a tissue of the subject to be diagnosed and supplies the transducers 3 with adjusted driving signals.

[0032] The reception signal connecting section 4 comprises a plurality of switches connecting and disconnecting between the transducers 3 and corresponding input terminals of the multiplexer 5. According to the instruction by the probe controller 15, the reception signal connecting section 4 is turned off during transmission of ultrasonic waves and turned on during reception of ultrasonic waves to connect the transducers 3 to the corresponding input terminals of the multiplexer 5.

[0033] The multiplexer 5 is a 2:1 multiplexer having one output terminal c for a pair of input terminals a and b and alternately connects the input terminals a and b to the output terminal c at a predetermined sampling period Ts according to the instruction from the probe controller 15.

[0034] Specifically, out of a plurality of channels of reception signals, two channels of reception signals from two transducers 3 adjacent to each other are alternately connected to the respective reception signal processor 6 at a predetermined sampling period Ts via each of the switches of the reception signal connecting section 4 turned on during ultrasonic wave reception.

[0035] Under the control by the reception controller 13, each of the reception signal processors 6 subjects the reception signal outputted from the transducers 3 connected via the reception signal connecting section 4 and the multiplexer 5 to quadrature detection or quadrature sampling to produce a complex baseband signal and samples the complex baseband signal to produce reception data containing information on the area of the tissue. The reception signal processors 6 may

produce reception data by performing high efficiency coding data compression on the data obtained by sampling the complex baseband signals.

[0036] The data storage unit 7 is configured by, for example, a memory and stores at least one frame of reception data produced by the reception signal processors 6.

[0037] The phasing adder 8, constituting a beam former in this invention, selects one reception delay pattern from a plurality of previously stored reception delay patterns according to a reception direction set by the controller 15 and, based on the selected reception delay pattern, provides respective delays in a plurality of complex baseband signals represented by the reception data and adds them up thereby to perform beam forming on reception data produced by the reception signal processors 6 and having time differences among them. This beam forming yields baseband signals (sound ray signals) in which the focal points of the ultrasonic echoes are made to converge.

[0038] The signal processor 9 corrects attenuation of the sound ray signal produced by the phasing adder 8, the attenuation depending on a distance in accordance with a depth of a position at which ultrasonic waves are reflected, and then converts the sound ray signal into an image signal compatible with an ordinary television signal scanning mode (raster conversion) to produce a B mode image signal, tomographic image information, on a tissue inside the subject.

[0039] The wireless communication unit 10 performs carrier modulation based on the B mode image signal produced by the signal processor 9 to produce transmission signals and supplies an antenna with the transmission signals so that the antenna transmits radio waves to achieve transmission of the B mode image signal. The modulation methods that may be employed herein include ASK (Amplitude Shift Keying), PSK (Phase Shift Keying), QPSK (Quadrature Phase Shift Keying), and 16QAM (16 Quadrature Amplitude Modulation).

[0040] The wireless communication unit 10 transmits the B mode image signal to the diagnostic apparatus body 2 through wireless communication with the diagnostic apparatus body 2, receives various control signals from the diagnostic apparatus body 2, and outputs the received control signals to the communication controller 14. The communication controller 14 controls the wireless communication unit 10 so that the B mode image signal is transmitted with a transmission wave intensity that is set by the probe controller 15 and outputs various control signals received by the wireless communication unit 10 to the probe controller 15.

[0041] The probe controller 15 controls various components in the ultrasound probe 1 according to control signals transmitted from the diagnostic apparatus body 2.

[0042] The ultrasound probe 1 has a built-in battery, not shown, which supplies electric power to the circuits inside the ultrasound probe 1.

[0043] The ultrasound probe 1 may be an external type probe such as linear scan type, convex scan type, and sector scan type or a probe of, for example, a radial scan type used for an ultrasound endoscope.

