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(54) **Ultrasound system and method for forming BC-mode image**

Ultraschallsystem und Verfahren zum Erzeugen eines BC-Mode-Bildes

Système et procédé à ultrasons pour former une image en mode BC

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- **KIRKHORN J ET AL: "A new technique for improved spatial resolution in high frame rate color doppler imaging", 2003 IEEE ULTRASONICS SYMPOSIUM PROCEEDINGS, vol. 2, 5 October 2003 (2003-10-05), pages 1947-1950, XP010701093, DOI: 10.1109/ULTSYM.2003.1293298 ISBN: 978-0-7803-7922-0**

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Description

BACKGROUND OF THE INVENTION

[Technical Field]

[0001] The present invention generally relates to ultrasound systems, and more particularly to an ultrasound system and a method for forming a BC-mode image.

[Background Art]

[0002] An ultrasound system has become an important and popular diagnostic tool due to its non-invasive and non-destructive nature. Modern high-performance ultrasound imaging diagnostic systems and techniques are commonly used to produce two- or three-dimensional images of internal features of patients.

[0003] The ultrasound system may provide a BC-mode image indicating a blood flow or a motion of a target object, which is estimated by using a Doppler effect, on a B-mode image. The BC-mode image is a combination image comprising a B-mode image of a grey scale and a color flow image (i.e., C-mode image) indicating the blood flow or the motion of the target object. The BC-mode image may provide anatomical information as well as information regarding the blood flow or the motion of the target object.

[0004] The conventional ultrasound image may form the B-mode image and the C-mode image with different frame rates and then combine the B-mode image with the C-mode image to thereby form the BC-mode image. Since the frame rate of the BC-mode may not be enough to obtain information regarding blood flow or the motion of the target object such as a cardiac muscle, the frame rate of the BC-mode must be improved such that motion information of the target object such as a cardiac, which is rapidly moved, can be accurately provided.

[0005] In the US 6 139 501 A multi-mode ultrasonic images are formed by processing the ultrasonic echoes from a single transmit pulse in parallel to display both tissue and motion. In a preferred embodiment short transmit bursts are employed to produce echo ensembles for tissue motion imaging. At least one sequence of echoes of the ensemble is also B mode processed for display of tissue structure. Preferably both the B mode and motion processing are performed in parallel. A substantially constant pulse repetition frequency reduces artifact development when imaging in the two modes from the same transmit pulse.

[0006] The WO 2004/106969 A2 describes an ultrasonic diagnostic imaging system in which two planes of a volumetric region which are in different elevation planes are scanned in real time. In one embodiment the two planes are scanned with less than the maximum number of scanlines which the transducer (500) can transmit in a single plane. A user control enables the two planes to be moved laterally without moving the transducer probe. In another embodiment each image plane contains a color box depicting flow or motion in the same respective position in the image. The color boxes of the two images can be sized and positioned in tandem so that both are in the same corresponding area of the two images.

[0007] In the US 6 537 217 B1 a method is provided to simultaneously acquire two ultrasound images. A first set of ultrasound pulses are transmitted at a first frame rate utilizing a first mode of operation. The echoes from the first set of ultrasound pulses are received. A second set of ultrasound pulses are transmitted at a second frame rate utilizing a second mode of operation. The first and second frame rates are different. The first set of ultrasound pulses defines an entire image, while the second set of ultrasound pulses defines a partial image. The echoes from the second set of ultrasound pulses are received, and the echoes from the first and second sets of ultrasound pulses are displayed as a single image.

[0008] Kirkhorn J et al: "A new technique for improved spatial resolution in high frame rate color Doppler imaging", 2003 IEEE Ultrasonics Symposium Proceedings, vol. 2, pages 1947-1950, 5 October 2003 (2003-10-05), XP01070193 discloses in ultrasound Color Doppler imaging, a grayscale B-mode image and a Doppler image representing velocities are overlaid to produce a color coded image of e.g. blood flow or myocardial movement. Normally, the B-mode and Doppler images are acquired at the same rate, resulting in trade offs between B-mode image quality and Doppler frame rate. In this work, a new scan sequencing technique for Color Doppler imaging is presented, where the B-mode image is acquired at a lower frame rate than the Doppler scan. This is achieved by splitting the B-mode image in subscans which are acquired in between multiple scans of the entire Doppler image. In this way, a full width B-mode image with high spatial resolution is kept while the temporal resolution of the velocity information is increased. In this paper, application of the new technique in Tissue Velocity Imaging (TVI), is discussed, showing the potential for improving lateral beam density or temporal resolution in Color Doppler imaging.

