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(54) **Ultrasound system and method of forming ultrasound data**

Ultraschallsystem und Verfahren zur Bildung von Ultraschalldaten

Système ultrasonore et procédé pour former des données ultrasonores

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Description

TECHNICAL FIELD

[0001] The present disclosure generally relates to an ultrasound system and method of forming ultrasound data, and more particularly to a system and method of forming ultrasound data independent of a synthetic aperture.

BACKGROUND

[0002] Recently, an ultrasound system has been extensively used in the medical field due to its non-invasive and non-destructive nature. Specifically, in the ultrasound system, there is no need to perform any surgical operation procedures. Using the ultrasound system allows a medical professional to see the inside of a target object as a high-resolution video image to facilitate operations. As such, the ultrasound system has become very popular in the medical field.

[0003] The ultrasound system transmits ultrasound signals to the target object by using an ultrasound probe. The ultrasound probe has a plurality of transducer elements and can receive ultrasound signals (ultrasound echo signals) reflected from the target object, which then forms an ultrasound image showing the inside of the target object.

[0004] To improve the resolution of the ultrasound image, a plurality of array type transducer elements are used. Using a number of the transducer elements prevents the ultrasound signal from being diffused compared to using a single transducer element. As such, the ultrasound signal can be electrically focused to thereby improve sensitivity.

[0005] Focusing ultrasound signals include transmit focusing and receive focusing. In the transmit focusing, the transmit order of the ultrasound signals transmitted from each of the transducer elements is determined by a distance difference between each of the transducer elements and the focusing point. As such, the ultrasound signals transmitted from each of the transducer elements, which contribute to a single transmitting/receiving of the ultrasound signals (i.e., formation of one scan line), are simultaneously added at one focusing point in phase. This causes the amplitude of the transmitting ultrasound signals (i.e., ultrasound beams) to peak. In the receive focusing, each of the ultrasound signals reaching the transducer elements are subject to time-delay. This allows the ultrasound signals reflected from the focusing point to be in phase. Many focusing points are required to improve the resolution of the ultrasound image. Further, to produce one ultrasound image, there must be a repetition of same signal processing procedures for all the focusing points, which deteriorates the frame rate.

[0006] To solve the above-described problem, a dynamic receive focusing was used wherein transmit focusing points were fixed and receive focusing points were increased, which allowed the ultrasound signals to be finely focused. In the dynamic receive focusing, the transmit focusing points are fixed so that the resolution of the ultrasound image can be improved. As an alternative measure, there was proposed a method of using all transmit focusing signals of adjacent transmit scan lines to acquire ultrasound data of the transmit scan lines.

[0007] Further, to improve the lateral resolution of the ultrasound image and the signal-to-noise ratio (SNR), it is ideal to direct the received signal obtained from all transducer elements (channels) contributed to a single reception of the ultrasound signals to a beam former. This implements synthetic aperture imaging (SAI) at a full frame rate, wherein the received signal constitutes more proper radio frequency (RF) data obtained from the received signal. To achieve this, however, it is necessary to simultaneously form low resolution images (LRIs) corresponding to all scan lines and update high resolution images (HRIs), which are already formed by using each of the LRIs. To do this, the received signals must be corresponded at all transducer elements, which are contributed to the single reception of the ultrasound signals, to each of the scan lines, thereby significantly increasing hardware complexity.

[0008] The WO 2007/133878 A2 describes an ultrasonic diagnostic imaging system producing an image with an extended focal range by transmitting a plurality of beams spaced along an array for multiline reception. The receive multilines of a plurality of transmit beams are spatially aligned and are combined with phase adjustment between the respective receive multilines to prevent undesired phase cancellation. The combined multilines produce the effect of an extended transmit focus so that an image produced using the combined multilines exhibits an extended focal range. To prevent motion artifacts the multiline order is adjustable as a function of image motion.

SUMMARY

[0009] It is an object of the present disclosure to provide an ultrasound system and method of forming ultrasound data corresponding to each receive scan line independent of a synthetic aperture.

[0010] An aspect of the present disclosure encompasses an ultrasound system according to claim 1.

[0011] Another aspect of the present disclosure encompasses a method according to claim 9.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIG. 1 is a block diagram showing the architecture of an ultrasound system in accordance with one embodiment of the present disclosure.

FIG. 2 is a detailed block diagram showing an ultrasound data acquisition unit shown in Fig. 1 in accordance with the embodiment of the present disclosure.

FIG. 3 is a detailed block diagram showing an ultrasound data forming unit shown in Fig. 2 in accordance with the embodiment of the present disclosure.

FIG. 4 is an illustrative diagram showing transmit scan lines and receive scan lines in accordance with an embodiment of the present disclosure.

FIG. 5 is an illustrative diagram showing the formation of ultrasound data in accordance with an embodiment of the present disclosure.

FIG. 6 is an illustrative diagram showing an ultrasound data forming unit in accordance with another embodiment of the present disclosure.

FIG. 7 is an illustrative diagram showing an ultrasound data forming unit in accordance with yet another embodiment of the present disclosure.

FIG. 8 is an illustrative diagram showing an ultrasound data forming unit in accordance with yet another embodiment of the present disclosure.

FIG. 9 is an illustrative diagram showing an ultrasound data forming unit in accordance with still yet another embodiment of the present disclosure.

FIG.10 is an illustrative diagram showing an ultrasound data forming unit in accordance with still yet another embodiment of the present disclosure.

DETAILED DESCRIPTION

[0013] A detailed description is provided with reference to the accompanying drawings.

[0014] FIG. 1 is a block diagram showing the architecture of an ultrasound system in accordance with one embodiment of the present disclosure. Referring to FIG.1, the ultrasound system 100 includes a user input unit 110, an ultrasound data acquisition unit 120, a processor 130 and a display unit 140.

[0015] The user input unit 110 receives information input by a user. In the embodiment, the input information includes transmit (Tx) synthesis information. The Tx synthesis information includes information related to the number of scan lines (receive scan lines) to be simultaneously formed by transmitting ultrasound signals once. The user input unit 110 includes a control panel, a mouse, a key board, etc.

[0016] The ultrasound data acquisition unit 120 transmits the ultrasound signals to a target object and receive ultrasound signals (i.e., ultrasound echo signals) reflected therefrom to thereby acquire ultrasound data. The ultrasound data acquisition unit 120 will be described in more detail with reference to FIG. 2.

[0017] FIG. 2 is a detailed block diagram showing the ultrasound data acquisition unit shown in FIG. 1 in accordance with the embodiment of the present disclosure.

[0018] Referring to FIG. 2, the ultrasound data acquisition unit 120 includes an ultrasound probe 121, a transmit signal forming unit 122 and an ultrasound data forming unit 123.

[0019] The ultrasound probe 121 includes a plurality of transducer elements 121a, which allows electrical signals and ultrasound signals to be interchangeable. The ultrasound probe 121 converts the electrical signals (hereinafter referred to as transmit signals) provided thereto from the transmit signal forming unit 122 into the ultrasound signals to be transmitted to the target object. The ultrasound probe 121 receives ultrasound echo signals reflected from the target object to form the electrical signals (hereinafter referred to as receive signals), wherein the electrical signals are analog signals.

[0020] The transmit signal forming unit 122 forms the transmit signals in view of the position of the transducer elements 121a and focusing points. In the embodiment, the transmit signal forming unit 122 includes a transmit focus delay memory (not shown) for storing therein delay patterns of the ultrasound signals to be transmitted to the target object through the transducer elements 121a. Thus, the ultrasound signals transmitted from each of the transducer elements 121a are focused along the scan lines (hereinafter referred to as transmit (Tx) scan lines) to form an ultrasound beam.

[0021] The ultrasound data forming unit 123, which is responsive to the received signals provided thereto from the ultrasound probe 121, performs analog-to-digital conversion on the received signals to form digital data. The ultrasound data forming unit 123 also forms ultrasound data of each of the scan lines (hereinafter referred to as receive (Rx) scan lines) corresponding to the Tx scan lines based on the digital data input thereto. The ultrasound data forming unit 123 is implemented by at least one application specific integrated circuit (ASIC) having a plurality of receive channels (not shown) as its inputs (i.e., a plurality of inputs).

[0022] FIG. 3 is a detailed block diagram showing the ultrasound data forming unit shown in FIG. 2 in accordance with the embodiment of the present disclosure. Referring to FIG.3, the ultrasound data forming unit 123 includes a first data storing unit 310, a focusing delay calculation unit (FDCU) 320, a first data forming unit 330, a second data forming unit 340, a second data storing unit 350 and a control unit 360. The ultrasound data forming unit 123 further includes an amplifying unit (not shown) configured to amplify the analog received signals provided thereto from the ultrasound probe 121, as well as an analog-to-digital convert (ADC) (not shown) configured to convert the analog amplified received signals into digital data.

[0023] The first data storing unit 310 stores the digital data provided thereto from a plurality of receive channels (not shown) therein. In the embodiment, the first data storing unit 310 includes a plurality of storage areas (not shown), each of which corresponding to each of the receive channels on a one-to-one basis and storing therein digital data corresponding thereto.

[0024] The FDCU 320 stores a receive delay curve lookup table, which is used in receive-focusing the digital data in view of positions of the transducer elements 121a and focusing points.

[0025] In general, the ASIC (the ultrasound data forming unit 123) requires receive delay curve lookup tables by the number of input channels (i.e., number of receive channels serviced by ASIC) in receive-focusing the digital data stored in the first data storing unit 310 to form one receive scan line. In case of simultaneously forming the plurality of receive scan lines with a single transmission of the ultrasound signals, the ASIC requires receive delay curve lookup tables, which correspond to (number of receive channels serviced by ASIC) × (number of receive scan lines simultaneously formed). In this case, the ASIC includes a minimum number of receive delay curve lookup tables in view of the capacity of the ASIC.

[0026] Thus, to minimize the number of the receive delay curve lookup tables, the receive delay curve lookup tables required for the plurality of receive scan lines simultaneously formed, are shared. In case the receive scan lines simultaneously formed in the ASIC are placed adjacent to each other and are disposed at regular intervals on the transducer elements 121a of the ultrasound probe 121, the receive delay curve lookup tables of the adjacent receive scan lines are shared with each other.

[0027] For example, the simultaneously-formation of 32 receive scan lines through the use of digital data of 32 receive channels requires 1024 (32×32) receive delay curve lookup tables. Alternatively, sharing the receive delay curve lookup tables of adjacent receive scan lines allows the number of the receive delay curve lookup table to be reduced. Assuming that all of the receive scan lines are disposed on the transducer elements 121a of the ultrasound probe 121 at regular intervals, M^{th} receive scan line is in a curve on which receive delay curve of $(M-1)^{th}$ receive scan line is shifted by one. In other words, if the distance between the $(M-1)^{th}$ receive scan line and the receive channels is -15, -14, ···, 0, 1, ···, 15, 16, then the distance between the M^{th} receive scan line and the receive channels is -16, -15, -14, ···, 0, 1, ···, 14, 15 and the position of the $(M-1)^{th}$ receive scan line [-15 to 16] is shifted to the right by one in the M^{th} receive scan line. This allows a new position [-16] to be produced. As described above, the receive delay curve lookup tables for the M^{th} receive scan line share 31 of the receive delay curves used in the $(M-1)^{th}$ receive scan line. As such, it is only necessary to add one table to 32 receive delay curve lookup tables required for $(M-1)^{th}$ receive scan line for focus of M^{th} receive scan line. As such, in case of forming 32 receive scan lines, the required number of the scan delay curve lookup tables is derived from (number of receive channels serviced by ASIC) + ((number of receive scan lines simultaneously formed) -1).