[0044] On the other hand, the diagnostic apparatus body 2 comprises a wireless communication unit 21, which is connected to an image processor 22. A display controller 23 and an image storage unit 24 are connected to the image processor 22, and a monitor 25 is connected to the display controller 23. Also, a communication controller 26 is connected to the wireless communication unit 21, and an apparatus body con-

troller 27 is connected to the display controller 23 and the communication controller 26. Further, an operating unit 28 for an operator to perform input operations and a storage unit 29 for storing, for example, operation programs are connected to the apparatus body controller 27.

[0045] The wireless communication unit 21 transmits various control signals to the ultrasound probe 1 through wireless communication with the ultrasound probe 1. The wireless communication unit 21 demodulates a signal received through an antenna to output a B mode image signal.

[0046] The communication controller 26 controls the wireless communication unit 21 so that various control signals are transmitted with a transmission radio wave intensity that is set by the apparatus body controller 27.

[0047] The image processor 22 performs various processings required including gradation processing on the B mode image signal inputted from the communication controller 26 and outputs the B mode image signal to the display controller 23 or stores the B mode image signal in the image storage unit 24.

[0048] The display controller 23 causes the monitor 25 to display an ultrasound diagnostic image according to the B mode image signal processed by the image processor 22. The monitor 25 includes a display device such as an LCD, for example, and displays an ultrasound diagnostic image under the control of the display controller 23.

[0049] In such diagnostic apparatus body 2, the image processor 22, the display controller 23, the communication controller 26, and the apparatus body controller 27 are constituted by a CPU and operation programs for causing the CPU to perform various kinds of processing, but they may be constituted by digital circuits. The aforementioned operation programs are stored in the storage unit 29. The storage unit 29 may be formed by a recording medium such as a hard disk, a flexible disk, an MO, an MT, a RAM, a CD-ROM, a DVD-ROM, a SD card, a CF card, a USB memory, or a server.

[0050] Next, the operation of Embodiment 1 will be described.

[0051] Upon starting of ultrasound diagnosis, the probe controller 15 first turns off the switches of the reception signal connecting section 4, and in this state, the plurality of transducers 3 constituting the transducer array transmit ultrasonic waves according to the driving signals supplied from the transmission driver 11 of the ultrasound probe 1.

[0052] Upon termination of transmission of ultrasonic waves from the transducers 3, the probe controller 15 immediately turns on the switches of the reception signal connecting section 4, connecting the transducers 3 to the corresponding input terminals of the multiplexer 5. In this time, the multiplexer 5 alternately connects the input terminals a and b to one output terminal c at the predetermined sampling period Ts according to the instruction by the probe controller 15. Accordingly, a reception signal from one transducer 3 whose channel is connected to the input terminal a of the multiplexer 5 is supplied to one reception signal processor 6 to produce reception data A, thereafter a reception signal from a neighboring transducer 3 whose channel is connected to the input terminal b of the multiplexer 5 is supplied to the reception signal processor 6 to produce reception data B. That is, the reception data A and the reception data B are alternately produced by each of the reception signal processors 6 and stored in the data storage unit 7 in sequence.

[0053] As illustrated in FIG. 2, for example, a reception signal from one transducer 3 whose channel is connected to

the input terminal a of the multiplexer 5 is sampled by one reception signal processor 6 at time t1 to produce first reception data A1. At time t2 after a given sampling period Ts has elapsed from time t1, a reception signal from a neighboring transducer 3 whose channel is connected to the input terminal b of the multiplexer 5 is sampled by the reception signal processor 6 to produce first reception data B1'. Similarly, at time t3 after the given sampling period Ts has elapsed from time t2, a reception signal from the one transducer 3 whose channel is connected to the input terminal a of the multiplexer 5 is sampled by the reception signal processor 6 to produce second reception data A2.

[0054] Thus, one reception signal processor 6 alternately processes the reception signals from two channels of transducers 3.

[0055] The reception data based on the reception signals from the neighboring transducer 3 whose channel is connected to the input terminal b of the multiplexer 5 are labeled with "" attached such as "B1'" for the sake of convenience to show that they are data sampled at a timing the given sampling period Ts later than the reception data based on the reception signals from the one transducer 3 whose channel is connected to the input terminal a.