[0028] Based on the receive delay curve lookup tables stored in the FDCU 320, the first data forming unit 330 time-delays the digital data stored in the first data storing unit 310 and simultaneously form data (hereinafter referred to as scan line data) corresponding to each of the receive scan lines.

[0029] The second data forming unit 340 accumulates scan line data corresponding to the receive scan lines of the same position among the scan line data provided thereto from the first data forming unit 330, thereby producing accumulated data.

[0030] The second data storing unit 350 stores the accumulated data produced at the second data forming unit 340 therein in a sliding manner. The sliding manner will be described below. In the embodiment, the second data storing unit 350 includes a plurality of storage areas (not shown) for storing the accumulated data therein.

[0031] The control unit 360 sets a storage start position of the data (i.e., accumulated data) based on the input information (i.e., transmit synthesis information) provided thereto from the user input unit 110. The control unit 360 controls the storage of the scan line data and the formation of the ultrasound data. Furthermore, the control unit 360 controls the storage of the digital data and the formation of the scan line data.

[0032] A description will be made with reference to FIGS. 4 and 5 as to an example for forming ultrasound data corresponding to the receive scan lines by using the ultrasound data forming unit having a plurality of receive channels as its input, when 5 receive scan lines are simultaneously formed with respect to one transmit scan line (i.e., when the number of transmit synthesis is 5).

[0033] FIG. 4 is an illustrative diagram showing transmit scan lines and receive scan lines in accordance with an embodiment of the present disclosure. FIG.5 is an illustrative diagram showing the formation of ultrasound data in accordance with an embodiment of the present disclosure.

[0034] The ultrasound probe 121 transmits ultrasound signals to a target object along a first transmit scan line Tx_0 and receives ultrasound echo signals reflected therefrom.

[0035] A plurality of digital data is provided from each of the receive channels. The plurality of digital data is stored in a storing area (not shown) corresponding thereto.

[0036] Based on the receive delay curve lookup tables stored in the FDCU 320, the first data forming unit 330 applies receive-delays to the plurality of the digital data stored in the first data storing unit 310, thereby producing scan line data $Rx_{0,0}$, $Rx_{0,1}$ and $Rx_{0,2}$ of each of receive scan lines Rx_0 to Rx_2 corresponding to the first transmit scan line Tx_0.

[0037] The control unit 360 sets a first storing start position in the second data storing unit 350 based on the input information (i.e., transmit synthesis information) provided thereto from the user input unit 110. As an example, the control unit 360 sets the first storing start position (SSP) in the second data storing unit 350 by the following equation (1).

$$SSP = \text{round}\,(K/2) \qquad (1)$$

[0038] In the equation (1), round ( ) denotes rounding off to the nearest whole number and K indicates the number of the transmit synthesis.

[0039] That is, the control unit 360 sets the storing area M_2 corresponding to the storing start position (SSS=3=round(5/2) with reference to the first storing area M_0 of the second data storing unit 350, as shown in FIG. 5.

[0040] The second data forming unit 340 accumulates scan line data corresponding to the receive scan lines of the same position, among the scan line data provided therefrom, the first data forming unit 330 under the control of the control unit 360 to thereby produce accumulated data. That is, as to the receive scan lines of the same position, the second data forming unit 340 accumulates the scan line data provided from the first data forming unit 330 with the accumulated data already stored in the second data storing unit 350, thereby forming new accumulated data.

[0041] More specifically, the second data forming unit 340 accumulates the scan line data $Rx_{0,0}$ provided thereto from the first data forming unit 330 with the accumulated data already stored in a storing area M_3 of the second data storing unit 350 by reference to a first storing start position M_2, thereby producing accumulated data $AD_{1,0}$. In this case, the accumulated data already stored in the storing area M_3 are a stored predetermined value (0). In $Ad_{i,j}$, i indicates an accumulated number and j indicates position of the receive scan lines. The accumulated data $AD_{1,0}$ is stored in a storing area of the second data storing unit 350, i.e., storing area M_2 corresponding to the first storing start position under the control of the control unit 360.

[0042] The second data forming unit 340 accumulates the scan line data $Rx_{0,1}$ provided thereto from the first data forming unit 330 with accumulated data already stored in a storing area M_4 of the second data storing unit 350, thereby producing new accumulated data $AD_{1,1}$. The accumulated data $AD_{1,1}$ is stored in the storing area M_3 of the second data storing unit 350 by reference to the first start storing start position M_2 under the control of the control unit 360.

[0043] The second data forming unit 340 accumulates the scan line data $Rx_{0,2}$ provided thereto from the first data forming unit 330 with accumulated data already stored in a storing area M_5 of the second data storing unit 350, thereby producing accumulated data $AD_{1,2}$. The accumulated data $AD_{1,2}$ is stored in the storing area M_4 of the second data storing unit 350 by reference to the first storing start position M_2 under the control of the control unit 360.

[0044] Next, the ultrasound probe 121 transmits ultrasound signals to the target object along a second transmit scan line Tx_1 and receives ultrasound echo signals reflected therefrom. A plurality of digital data is provided from each of the receive channels. The plurality of digital data is stored in a storing area (not shown) corresponding thereto.

[0045] Based on the receive delay curve lookup tables stored in the FDCU 320, the first data forming unit 330 applies receive-delays to the plurality of the digital data stored in the first data storing unit 310 to thereby form scan line data $Rx_{1,0}$, $Rx_{1,1}$, $Rx_{1,2}$ and $Rx_{1,3}$ of each of receive scan lines Rx_0, Rx_1, Rx_2 and Rx_3 corresponding to a second transmit scan line Tx_1.

[0046] The control unit 360 sets the storing area M_1, which is shifted to the left by one, by reference to the first storing start position M_2 of the second data storing unit 350 as a new storing start position (hereinafter referred to as a second storing start position).

[0047] Under the control of the control unit 360, the second data forming unit 340 accumulates scan line data corresponding to the receive scan lines of the same position to thereby form accumulated data. More specifically, the second data forming unit 340 accumulates each of the scan line data $Rx_{1,0}$, $Rx_{1,1}$, $Rx_{1,2}$ and $Rx_{1,3}$ provided thereto from the first data forming unit 330 with each of the accumulated data $AD_{1,0}$, $AD_{1,1}$, $AD_{1,2}$ and 0 already stored in each of the storing areas M_2, M_3, M_4 and M_5 by reference to the second storing start position M_1 of the second data storing unit 350, thereby producing new accumulated data $AD_{2,0}$, $AD_{2,1}$, $AD_{2,2}$ and $A,D_{1,3}$. Each of the new accumulated data $AD_{2,0}$, $AD_{2,1}$, $AD_{2,2}$ and $AD_{1,3}$ is stored in each of the storing areas M_1 to M_4 corresponding thereto by reference to the second storing start position M_1.

[0048] Next, the ultrasound probe 121 transmits ultrasound signals to the target object along a third transmit scan line Tx_2 and receives ultrasound echo signals reflected therefrom. A plurality of digital data is provided from each of the receive channels. The plurality of digital data is stored in a storing area (not shown) corresponding thereto.

[0049] Based on the receive delay curve lookup tables stored in the FDCU 320, the first data forming unit 330 applies receive-delays to the digital data stored in the first data storing unit 310 to thereby form scan line data $Rx_{2,0}$, $Rx_{2,1}$, $Rx_{2,2}$, $Rx_{2,3}$ and $Rx_{2,4}$ of each of receive scan lines Rx_0, Rx_1, Rx_2, Rx_3 and Rx_4 corresponding to the third transmit scan line Tx_2.

[0050] The control unit 360 sets the storing area M_0, which is shifted to the left by one, by reference to the second storing start position M_1 of the second data storing unit 350 as a new storing start position (hereinafter referred to as a third storing start position).

[0051] Under the control of the control unit 360, as to the receive scan lines of the same position, the second data forming unit 340 accumulates each of the scan line data $Rx_{2,0}$, $Rx_{2,1}$, $Rx_{2,2}$, $Rx_{2,3}$ and $Rx_{2,4}$ provided thereto from the first data forming unit 330 with each of the accumulated data $AD_{2,0}$, $AD_{2,1}$, $AD_{2,2}$, $AD_{1,3}$ and 0 already stored in each of the storing areas M_1, M_2, M_3, M_4 and M_5 by reference to the third storing start position M_0 of the second data storing unit 350, thereby producing new accumulated data $AD_{3,0}$, $AD_{3,1}$, $AD_{3,2}$, $AD_{2,3}$ and $AD_{1,4}$. The formed accumulated data $AD_{3,0}$, $AD_{3,1}$, $AD_{3,2}$, $AD_{2,3}$ and $AD_{1,4}$ are stored in the storing areas M_0 to M_4 based on the third storing start position M_0 under the control of the control unit 360.

[0052] Next, the ultrasound probe 121 transmits ultrasound signals to the target object along a fourth transmit scan line Tx_3 and receives ultrasound echo signals reflected therefrom. A plurality of digital data is provided from each of the receive channels. Each of the plurality of digital data is stored in a corresponding storing area (not shown) of the first data storing unit 310.

[0053] Based on the receive delay curve lookup tables stored in the FDCU 320, the first data forming unit 330 applies receive-delays to the digital data stored in the first data storing unit 310 to thereby form scan line data $Rx_{3,1}$, $Rx_{3,2}$, $Rx_{3,3}$, $Rx_{3,4}$ and $Rx_{3,5}$ of each of the receive scan lines Rx_1, Rx_2, Rx_3, Rx_4 and Rx_5 corresponding to the fourth transmit scan line Tx_3.

[0054] Since the third storing start position of the second data storing unit 350 is the first storing area M_0, no further setting on a new storing start position is performed at the control unit 360.

[0055] Under the control of the control unit 360, as to the receive scan lines of the same position, the second data forming unit 340 accumulates each of the scan line data $Rx_{3,1}$, $Rx_{3,2}$, $Rx_{3,3}$, $Rx_{3,4}$ and $Rx_{3,5}$ provided thereto from the first data forming unit 330 with each of the accumulated data $AD_{3,1}$, $AD_{3,2}$, $AD_{2,3}$, AD_1, 4 and 0 already stored in each of the storing areas M_0 to M_5 by reference to the third storing start position M_0 of the second data storing unit 350, thereby producing new accumulated data $AD_{4,1}$, $AD_{4,2}$, $AD_{3,3}$, $AD_{2,4}$ and $AD_{1,5.}$ Each of the new accumulated data $And_{4,1}$, $AD_{4,2}$, $AD_{3,3}$, $AD_{2,4}$ and $AD_{1,5}$ is stored in each of storing areas M_0 to M_4 corresponding thereto by reference to the third storing start position M_0 under the control of the control unit 360. In this case, the accumulated data $AD_{3,0}$ is outputted as the ultrasound data corresponding to the receive scan line Rx_0, without further storing in the second data storing unit 350.

[0056] Next, the ultrasound probe 121 transmits ultrasound signals to the target object along a fifth transmit scan line Tx_4 and receives ultrasound echo signals reflected therefrom. A plurality of digital data is provided from each of the receive channels. Each of the digital data is stored in a corresponding storing area (not shown) of the first data storing unit 310.

[0057] Based on the receive delay curve lookup tables stored in the FDCU 320, the first data forming unit 330 applies receive-delays to the digital data stored in the first data storing unit 310 to thereby form scan line data $Rx_{4,2}$, $Rx_{4,3}$, $Rx_{4,4}$, $Rx_{4,5}$ and $Rx_{4,6}$ of each of receive scan lines Rx_2, Rx_3, Rx_4, Rx_5 and Rx_6 corresponding to the fifth transmit scan line Tx_4.

[0058] Since the third storing start position of the second data storing unit 350 is the first storing area M_0, no further setting on a new storing start position is performed at the control unit 360.

[0059] Under the control of the control unit 360, as to the receive scan line of the same position, the second data forming unit 340 accumulates each of the scan line data $Rx_{4,2}$, $Rx_{4,3}$, $Tx_{4,4}$, $Rx_{4,5}$ and $Rx_{4,6}$ provided thereto from the first data forming unit 330 with each of the accumulated data $AD_{4,1}$, $AD_{4,2}$, $AD_{3,3}$, $AD_{2,3}$, $AD_{1,5}$ and 0 already stored in each of the storing areas M_0 to M_5 by reference to the third storing start position M_0 of the second data storing unit 350, thereby producing new accumulated data $AD_{5,2}$, $AD_{4,3}$, $AD_{3,4}$, $AD_{2,5}$ and $AD_{1,6}$. Each of the new accumulated data $AD_{5,2}$, $AD_{4,3}$, $AD_{3,4}$, $AD_{2,5}$ and $AD_{1,6}$ is stored in each of the storing area M_0 to M_4 by reference to the third storing start position M_0 under the control of the control unit 360. In this case, the accumulated data $AD_{4,1}$ is outputted as the ultrasound data corresponding to the receive scan line Rx_1 without further storing in the second data storing unit 350.

[0060] The ultrasound data forming unit 123 produces ultrasound data $AD_{5,2}$, $AD_{5,3}$, ··· corresponding to each of the receive scan lines Rx_2, Rx_3, ··· by repeating the above-mentioned procedures.

[0061] FIG. 6 is an illustrative diagram showing the ultrasound data forming unit in accordance with an embodiment of the present disclosure. Referring to FIG. 6, the ultrasound data forming unit 123 has 32 receive channels ch_0 to ch_{31} as its inputs. In order words, the ultrasound data forming unit 123 includes an ASIC 610 with 32 inputs.

[0062] As shown in FIG. 3, the ASIC 610 includes the first data storing unit 310, the FDCU 320, the first data forming unit 330, the second data forming unit 340, the second data storing unit 350 and the control unit 360.

[0063] The ASIC 610 sets a storing start position (SSP=16) of the second data storing unit 350 based on a transmit synthesis number (K=32) and shift to the left by one the storing start position of the second data storing unit 350 with respect to each of the transmit scan lines every transmission of the ultrasound signals. The ASIC 610 accumulates scan line data corresponding to the receive scan lines of the same position to thereby produce accumulated data. Next, each of the accumulated data, which is produced by reference to the storing start position, is stored in a corresponding storing area of the second data storing unit 350.

[0064] Thus, if the scan line data corresponding to the receive scan lines of the same position are accumulated (i.e., synthesized) by (transmit synthesis number/2) or the transmit synthesis number, and no storing area to be further shifted in the second data storing unit 350 is detected, then the ASIC 610 outputs accumulated data $AD_{16,0}$, $AD_{17,0}$, $AD_{18,0}$, ··· output from the second data storing unit 350 as ultrasound data corresponding to each of the receive scan lines Rx_0, Rx_1, Rx_2, ···.

[0065] In accordance with the embodiment, in case the ultrasound data of the receive scan lines is formed with the help of the ASIC 610 having 32 receive channels as its inputs, the number of the ASIC is increased by the transmit synthesis number rather than the number of the total receive scan lines. This allows further simple implementations of the ultrasound data forming unit 123 over the prior art.

[0066] Even though the embodiment has been described with respect to the ultrasound data forming unit 123 having 32 receive channels as its inputs (i.e., 32 inputs), in another embodiment, the ultrasound data forming unit 123 has 128 receive channels as its inputs (i.e., 128 inputs), as shown in FIG. 7. In this case, the ultrasound data forming unit 123 includes first to fourth ASICs 710 to 740, each of which has 32 receive channels as its inputs. Also, each of the first to fourth ASICs 710 to 740 includes the first data storing unit 310, the FDCU 320, the first data forming unit 330, the second data forming unit 340, the second data storing unit 350 and the control unit 360, as shown in FIG. 3.

[0067] FIG.8 is an illustrative diagram showing an ultrasound data forming unit in accordance with another embodiment of the present disclosure. Referring to FIG.8, the ultrasound data forming unit 123 includes 64 receive channels ch_0 to ch_{63} as its inputs, i.e., 64 inputs. The ultrasound data forming unit 123 may further include a first ASIC 810 and a second ASIC 820.

[0068] The first ASIC 810 may have 32 receive channels ch_0 to ch_{31} as its inputs. The first ASIC 810 includes the first data storing unit 310, the FDCU 320, the first data forming unit 330, the second data forming unit 340, the second data storing unit 350 and the control unit 360, as shown in FIG. 3. The first ASIC 810 further includes an adding unit 370.

[0069] The first ASIC 810 forms ultrasound data $AD_{16,0}$, $AD_{17,1}$, ⋯ corresponding to the receive scan lines Rx_0, Rx_1, ⋯ based on the digital data provided thereto from the receive channels ch_0 to ch_{31}, as described above.

[0070] The second ASIC 820 has 32 receive channels ch_{31} to ch_{63} as its inputs. The second ASIC 820 includes the first data storing unit 310, the FDCU 320, the first data forming unit 330, the second data forming unit 340, the second data storing unit 350 and the control unit 360, as shown in FIG. 3. The second ASIC 820 further includes the adding unit 370.

[0071] The second ASIC 820 forms ultrasound data $AD'_{16,0}$, $AD'_{17,1}$, ⋯ corresponding to the receive scan lines Rx_0, Rx_1, ⋯ based on the digital data provided thereto from the receive channels ch_{31} to ch_{63}. The second ASIC 820 adds the ultrasound data $AD_{16,0}$, $AD_{17,1}$, ⋯ provided thereto from the first ASIC 810 and the ultrasound data $AD'_{16,0}$, $AD'_{17,1}$, ⋯ provided thereto from the second ASIC 820 through the help of the adding unit 370, thereby outputting the ultrasound data corresponding to the receive scan lines Rx_0, Rx_1, ⋯. At this time, the adding unit 370 performs an addition on ultrasound data corresponding to the receive scan lines of the same position.

[0072] Even though the embodiment has been described for the addition of the ultrasound data from the first ASIC 810 and the ultrasound data from the second ASIC 820 at the adding unit 370 of the second ASIC 820, in another embodiment, the addition of the ultrasound data from the first ASIC 810 and the ultrasound data from the second ASIC 820 is performed at the adding unit 370 of the first ASIC 810.

[0073] FIG. 9 is an illustrative diagram showing an ultrasound data forming unit in accordance with yet another embodiment of the present disclosure. The ultrasound data forming unit 123 defines an ASIC group 910 having a plurality of ASICs based on the transmit synthesis number.

[0074] As an example, if each of the first and second ASICs 911 and 912 has 32 receive channels ch_0 to ch_{31} as its inputs and simultaneously form 32 receive scan lines, then the ultrasound data forming unit 123 defines the ASIC group 910 having the first and second ASICs 911 and 912 based on the transmit synthesis number (K=64), as shown in FIG. 9. Herein, each of the first and second ASICs 911 and 912 may include the first data storing unit 310, the FDCU 320, the first data forming unit 330, the second data forming unit 340, the second data storing unit 350 and the control unit 360, as shown in FIG. 3.

[0075] The ultrasound data forming unit 123 allocates indexes M_0 to M_{31} to the storing areas of the second data storing unit 350 in the first ASIC 911 and allocate indexes M_{32} to M_{63} to the storage areas of the second data storing unit 350 in the second ASIC 912. Thus, the ultrasound data forming unit 123 forms the ultrasound data of the receive scan lines in a sliding manner, as shown in FIG. 9.

[0076] FIG. 10 is an illustrative diagram showing an ultrasound data forming unit in accordance with still yet another embodiment of the present disclosure. The ultrasound data forming unit 123 defines a plurality of ASIC groups based on the number of receive channels and the transmit synthesis number.

[0077] As an example, when the number of the receive channels is 64 and each of the first to fourth ASICs 1011, 1012, 1021 and 1022 has 32 receive channels ch_0 to ch_{31} as its inputs to simultaneously form 32 receive scan lines, the ultrasound data forming unit 123 defines a first ASIC group 1010 and an second ASIC group 1020 based on the transmit synthesis number (K=64), as shown in FIG. 10.

[0078] The first ASIC group 1010 has 32 receive channels ch_0 to ch_{31} as its inputs. The first ASIC group 1010 includes the first ASIC 1011 and the second ASIC 1012. Herein, each of the first ASIC 1011 and the second ASIC 1012 has 32 receive channels ch_0 to ch_{31} as its inputs and may include the first data storing unit 310, the FDCU 320, the first data forming unit 330, the second data forming unit 340, the second data storing unit 350 and the control unit 360, as shown in FIG. 3. Each of the first ASIC 1011 and the second ASIC 1012 further includes the adding unit 370. The first ASIC group 1010 forms the ultrasound data $AD_{16,0}$, $AD_{17,1}$, ⋯ corresponding to the receive scan lines Rx_0, Rx_1, ⋯, as described above.

[0079] The second ASIC group 1020 has 32 receive channels ch_{32} to ch_{63} as its inputs. The second ASIC group 1020 includes the third ASIC 1021 and the fourth ASIC 1022. Herein, each of the third ASIC 1021 and the fourth ASIC 1022 has 32 receive channels ch_{32} to ch_{63}

as its inputs and includes the first data storing unit 310, the FDCU 320, the first data forming unit 330, the second data forming unit 340, the second data storing unit 350 and the control unit 360, as shown in FIG. 3. Each of the third ASIC 1021 and the fourth ASIC 1022 further includes the adding unit 370. The second ASIC group 1020 forms the ultrasound data $AD'_{16,0}$, $AD'_{17,1}$, ··· corresponding to the receive scan lines Rx_0, Rx_1, ···, as described above. The second ASIC group 1020 adds the ultrasound data $AD_{16,0}$, $AD_{17,1}$, ··· provided thereto from the first ASIC group 1010 and the ultrasound data $AD'_{16,0}$, $AD'_{17,1}$, ··· provided thereto from the second ASIC group 1020 through the use of the adding unit 370 of the third ASIC 1021 to thereby output ultrasound data corresponding to the receive scan lines Rx_0, Rx_1, ···. At this time, the adding unit 370 adds ultrasound data corresponding to the receive scan lines of the same position.

[0080] Even though the embodiment has been described for the addition of the ultrasound data from the first ASIC group 1010 and the ultrasound data from the second ASIC group 1020 at the adding unit 370 of the third ASIC 1021, in another embodiment, the addition of the ultrasound data from the first ASIC group 1010 and the ultrasound data from the second ASIC group 1020 is performed at the adding unit 370 of at least one of the first to fourth ASICs 1011 to 1022.