[0056] Thus, the reception data A1, B1', A2, B2', A3, B3', . . . produced at intervals of the given sampling period Ts are stored in the data storage unit 7.

[0057] The phasing adder 8 first makes time adjustment between the reception data A1, A2, A3, . . . based on the reception signals from the one transducer 3 whose channel is connected to the input terminal a of the multiplexer 5 and the reception data B1', B2', B3' . . . based on the reception signals from the neighboring transducer 3 whose channel is connected to the input terminal b of the multiplexer 5 to eliminate time difference between the reception data A1, A2, A3, . . . and the reception data B1', B2', B3',

[0058] For example, out of the two channels connected to the input terminals a and b of the multiplexer 5, let the channel connected to the input terminal a be a base channel. Then, because the reception data A1, A2, A3, . . . for this base channel are sampled once every two periods (2·Ts), these data are handled as data for two periods (2·Ts) to form the time-adjusted reception data A.

[0059] On the other hand, as to the reception data B in the other channel than the base channel, i.e., the channel connected to the input terminal b of the multiplexer 5, the reception data B1', for example, is data obtained by sampling at a timing earlier than the reception data A2 of the base channel by one sampling period Ts, and the reception data B2' is data obtained by sampling at a timing later than the reception data A2 of the base channel by one sampling period Ts. Therefore, a temporal 2-point interpolated value $(B1' + B2')/2$ between the reception data B1' and B2' is calculated and thus calculated value is regarded as data for 2 periods (2·Ts) sampled at the same timing as the reception data A2. Similarly, 2-point interpolated values $(B2' + B3')/2$, $(B3' + B4')/2$, $(B4' + B5')/2$, . . . , which can be regarded as data sampled at the same timing as the reception data A3, A4, A5, . . . , respectively, are calculated to obtain time-adjusted reception data B.

[0060] Subsequently, the phasing adder 8 adds the reception data A and the reception data B with making a delay therebetween corresponding to the reception direction set by the probe controller 15. FIG. 2 illustrates results of, for example, the reception data B being delayed by 2 periods (2·Ts) and added to the reception data A.

[0061] The reception signals from two transducers **3** neighboring to each other are likewise alternately processed by each of the reception signal processors **6**, until all the reception signals from the transducers **3** are processed, whereupon the phasing adder **8** performs beam forming to produce sound ray signals.

[0062] Then, based on the sound ray signals produced by the phasing adder **8**, a B-mode image signal is produced by the signal processor **9** and wirelessly transmitted via the wireless communication unit **10** to the diagnostic apparatus body **2**. The B mode image signal received by the wireless communication unit **21** is suffered with image processing including gradation processing by the image processor **22**, and based on this processed B-mode image signal, an ultrasound diagnostic image is displayed on the monitor **25** by the display controller **23**.

[0063] Because Embodiment 1 has a configuration such that the reception signals from two transducers **3** are processed by one reception signal processor **6** using the 2:1 multiplexer **5**, in comparison with a number of channels of transducers **3**, only half a number of reception signal processors **6** need be mounted. Therefore, high-quality images can be obtained while greatly saving on power consumption.

[0064] The sampling period T_s may be one that is selected as appropriate. However, because the reception signals from two transducers **3** are processed by one reception signal processor **6**, the multiplexer **5** needs to be operated at twice the frequency of the data formed by the phasing addition. For example, in order to obtain data formed by the phasing addition at a frequency of 40 MHz, the multiplexer **5** may be operated at a frequency of 80 MHz and therefore the sampling period T_s may be 1.25 ns.

[0065] In place of the 2:1 multiplexer **5**, an N:1 ($N \geq 3$) multiplexer may be used to sequentially select one channel of reception signal in every N number of channels of reception signals, so that one reception signal processor may sequentially processes an N number of channels of reception signals to produce reception data. In this case, out of the reception signals of the N number of channels, the reception signals of the (N-1) number of channels other than the base channel may be temporally interpolated to make time adjustment.

Embodiment 2

[0066] Although in Embodiment 1, the 2-point interpolation is performed on only the reception data B for time adjustment among the reception data A and the reception data B produced by the respective reception signal processors **6**, the time adjustment may be made by performing the 2-point interpolation on both channels of reception data, the reception data A and B.