[0081] Referring back to FIG. 1, the processor 130 is connected with the user input unit 110 and the ultrasound data acquisition unit 120. The processor 130 processes the ultrasound data provided thereto from the ultrasound data acquisition unit 120 to form an ultrasound image. The display unit 140 displays the ultrasound image formed at the processor 130.

[0082] As an example, even though, in the above embodiments, setting of data storing start positions by the sliding manner are performed based on the transmit synthesis information provided from the user input unit 110, in another embodiment, automatic setting of the transmit synthesis number allows the data storing start positions to be set by the sliding manner based on the transmit synthesis number set.

[0083] Since the ultrasound data corresponding to each of the receive scan lines may be formed independent of the synthetic aperture as described above, the ultrasound system in accordance with the present disclosure will be implemented with low cost and low complexity.

Claims

1. An ultrasound system (100) of forming ultrasound data, comprising:

    an ultrasound data forming unit (123) having a plurality of receive channels
    wherein the ultrasound data forming unit (123) is configured to perform the functions of:

    A. storing data provided from the receive channels in a first data storing unit (310);
    B. receive-focusing the data based on receive delay curve lookup tables to form scan line data corresponding to each of receive scan line to be simultaneously formed in a single transmission of ultrasound signals;
    C. setting a storing start position on a second data storing unit (350) having a plurality of consecutively numbered storage areas based on the number of the receive scan lines to be simultaneously formed;
    D. accumulating the scan line data corresponding to the receive scan lines of the same position to form accumulated data;
    E. storing the accumulated data in the second data storing unit (350) based on the storing start position; and
    F. shifting the storing start position by one towards a lower numbered storage area to reset the storing start position, and

    wherein the ultrasound data forming unit (123) is further configured to perform the functions A, B, D, E, F until no storing area to be further shifted in the second data storing unit (350) is detected, and then to perform the functions A, B, D, E and outputting the accumulated data stored in the first storage area of the second data storing unit (350) before function E.

2. The ultrasound system (100) of Claim 1, wherein the ultrasound data forming unit (123) includes:

    a focusing delay calculation unit (320) configured to store the receive delay curve lookup tables;
    a first data forming unit (330) configured to receive-focus the data stored in the first data storing unit (310) based on the receive delay curve lookup tables to thereby form the scan line data corresponding to each of the receive scan lines;
    a second data forming unit (340) configured to accumulate the scan line data corresponding to the receive scan lines of the same position to thereby form the accumulated data; and
    a control unit (360) configured to set the storage position based on the number of the receive scan lines to be simultaneously formed and shift the storage start position towards a lower numbered storage area, thereby resetting the storing start position.

3. The ultrasound system (100) of Claim 2, wherein the ultrasound data forming unit (123) is configured to:

    accumulate the accumulated data already stored in the second data storing unit (350) and scan line data newly formed by the first forming unit (330) to form new accumulated data; and output the new accumulated data formed by accumulating the accumulated data stored in a first storage area of the second data storing unit (350) and the scan line data as the ultrasound data corresponding to each of the receive scan lines.

4. The ultrasound system (100) of Claim 2, wherein the focusing delay calculation unit (320) is configured to share in the receive scan lines the receive delay curve lookup tables required in forming the scan line data corresponding to each of the receive scan lines.

5. The ultrasound system (100) of Claim 2, wherein the ultrasound data forming unit (123) is configured to be implemented by at least one application specific integrated circuit.

6. The ultrasound system (100) of Claim 5, wherein the receive channels include N receive channels and M receive channels;
wherein the ultrasound data forming unit (123) further includes:

a first application specific integrated circuit having the N receive channels as its inputs and being configured to form a first ultrasound data corresponding to each of the receive scan lines based on data provided thereto from the N receive channels, wherein N is an integer; and
a second application specific integrated circuit having the M receive channels as its inputs and being configured to form a second ultrasound data corresponding to each of the receive scan lines based on data provided from the M receive channels, and add the first and second ultrasound data of the receive scan lines of the same position, to thereby produce the ultrasound data, wherein M is the same integer as N.

7. The ultrasound system (100) of Claim 6, wherein the first and second application specific integrated circuits further include an adding unit for adding the first ultrasound data and the second ultrasound data.

8. The ultrasound system (100) of Claim 5, wherein the ultrasound data forming unit (123) is configured to define at least one application specific integrated circuit group based on the transmit synthesis number, wherein the application specific integrated circuit group includes at least two application specific integrated circuits.

9. A method of forming ultrasound data, comprising:

(a) storing data provided from a plurality of receive channels in a first data storing unit;
(b) receive-focusing the data based on receive delay curve lookup tables to form scan line data corresponding to each of receive scan lines to be simultaneously formed in a single transmission of ultrasound signals;
(c) setting a storing start position on a second data storing unit having a plurality of consecutively numbered storage areas based on the number of the receive scan lines to be simultaneously formed;
(d) accumulating the scan line data corresponding to the receive scan lines of the same position to form accumulated data;
(e) storing the accumulated data in the second data storing unit based on the storing start position;
(f) shifting the storing start position towards a lower numbered storage area by one to reset the storing start position; and
(g) performing the steps (a), (b), (d), (e), (f) until no storing area to be further shifted in the second data storing unit is detected, and then performing the steps (a), (b), (d), (e) and outputting the accumulated data stored in the first storage area of the second data storing unit before step (e).

10. The method of Claim 9, wherein the step (c) comprises:

setting the storing start position by using the following equation:

Storing start position = round (the number of the receive scan lines to be simultaneously formed /2)
wherein round ( ) indicates rounding off to the closest whole number.

11. The method of Claim 10, wherein the step (d) includes accumulating data already stored in the plurality of storage areas and the scan line data by reference to the storing start position, thereby forming the accumulated data.

Patentansprüche

1. Ultraschallsystem (100) zur Erzeugung von Ultraschalldaten, welches Folgendes aufweist:

eine Ultraschalldatenerzeugungseinheit (123), die eine Vielzahl von Empfangskanälen aufweist, wobei die Ultraschalldatenerzeugungseinheit (123) dafür vorgesehen ist, die folgenden Funktionen durchzuführen:

A. Speichern von Daten, die von den Empfangskanälen zur Verfügung gestellt werden, in einer ersten Datenspeichereinheit (310);

B. Empfangsfokussieren der Daten basierend auf Empfangsverzögerungskurven-Nachschlagtabellen, um Scanliniendaten zu erzeugen, die jeder von Empfangsscanlinien entsprechen, die in einer einzelnen Übertragung von Ultraschallsignalen simultan erzeugt werden;

C. Festlegen einer Speicherstartposition auf einer zweiten Datenspeichereinheit (350), die eine Vielzahl von aufeinanderfolgend nummerierten Speicherbereichen aufweist, basierend auf der Anzahl der kontinuierlich zu erzeugenden Empfangsscanlinien;

D. Ansammeln der Scanliniendaten die der Empfangsscanlinien derselben Position entsprechen, um angesammelte Daten zu erzeugen;

E. Speichern der angesammelten Daten in der zweiten Datenspeichereinheit (350) basierend auf der Speicherstartposition; und

F. Verschieben der Speicherstartposition um Eins in Richtung eines niedriger nummerierten Speicherbereichs, um die Speicherstartposition zurückzusetzen, und

wobei die Ultraschalldatenerzeugungseinheit (123) des Weiteren dafür vorgesehen ist, die Funktionen A, B, D, E, F so lange durchzuführen, bis kein weiterer zu verschiebender Speicherbereich in der zweiten Datenspeichereinheit (350) detektiert wird, und dann die Funktionen A, B, D, E durchzuführen und die in dem ersten Speicherbereich der zweiten Datenspeichereinheit (350) angesammelten Daten vor der Funktion E auszugeben.

2. Ultraschallsystem (100) nach Anspruch 1, wobei die Ultraschalldatenerzeugungseinheit (123) Folgendes aufweist:

eine Fokusverzögerungs-Berechnungseinheit (320), die dafür vorgesehen ist, die Empfangsverzögerungskurven-Nachschlagtabellen zu speichern;

eine erste Datenerzeugungseinheit (330), die dafür vorgesehen ist, die in der ersten Datenspeichereinheit (310) basierend auf den Empfangsverzögerungskurven-Nachschlagtabellen gespeicherten Daten zu empfangen und zu fokussieren, um dadurch die Scanliniendaten, die jeder der empfangenen Scanlinien entsprechen, zu erzeugen;

eine zweite Datenerzeugungseinheit (340), die dafür vorgesehen ist, die Scanliniendaten, die den Empfangsscanlinien derselben Position entsprechen, zu sammeln, um dadurch die angesammelten Daten zu erzeugen; und

eine Steuereinheit (360), die dafür vorgesehen ist, die Speicherposition basierend auf der Anzahl der gleichzeitig zu erzeugenden Empfangsscanlinien festzulegen und die Speicherstartposition in Richtung eines niedriger nummerierten Speicherbereichs zu verschieben und dadurch die Speicherstartposition zurückzusetzen.

3. Ultraschallsystem (100) nach Anspruch 2, wobei die Ultraschalldatenerzeugungseinheit (123) für Folgendes vorgesehen ist:

Ansammeln der bereits in der zweiten Datenspeichereinheit (350) gespeicherten Daten und der durch die erste Erzeugungseinheit (330) neu erzeugten Scanliniendaten anzusammeln, um neue angesammelte Daten zu erzeugen;
und
Ausgeben der neu angesammelten Daten, die durch Ansammeln der in einem ersten Speicherbereich der zweiten Datenspeichereinheit (350) gespeicherten angesammelten Daten erzeugt werden und der Scanliniendaten als die Ultraschalldaten, die jeder der Empfangsscanlinien entsprechen.

4. Ultraschallsystem (100) nach Anspruch 2, wobei die Fokusverzögerungs-Berechnungseinheit (320) dafür vorgesehen ist, in den Empfangsscanlinien die Empfangsverzögerungskurven-Nachschlagtabellen, die beim Erzeugen der Scanliniendaten, die jeder der Empfangsscanlinien entsprechen, erforderlich sind, zu teilen.

5. Ultraschallsystem (100) nach Anspruch 2, wobei die Ultraschalldatenerzeugungseinheit (123) dafür vorgesehen ist, von wenigstens einem für eine Anwendung spezifischen integrierten Schaltkreis implementiert zu werden.

6. Ultraschallsystem (100) nach Anspruch 5, wobei die Empfangskanäle N Empfangskanäle und M Empfangskanäle beinhalten;
wobei die Ultraschalldatenerzeugungseinheit (123) des Weiteren Folgendes aufweist:

einen ersten für eine Anwendung spezifischen integrierten Schaltkreis, der die N Empfangskanäle als seine Eingänge aufweist und dafür vorgesehen ist, erste Ultraschalldaten, die jeder der Empfangsscanlinien entsprechen, basierend auf Daten zu erzeugen, die dafür von den N Empfangskanälen zur Verfügung gestellt werden, wobei N eine ganze Zahl ist; und

einen zweiten für eine Anwendung spezifischen integrierten Schaltkreis, der die M Empfangskanäle als seine Eingänge aufweist und dafür vorgesehen ist,
zweite Ultraschalldaten, die jeder der Empfangsscanlinien entsprechen, basierend auf Daten zu erzeugen, die von den M Empfangskanälen zur Verfügung gestellt werden, und die ersten und zweiten Ultraschalldaten der Empfangsscanlinien derselben Position zu addieren, um dadurch die Ultraschalldaten zu produzieren, wobei M dieselbe ganze Zahl wie N ist.

7. Ultraschallsystem (100) nach Anspruch 6, wobei die ersten und zweiten für eine Anwendung spezifischen integrierten Schaltkreise des Weiteren eine Additionseinheit zum Addieren der ersten Ultraschalldaten und der zweiten Ultraschalldaten aufweisen.

8. Ultraschallsystem (100) nach Anspruch 5, wobei die Ultraschalldatenerzeugungseinheit (123) dafür vorgesehen ist, wenigstens eine für eine Anwendung spezifische Gruppe integrierter Schaltkreise basierend auf der Übertragungssynthese-Anzahl zu definieren, wobei die für eine Anwendung spezifische Gruppe integrierter Schaltkreise wenigstens zwei für eine Anwendung spezifische integrierte Schaltkreise aufweist.

9. Verfahren zum Erzeugen von Ultraschalldaten, welches Folgendes aufweist:

(a) Speichern von Daten, die von einer Vielzahl von Empfangskanälen zur Verfügung gestellt werden, in einer ersten Datenspeichereinheit;
(b) Empfangsfokussieren der Daten basierend auf Empfangsverzögerungskurven-Nachschlagtabellen, um Scanliniendaten zu erzeugen, die jeder der Empfangsscanlinien entsprechen, die in einer einzelnen Übertragung von Ultraschallsignalen simultan erzeugt werden;
(c) Festlegen einer Speicherstartposition auf einer zweiten Datenspeichereinheit, die eine Vielzahl von aufeinanderfolgend nummerierten Speicherbereichen aufweist, basierend auf der Anzahl der gleichzeitig zu erzeugenden Empfangsscanlinien;
(d) Ansammeln der Scanliniendaten, die den Empfangsscanlinien derselben Position entsprechen, um angesammelte Daten zu erzeugen;
(e) Speichern der angesammelten Daten in der zweiten Datenspeichereinheit, basierend auf der Speicherstartposition;
(f) Verschieben der Speicherstartposition um Eins in Richtung eines niedriger nummerierten Speicherbereichs, um die Speicherstartposition zurückzusetzen; und
(g) Durchführen der Schritte (a), (b), (d), (e), (f) bis kein weiterer zu verschiebender Speicherbereich in der zweiten Datenspeichereinheit detektiert wird, und dann Durchführen der Schritte (a), (b), (d), (e) und Ausgeben der in dem ersten Speicherbereich der zweiten Datenspeichereinheit gespeicherten angesammelten Daten vor dem Schritt (e).

10. Verfahren nach Anspruch 9, wobei der Schritt (c) Folgendes aufweist:

Festlegen der Speicherstartposition durch Verwenden der folgenden Gleichung:

Speicherstartposition = Runde (die Anzahl der gleichzeitig zu erzeugenden Empfangsscanlinien/2),
wobei Runde das Abrunden zu der nächsten ganzen Zahl anzeigt.

11. Verfahren nach Anspruch 10, wobei der Schritt (d) das Ansammeln der bereits in der Vielzahl von Speicherbereichen gespeicherten Daten und der Scanliniendaten durch Referenz auf die Speicherstartposition beinhaltet, wodurch die angesammelten Daten erzeugt werden.

Revendications

1. Système ultrasonique (100) pour créer des données ultrasoniques comportant :

une unité (123) de création de données ultrasoniques ayant une pluralité de canaux récepteurs dans lequel l'unité (123) de création de données ultrasoniques est configurée pour exécuter les fonctions :

A. de stockage de données obtenues des canaux de réception dans la première unité de stockage de données (310) ;
B. de réception-focalisation de données basées sur des tables de visualisation de la courbe de délais de réception pour constituer des données de lignes de balayage correspondant à chacune des lignes de balayage de réception qui sont formées simultanément dans une transmission unique de signaux ultrasoniques ;
C. de détermination d'une position de départ stockée sur une seconde unité de stockage de données (350) ayant une pluralité de zones de stockage numérotées consécutivement, basées sur le nombre de lignes de balayage de réception formées simultanément ;

D. d'accumulation de données de lignes de balayage correspondant aux lignes de balayage de réception de même position pour constituer des données cumulées ;
E. de stockage des données cumulées dans la seconde unité de stockage de données (350) basées sur la position de départ stockée ; et
F. de déplacement de la position de départ stockée d'une position en direction d'une zone de stockage correspondant à un nombre inférieur pour restituer la position de départ stockée, et

dans lequel l'unité (123) de création de données ultrasoniques est en outre configurée pour exécuter les fonctions A, B, D, E, F
tant qu'aucun déplacement de zone de stockage dans la seconde unité de stockage (350) n'est détecté et ensuite pour exécuter les fonctions A, B, D, E et extraire les données cumulées stockées dans la première zone de stockage de la seconde unité de stockage de données (350) avant la fonction E.

2. Système ultrasonique (100) selon la revendication 1, dans lequel l'unité de création de données ultrasoniques (123) comporte :

une unité (320) de calcul de focalisation de délai configurée pour stocker les tables de visualisation des courbes de délais réceptionnées ;
une première unité (330) de création de données pour recevoir et focaliser les données stockées dans la première unité de stockage de données (310) basées sur les tables de visualisation des courbes de délais réceptionnées pour constituer ainsi les données de lignes de balayage correspondant à chaque ligne de balayage reçues ;
une seconde unité (340) de création de données configurée pour cumuler les données de lignes de balayage correspondant aux lignes de balayage de la même position pour constituer ainsi les données cumulées ; et
une unité de commande (360) configurée pour déterminer la position de stockage basée sur le numéro des lignes de balayage formées simultanément et décaler la position de début du stockage vers un numéro inférieur de zone de stockage, pour ainsi réinitialiser la position de stockage de départ.

3. Système ultrasonique (100) selon la revendication 2, dans lequel l'unité de création de données ultrasoniques (123) est configurée pour :

accumuler les données cumulées toujours stockées dans la seconde unité de stockage (350) et les lignes de balayage nouvellement formées par la première unité (330) de création pour créer des nouvelles données cumulées ; et
extraire les nouvelles données cumulées formées en cumulant les données cumulées stockées dans une première zone de stockage de la seconde unité de stockage de données (350) et les données de lignes de balayage ainsi que les données ultrasoniques correspondant à chacune des lignes de balayage réceptionnées.

4. Système ultrasonique (100) selon la revendication 2, dans lequel l'unité (320) de calcul de focalisation de délai est configurée pour séparer dans les lignes de balayage reçues, les tables de visualisation des courbes de délais réceptionnées pour constituer ainsi les données de lignes de balayage correspondant à chaque ligne de balayage réceptionnée.

5. Système ultrasonique (100) selon la revendication 2, dans lequel l'unité de création de données ultrasoniques (123) est configurée pour être implémentée par au moins un circuit intégré d'une application spécifique.

6. Système ultrasonique (100) selon la revendication 5, dans lequel les canaux de réception comportent N canaux de réception et M canaux de réception ;
dans lequel l'unité de création de données ultrasoniques (123) comporte en outre :

un premier circuit intégré pour une application spécifique ayant les N canaux de réception comme entrées et étant configurés pour créer des premières données ultrasoniques correspondant à chacune des lignes de balayage de réception basées sur les données formées à cet effet par les N canaux récepteurs, dans lequel N est un nombre entier ; et

un second circuit intégré pour une application spécifique ayant les M canaux de réception comme entrées et étant configurés pour créer des secondes données ultrasoniques correspondant à chacune des lignes de balayage de réception basées sur les données formées à cet effet par les M canaux récepteurs, et pour additionner les premières et les secondes données ultrasoniques des lignes de balayage réceptionnées ayant les mêmes positions, pour créer ainsi les données ultrasoniques, dans lequel M est le même nombre entier que N.

7. Système ultrasonique (100) selon la revendication 6, dans lequel le premier et le second circuits intégrés pour une application spécifique comprennent en outre une unité d'addition pour additionner les premières données ultrasoniques et les secondes données ultrasoniques.

8. Système ultrasonique (100) selon la revendication 5, dans lequel l'unité de création de données ultrasoniques (123) est configurée pour définir au moins un circuit intégré d'un groupe d'applications spécifiques basées sur la transmission du nombre de synthèse, dans lequel le circuit intégré d'un groupe d'applications spécifiques comporte au moins deux circuits intégrés pour une application spécifique.

9. Procédé pour créer des données ultrasoniques, comprenant :

(a) le stockage de données provenant d'une pluralité de canaux récepteurs dans une première unité de stockage de données;
(b) la réception-focalisation de données basées sur des tables de visualisation de la courbe de délais de réception pour constituer des données de lignes de balayage correspondant à chacune des lignes de balayage de réception qui sont formées simultanément dans une transmission unique de signaux ultrasoniques ;
(c) la détermination d'une position de départ stockée sur une seconde unité de stockage de données ayant une pluralité de zones de stockage numérotées consécutivement, basées sur le nombre de lignes de balayage de réception formées simultanément ;
(d) l'accumulation de données de lignes de balayage correspondant aux lignes de balayage de réception de même position pour constituer des données cumulées ;
(e) le stockage des données cumulées dans la seconde unité de stockage de données basées sur la position de départ stockée ; et
(f) le déplacement de la position de départ stockée d'une position en direction d'une zone de stockage correspondant à un nombre inférieur pour restituer la position de départ stockée, et
(f) l'exécution des étapes (a), (b), (d), (e), (f)

tant qu'aucun déplacement de zone de stockage n'est ensuite effectué dans la seconde unité de stockage et ensuite pour exécuter les fonctions (a), (b), (d), (e) et extraire les données cumulées stockées dans la première zone de stockage de la seconde unité de stockage de données avant l'étape (e).

10. Procédé selon la revendication 9, dans lequel l'étape (c) comprend :

la détermination de la position de départ enregistrée en utilisant l'équation suivante :

le stockage de la position de départ = arrondi (le nombre des lignes de balayage de réception pouvant être constituées simultanément /2) dans lequel arrondi indique le nombre des lignes de balayage arrondi par rapport au nombre réel le plus proche.

11. Procédé selon la revendication 10, dans lequel l'étape (d) comprend les données cumulées stockées dans la pluralité de zones de stockage et les données de lignes de balayage en référence à la position de départ de stockage, constituant ainsi les données stockées cumulées.