[0067] As illustrated in FIG. 3, because the reception data A1, A2, A3, . . . are sampled once in every two periods ($2 \cdot T_s$), the reception data A for every sampling period T_s is formed by sequentially performing the 2-point interpolation on the reception data A1, A2, A3, . . . , and, similarly, the reception data B for every sampling period T_s is formed by sequentially performing the 2-point interpolation on the reception data B1', B2', B3', . . . sampled once in every two periods ($2 \cdot T_s$).

[0068] Subsequently, the reception data A and the reception data B may be added with making a delay therebetween corresponding to the reception direction set by the probe controller **15**. FIG. 3 illustrates results of, for example, the reception data B being delayed by 2 periods ($2 \cdot T_s$) and added to the reception data A.

[0069] The above process forms the reception data A and B for every sampling period T_s , and therefore enables reduction in the number of the reception signal processors **6** required, making it possible to obtain images having a still higher image quality while saving on power consumption.

[0070] Also according to Embodiment 2, an N:1 ($N \geq 3$) multiplexer may be used in place of the 2:1 multiplexer **5** to sequentially select one channel of reception signal in every N number of channels of reception signals, so that one reception signal processor sequentially processes an N number of channels of reception signals to produce reception data. In this case, the time adjustment may be made by temporally interpolating all the N number of channels of reception signals.

Embodiment 3

[0071] FIG. 4 illustrates the internal structure of an ultrasound probe **31** used in an ultrasound diagnostic apparatus according to Embodiment 3. As compared with the ultrasound probe **1** illustrated in FIG. 1, the ultrasound probe **31** has a delay circuit **16** inserted between each input terminal a of pairs of terminals a and b of the multiplexer **5** and the corresponding switch of the reception signal connecting section **4**. The other components are the same as those of the ultrasound probe **1** according to Embodiment 1.

[0072] The delay circuits **16** have a delay time T_d of the same length as the sampling period T_s and delay the reception signals from the transducers **3** whose channels are connected to the input terminals a of the multiplexer **5** by the delay time T_d with respect to the reception signals from the transducers **3** whose channels are connected to the input terminals b.

[0073] According to Embodiment 3, out of the two channels connected to the input terminals a and b of the multiplexer **5**, the channel connected to the input terminal b is the base channel, and the reception signal of the other channel than the base channel, i.e., the channel connected to the input terminal a of the multiplexer **5** is delayed by the delay time T_d with respect to the reception signal of the base channel.

[0074] The multiplexer **5** so operates that the reception data B in the base channel is sampled with a delay corresponding to the sampling period T_s with respect to the reception data A in the other channel than the base channel. Therefore, the reception data A and B that are the same as those sampled at the same timing with respect to each other's channel can be obtained by delaying the reception signal of the other channel than the base channel by the delay time T_d having the same length as the sampling period T_s through the corresponding delay circuit **16**.

[0075] Thus, as illustrated in FIG. 5, the phasing adder **8** makes time adjustment such that the reception data A and B are each for 2 periods ($2 \cdot T_s$) and have the same timing as each other, subsequently adds the reception data A and the reception data B with making a delay therebetween corresponding to the reception direction set by the probe controller **15**. FIG. 5 illustrates results of, for example, the reception data B being delayed by 2 periods ($2 \cdot T_s$) and added to the reception data A.

[0076] The above process reduces the number of the reception signal processors **6** required, thus making it possible to obtain images having a still higher image quality while saving on power consumption without conducting the interpolation process as required in Embodiments 1 and 2.

[0077] Also in Embodiment 3, an N:1 ($N \geq 3$) multiplexer may be used in place of the 2:1 multiplexer **5** to sequentially select one channel of reception signal in every N number of channels of reception signals, so that one reception signal

processor sequentially processes an N number of channels of reception signals to produce reception data. In this case, out of the reception signals of the N number of channels, the reception signals of the (N-1) number of channels other than the base channel may be each delayed by delay times corresponding to their respective channels to eliminate the time difference among the reception signals.