FIG. 1

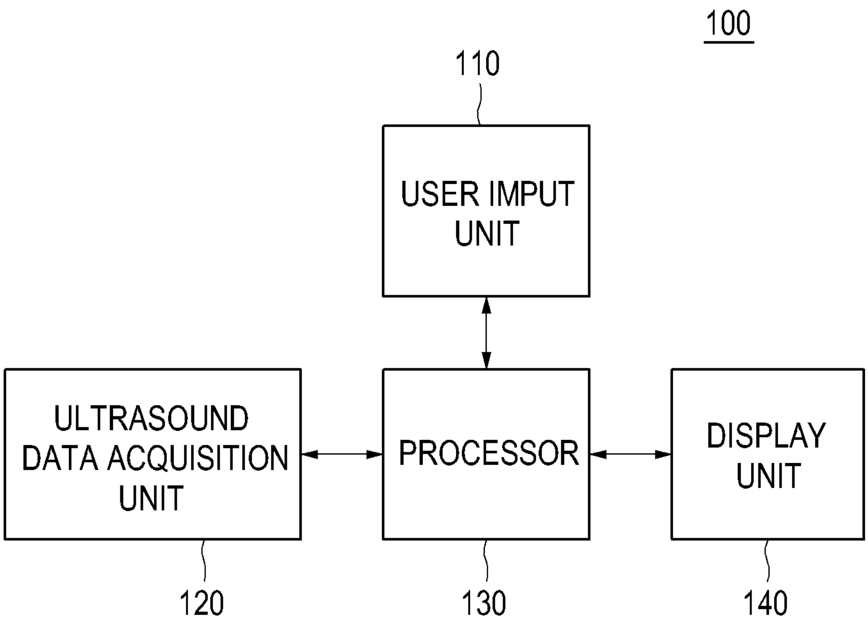

100
110
USER IMPUT UNIT
ULTRASOUND DATA ACQUISITION UNIT
PROCESSOR
DISPLAY UNIT
120
130
140

FIG. 2

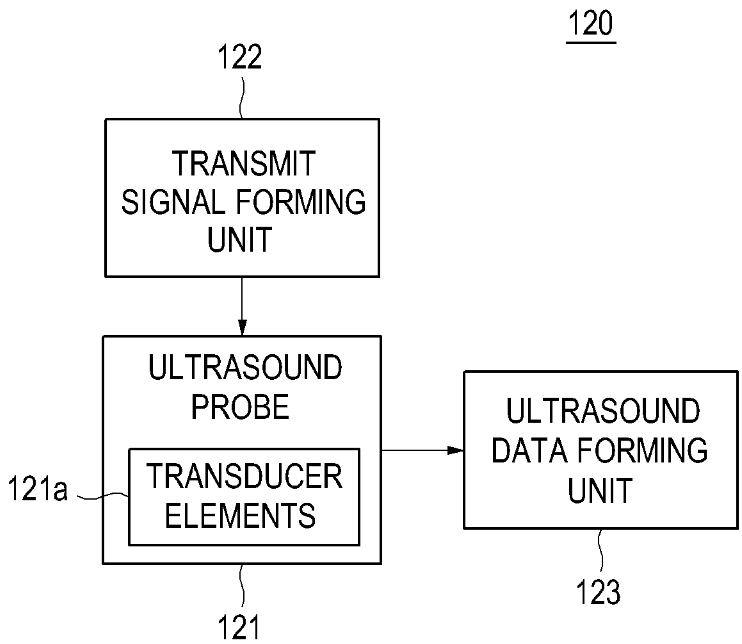

120
122
TRANSMIT SIGNAL FORMING UNIT
ULTRASOUND PROBE
TRANSDUCER ELEMENTS
121a
121
ULTRASOUND DATA FORMING UNIT
123

FIG. 3

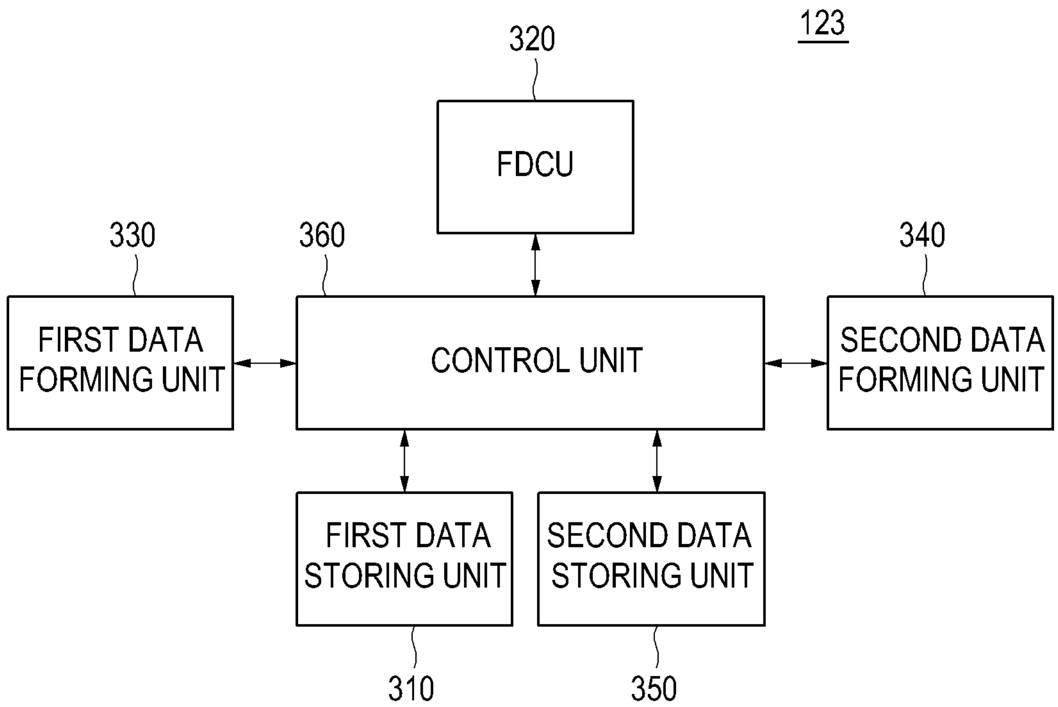
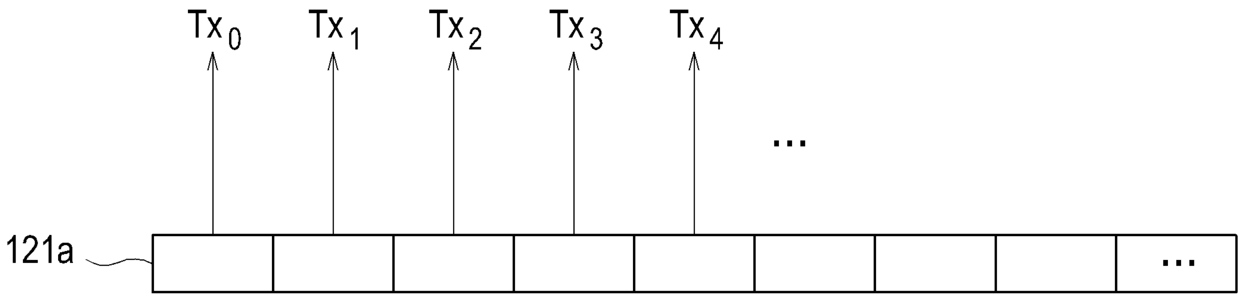

123
320
FDCU
330
360
340
FIRST DATA FORMING UNIT
CONTROL UNIT
SECOND DATA FORMING UNIT
FIRST DATA STORING UNIT
SECOND DATA STORING UNIT
310
350

FIG. 4



Tx_0	:	$Rx_{0,0}$	$Rx_{0,1}$	$Rx_{0,2}$					
Tx_1	:	$Rx_{1,0}$	$Rx_{1,1}$	$Rx_{1,2}$	$Rx_{1,3}$				
Tx_2	:	$Rx_{2,0}$	$Rx_{2,1}$	$Rx_{2,2}$	$Rx_{2,3}$	$Rx_{2,4}$			
Tx_3	:		$Rx_{3,1}$	$Rx_{3,2}$	$Rx_{3,3}$	$Rx_{3,4}$	$Rx_{3,5}$		
Tx_4	:			$Rx_{4,2}$	$Rx_{4,3}$	$Rx_{4,4}$	$Rx_{4,5}$	$Rx_{4,6}$	
Tx_5	:				$Rx_{5,3}$	$Rx_{5,4}$	$Rx_{5,5}$	$Rx_{5,6}$	$Rx_{5,7}$
$\vdots$							$\vdots$		

FIG. 5

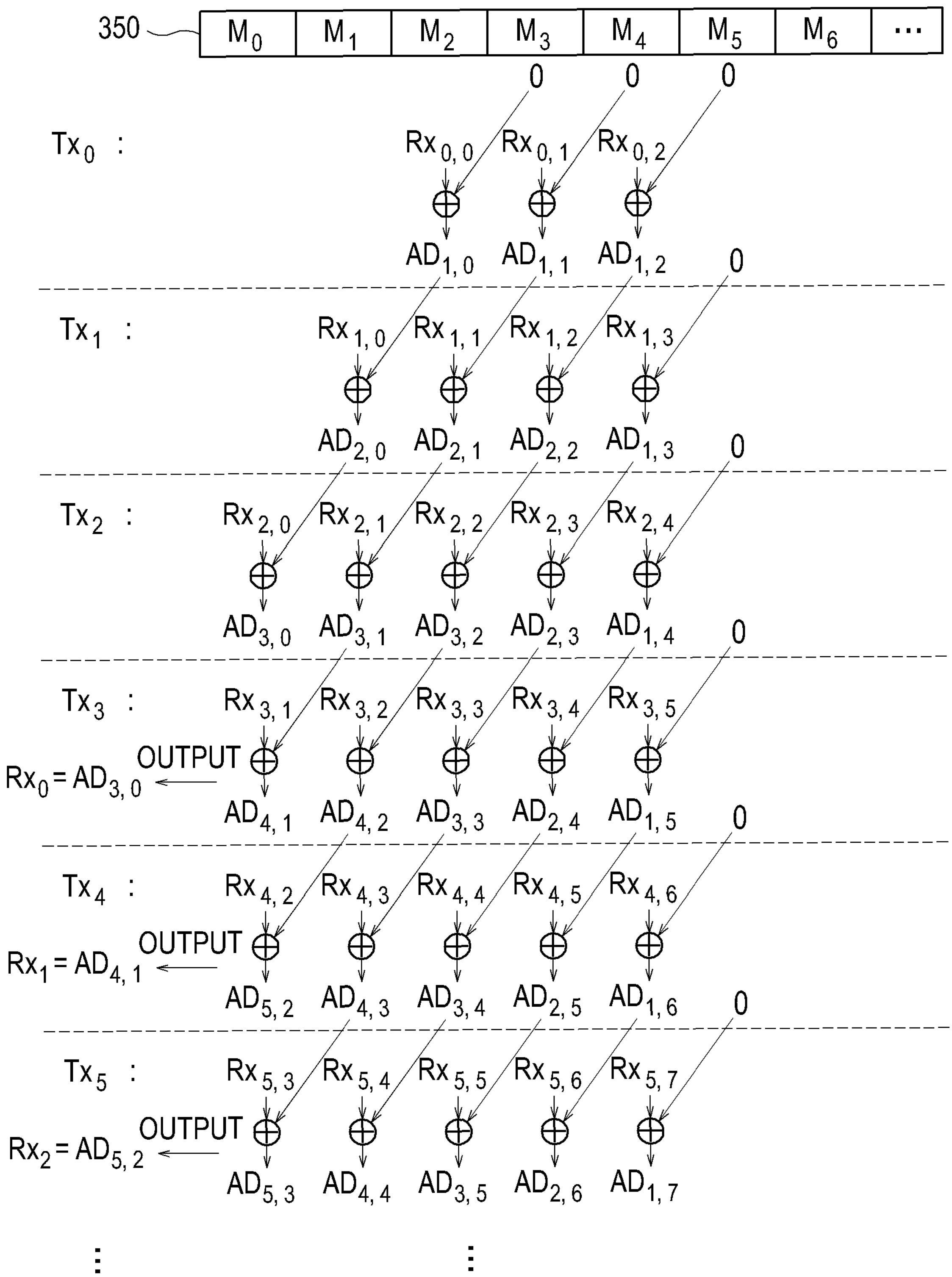
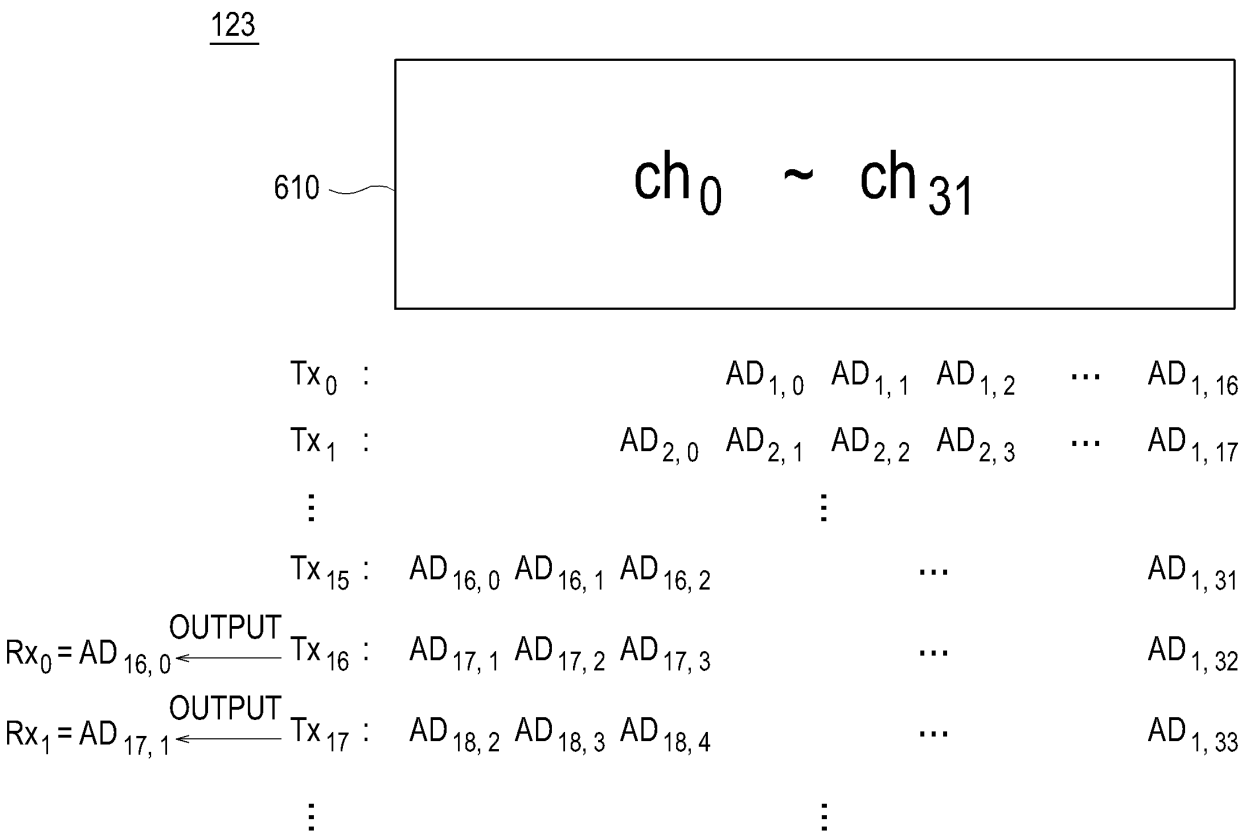

350
M0 M1 M2 M3 M4 M5 M6 ...
0 0 0
Tx0 :
Rx0, 0 Rx0, 1 Rx0, 2
AD1, 0 AD1, 1 AD1, 2 0
Tx1 :
Rx1, 0 Rx1, 1 Rx1, 2 Rx1, 3
AD2, 0 AD2, 1 AD2, 2 AD1, 3 0
Tx2 :
Rx2, 0 Rx2, 1 Rx2, 2 Rx2, 3 Rx2, 4
AD3, 0 AD3, 1 AD3, 2 AD2, 3 AD1, 4 0
Tx3 :
Rx3, 1 Rx3, 2 Rx3, 3 Rx3, 4 Rx3, 5
OUTPUT
Rx0 = AD3, 0
AD4, 1 AD4, 2 AD3, 3 AD2, 4 AD1, 5 0
Tx4 :
Rx4, 2 Rx4, 3 Rx4, 4 Rx4, 5 Rx4, 6
OUTPUT
Rx1 = AD4, 1
AD5, 2 AD4, 3 AD3, 4 AD2, 5 AD1, 6 0
Tx5 :
Rx5, 3 Rx5, 4 Rx5, 5 Rx5, 6 Rx5, 7
OUTPUT
Rx2 = AD5, 2
AD5, 3 AD4, 4 AD3, 5 AD2, 6 AD1, 7

FIG. 6



123
610
$ch_0 \sim ch_{31}$
Tx_0 : $AD_{1,0}$ $AD_{1,1}$ $AD_{1,2}$ ⋯ $AD_{1,16}$
Tx_1 : $AD_{2,0}$ $AD_{2,1}$ $AD_{2,2}$ $AD_{2,3}$ ⋯ $AD_{1,17}$
Tx_{15} : $AD_{16,0}$ $AD_{16,1}$ $AD_{16,2}$ ⋯ $AD_{1,31}$
$Rx_0 = AD_{16,0} \xleftarrow{\text{OUTPUT}} Tx_{16}$: $AD_{17,1}$ $AD_{17,2}$ $AD_{17,3}$ ⋯ $AD_{1,32}$
$Rx_1 = AD_{17,1} \xleftarrow{\text{OUTPUT}} Tx_{17}$: $AD_{18,2}$ $AD_{18,3}$ $AD_{18,4}$ ⋯ $AD_{1,33}$

FIG. 7

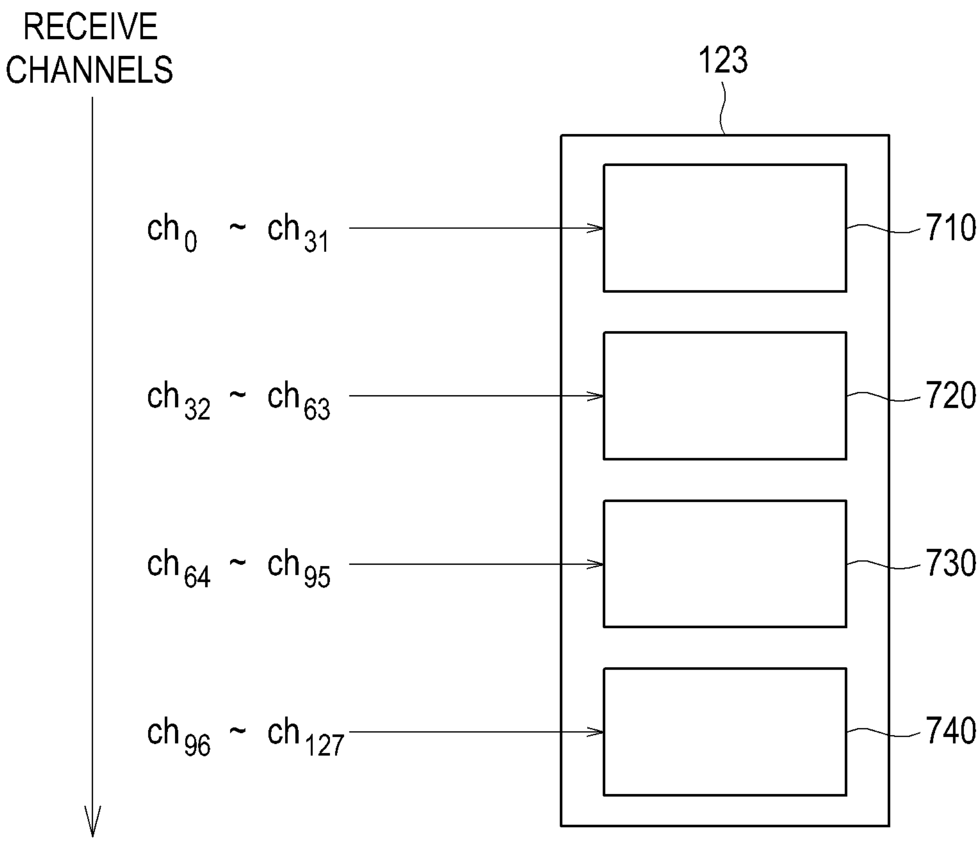

RECEIVE
CHANNELS
123
ch_0 ~ ch_{31}
710
ch_{32} ~ ch_{63}
720
ch_{64} ~ ch_{95}
730
ch_{96} ~ ch_{127}
740

FIG. 8

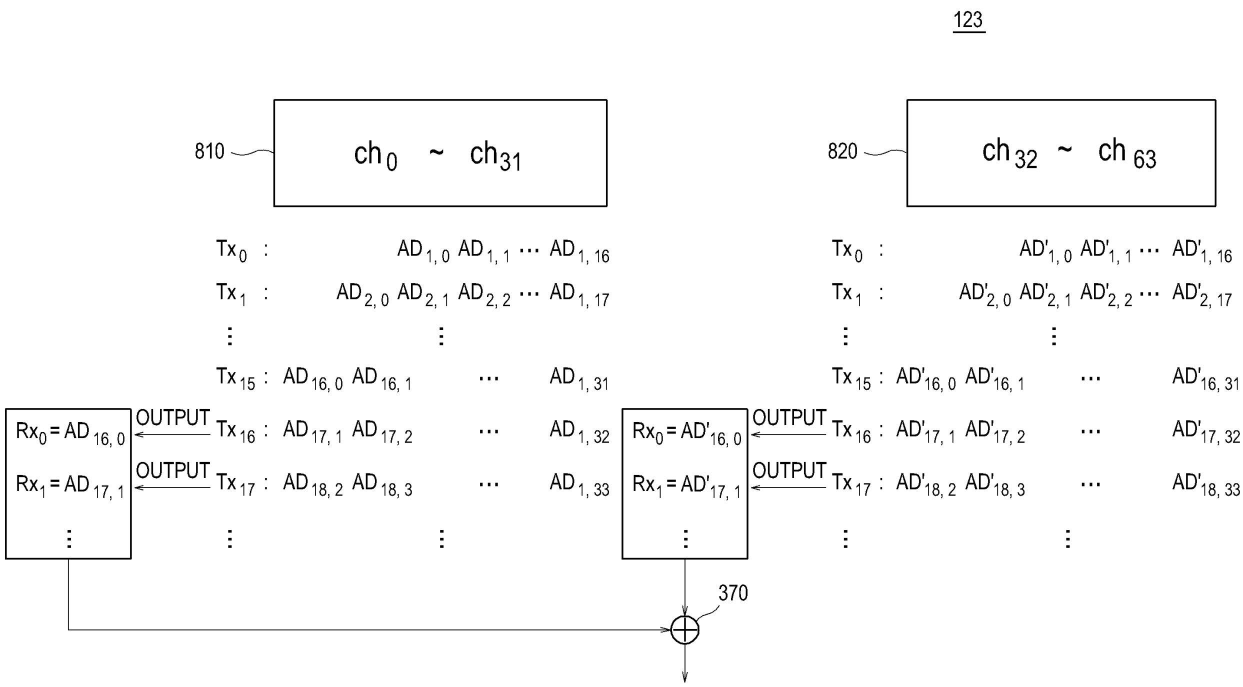

123
810
ch0 ~ ch31
820
ch32 ~ ch63
Tx0 : AD1, 0 AD1, 1 ⋯ AD1, 16
Tx1 : AD2, 0 AD2, 1 AD2, 2 ⋯ AD1, 17
Tx15 : AD16, 0 AD16, 1 ⋯ AD1, 31
Tx16 : AD17, 1 AD17, 2 ⋯ AD1, 32
Tx17 : AD18, 2 AD18, 3 ⋯ AD1, 33
Rx0 = AD16, 0
Rx1 = AD17, 1
OUTPUT
OUTPUT
Tx0 : AD'1, 0 AD'1, 1 ⋯ AD'1, 16
Tx1 : AD'2, 0 AD'2, 1 AD'2, 2 ⋯ AD'2, 17
Tx15 : AD'16, 0 AD'16, 1 ⋯ AD'16, 31
Tx16 : AD'17, 1 AD'17, 2 ⋯ AD'17, 32
Tx17 : AD'18, 2 AD'18, 3 ⋯ AD'18, 33
Rx0 = AD'16, 0
Rx1 = AD'17, 1
OUTPUT
OUTPUT
370