[0078] Although the ultrasound probe **1** or **31** and the diagnostic apparatus body **2** are connected to each other by wireless communication in Embodiments 1 to 3, the invention is not limited thereto. The ultrasound probe **1** or **31** may be connected to the diagnostic apparatus body **2** via a connection cable. Such configuration obviates the necessity of providing the wireless communication unit **10** and the communication controller **14** of the ultrasound probe **1** or **31**, the wireless communication unit **21** and the communication controller **26** of the diagnostic apparatus body **2**, and the like.

What is claimed is:

1. An ultrasound diagnostic apparatus comprising:
 - a transducer array for transmitting ultrasonic beams to a subject and receiving ultrasonic echoes from the subject;
 - a multiplexer for sequentially selecting one channel of reception signal in every N number of channels of reception signals out of a plurality of channels of reception signals outputted from the transducer array which has received receiving ultrasonic echoes from the subject;
 - a plurality of reception signal processors for sequentially processing an N number of channels of reception signals selected by the multiplexer to produce reception data;
 - a beam former for performing beam forming on reception data sequentially produced by the plurality of reception signal processors and having time difference to produce sound ray signals; and
 - an image producing unit for producing an ultrasound image based on the sound ray signals produced by the beam former.
2. The ultrasound diagnostic apparatus according to claim 1, wherein the beam former performs beam forming after eliminating the time difference by temporally interpolating reception data of respective channels.
3. The ultrasound diagnostic apparatus according to claim 2, wherein the beam former temporally interpolates reception data other than reception data of a base channel out of reception data of an N number of channels sequentially produced by the respective reception signal processors.

4. The ultrasound diagnostic apparatus according to claim 2, wherein the beam former temporally interpolates all reception data of an N number of channels sequentially produced by the respective reception signal processors.

5. The ultrasound diagnostic apparatus according to claim 1, further comprising delay circuits for delaying reception signals other than reception signals of base channels out of the N number of reception signals selected by the multiplexer to eliminate time difference among respective reception signals.

6. An ultrasound diagnostic method comprising the steps of:

transmitting an ultrasonic beam from a transducer array to a subject;

sequentially selecting one channel of reception signal in every N number of channels of reception signals out of a plurality of channels of reception signals outputted from the transducer array which has received receiving ultrasonic echoes from the subject;

producing reception data by sequentially processing a selected N number of channels of reception signals;

beam forming reception data sequentially produced and having time difference to produce sound ray signals; and

producing an ultrasound image based on the produced sound ray signals.

7. The ultrasound diagnostic method according to claim 6, wherein beam forming is performed after eliminating time difference by temporally interpolating reception data of respective channels.

8. The ultrasound diagnostic method according to claim 7, wherein reception data other than reception data of a base channel out of reception data of an N number of channels sequentially produced by reception signal processors are temporally interpolated.

9. The ultrasound image producing method according to claim 7, wherein all reception data of an N number of channels sequentially produced by reception signal processors are temporally interpolated.

10. The ultrasound diagnostic apparatus according to claim 6, wherein reception signals other than reception signals of the base channels out of the N number of reception signals are delayed to eliminate time difference among respective reception signals.

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专利名称(译)	超声诊断设备和超声图像产生方法		
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[标]申请(专利权)人(译)	村上 博		
申请(专利权)人(译)	中村, KENJI 村上, HIROSHI		
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外部链接	Espacenet USPTO		

摘要(译)

超声诊断设备包括：换能器阵列，用于将超声波束发送到对象;复用器，用于从换能器阵列输出的多个接收信号通道中的每N个接收信号通道中顺序地选择一个接收信号通道。已接收到来自对象的超声回波，多个接收信号处理器，用于顺序处理由多路复用器选择的N个通道的接收信号以产生接收数据，用于对由多个顺序产生的接收数据进行波束成形的波束形成器接收信号处理器具有时间差以产生声线信号，以及图像产生单元，用于基于由波束形成器产生的声线信号产生超声图像。