FIG. 9

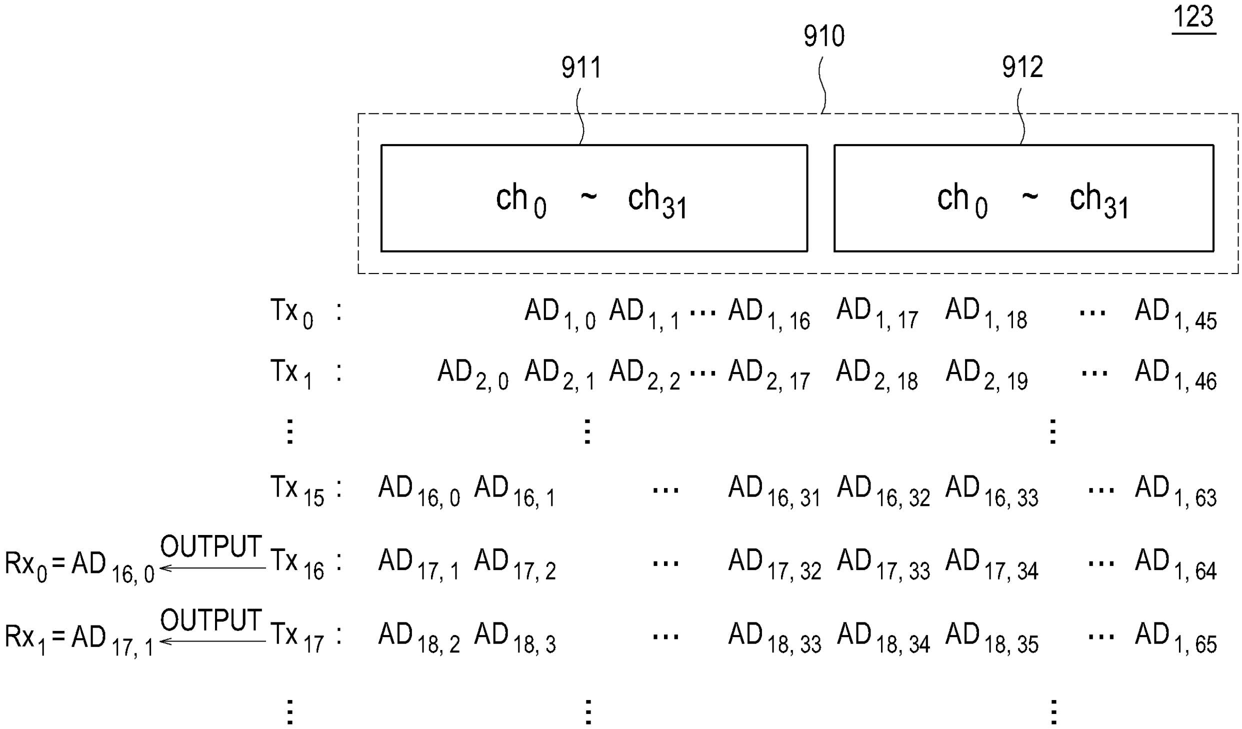
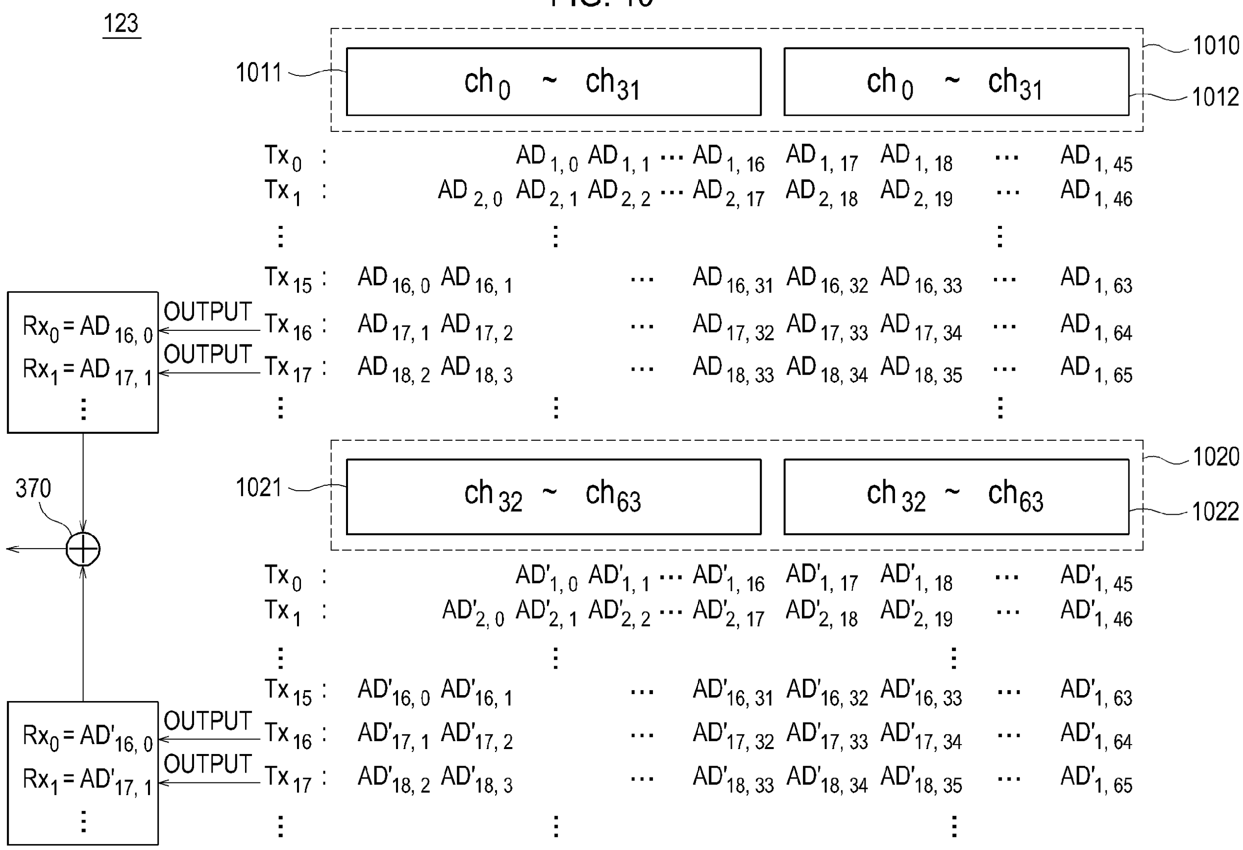

123
910
911
912
ch0 ~ ch31
ch0 ~ ch31
Tx0 : AD1,0 AD1,1 ··· AD1,16 AD1,17 AD1,18 ··· AD1,45
Tx1 : AD2,0 AD2,1 AD2,2 ··· AD2,17 AD2,18 AD2,19 ··· AD1,46
Tx15 : AD16,0 AD16,1 ··· AD16,31 AD16,32 AD16,33 ··· AD1,63
Rx0 = AD16,0 OUTPUT Tx16 : AD17,1 AD17,2 ··· AD17,32 AD17,33 AD17,34 ··· AD1,64
Rx1 = AD17,1 OUTPUT Tx17 : AD18,2 AD18,3 ··· AD18,33 AD18,34 AD18,35 ··· AD1,65

FIG. 10


123
1010
1011
ch0 ~ ch31
ch0 ~ ch31
1012
Tx0 : AD1, 0 AD1, 1 ··· AD1, 16 AD1, 17 AD1, 18 ··· AD1, 45
Tx1 : AD2, 0 AD2, 1 AD2, 2 ··· AD2, 17 AD2, 18 AD2, 19 ··· AD1, 46
Tx15 : AD16, 0 AD16, 1 ··· AD16, 31 AD16, 32 AD16, 33 ··· AD1, 63
Tx16 : AD17, 1 AD17, 2 ··· AD17, 32 AD17, 33 AD17, 34 ··· AD1, 64
Tx17 : AD18, 2 AD18, 3 ··· AD18, 33 AD18, 34 AD18, 35 ··· AD1, 65
OUTPUT
OUTPUT
Rx0 = AD16, 0
Rx1 = AD17, 1
370
1020
1021
ch32 ~ ch63
ch32 ~ ch63
1022
Tx0 : AD'1, 0 AD'1, 1 ··· AD'1, 16 AD'1, 17 AD'1, 18 ··· AD'1, 45
Tx1 : AD'2, 0 AD'2, 1 AD'2, 2 ··· AD'2, 17 AD'2, 18 AD'2, 19 ··· AD'1, 46
Tx15 : AD'16, 0 AD'16, 1 ··· AD'16, 31 AD'16, 32 AD'16, 33 ··· AD'1, 63
Tx16 : AD'17, 1 AD'17, 2 ··· AD'17, 32 AD'17, 33 AD'17, 34 ··· AD'1, 64
Tx17 : AD'18, 2 AD'18, 3 ··· AD'18, 33 AD'18, 34 AD'18, 35 ··· AD'1, 65
OUTPUT
OUTPUT
Rx0 = AD'16, 0
Rx1 = AD'17, 1

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2007133878 A2 **[0008]**

专利名称(译)	超声系统和形成超声数据的方法		
公开(公告)号	EP2248469B1	公开(公告)日	2017-03-22
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当前申请(专利权)人(译)	三星MEDISON CO.，LTD.		
[标]发明人	HAM JEONG HO YOON RA YOUNG BAE MOO HO		
发明人	HAM, JEONG HO YOON, RA YOUNG BAE, MOO HO		
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优先权	1020090038479 2009-04-30 KR 1020100039290 2010-04-28 KR		
其他公开文献	EP2248469A2 EP2248469A3		
外部链接	Espacenet		

摘要(译)

一种超声系统和形成对应于独立于合成孔径的接收扫描线的超声数据的方法。超声系统包括超声数据形成单元，被配置为：通过使用从接收通道提供的数据形成与每个接收扫描线对应的扫描线数据;通过累积对应于相同位置的接收扫描线的扫描线数据来形成累积数据;设置存储开始位置，用于根据发送合成号码存储累积数据;通过将存储开始位置移动1来存储累积数据，从而形成与每个接收扫描亚麻线对应的超声数据。


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Ultraschallsystem und Verfahren zur Bildung von Ultraschalldaten
Système ultrasonore et procédé pour former des données ultrasonores

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(56) References cited: EP-A2- 1 980 872 WO-A2-2007/133878

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