[0009] The invention is defined by claim 1. Regarding the method the invention is defined by claim 6.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

FIG. 1 is a block diagram showing an embodiment of an ultrasound system.
FIG. 2 is a schematic diagram showing an embodiment of a control unit.
FIG. 3 is a schematic diagram illustrating a display example of a B-mode image, a plurality of scan lines and a color box.
FIGS. 4 to 8 are schematic diagrams showing examples of forming a B-mode image in forming a BC-mode image in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0011] FIG. 1 is a block diagram showing an embodiment of an ultrasound system. As shown in FIG. 1, the ultrasound system 100 includes a control unit 110, a transmit/receive unit 120, a storage unit 130, an image processing unit 140 and a display unit 150. The ultrasound system 110 further includes an input unit (not shown) to receive input information from a user. The input information may include setup information for setting a color box on a B-mode image, i.e., position and size information of the color box.

[0012] The control unit 110 may be operable to control the formation of a BC-mode image in consideration of a time required to form a B-mode image and a time required to form a C-mode image. The control unit 110 may be further operable to control operations of the transmit/receive unit 120, the storage unit 130, the image processing unit 140 and the display unit 150.

[0013] FIG. 2 is a block diagram showing an illustrative embodiment of the control unit 110. A time computing unit 111 may be operable to compute a time required to form a B-mode image ("first time") and a time required to form a C-mode image ("second time"). The first time (T_B) and the second time (Tc) may be computed by using the following equations (1) and (2).

$$T_B = N_B / PRF_B \qquad (1)$$

$$T_C = N_C \times PS / PRF_C \qquad (2)$$

wherein N_B represents the number of scan lines used to form the B-mode image, PRF_B represents a pulse repetition frequency used to form the B-mode image, NC represents the number of the scan lines used to form the C-mode image, PS represents a packet size indicating repetition times of transmitting and receiving an ultrasound beam along one scan line, and PRF_C represents a pulse repetition frequency used to form the C-mode image.

[0014] A ratio computing unit 112 may be operable to compute a time ratio of the first time T_B to the second time Tc. The time ratio may be computed by dividing the first time T_B by the second time Tc in accordance with one embodiment of the present invention. For example, when the first time T_B is 8 ms and the second time Tc is 2 ms, the time ratio is 4 (=8 ms/ 2ms). When there is a fractional part in the division result, the time ratio may be determined with only integer part.

[0015] A determining unit 113 may be operable to compare the time ratio with a preset critical value (e.g., 1) to check whether the time ratio excesses the critical value. If the time ratio excesses the critical value, the determining unit 113 may output first determination information containing the time ratio. On the contrary, if not, the determining unit 113 may output second determination information.

[0016] If the first determination information is inputted, a scan line group setting unit 114 may be operable to set a plurality of scan line groups as many as the time ratio indicated by the first determination information. For example, when the time ratio is "4," scan lines S_1-S_{64} illustrated in FIG. 3 may be divided into four scan line groups SG_1, SG_2, SG_3 and SG_4, as follows.

$$\text{First scan line group SG1} = \{S_1, S_5, S_9, S_{13}, S_{17}, \cdots, S_{53}, S_{57}, S_{61}\}$$

$$\text{Second scan line group SG2} = \{S_2, S_6, S_{10}, S_{14}, S_{18}, \cdots, S_{54}, S_{58}, S_{62}\}$$

$$\text{Third scan line group SG3} = \{S_3, S_7, S_{11}, S_{15}, S_{19}, \cdots, S_{55}, S_{59}, S_{63}\}$$

Fourth scan line group SG4 = {S_4, S_8, S_{12}, S_{16}, S_{20}, ⋯, S_{56}, S_{60}, S_{64}}

[0017] A control signal generating unit 115 may be operable to generate a control signal for controlling transmission and reception of the ultrasound beam. The control signal may include a first control signal for controlling the formation of a B-mode image 210, i.e., a B-mode scan such that the ultrasound beam is transmitted are received along the scan lines S_1-S_{64}. The control signal may further include a second control signal for controlling the formation of the C-mode image, i.e., a C-mode scan such that the ultrasound beam is transmitted and received along scan lines S_{10} to S_{56} within a color box 220 set on the B-mode image 210 (see FIG. 3). The control signal also includes a third control signal for controlling the transmission and reception of the ultrasound beam such that the ultrasound beam for the B-mode image is alternately transmitted and received along scan lines included in the respective scan line groups.

[0018] If the second determination information is inputted from the determining unit 113, the control signal generating unit 115 may be operable to generate a fourth control signal for a B-mode scan such that the ultrasound beam is transmitted along scan lines S_1-S_9 and S_{57}-S_{64}, which do not belong to the color box 220.

[0019] The transmit/receive unit 120 is operable to transmit the ultrasound beam along scan lines set in a target object and receive ultrasound echoes reflected from the target object in response to the control signal. If the first control signal is inputted from the control unit 110, the transmit/receive unit 120 may be operable to sequentially transmit the ultrasound beam along the scan lines S_1-S_{64} in response to the first control signal and receive ultrasound echoes reflected from the target object to thereby form receive signals corresponding to the scan lines S_1-S_{64} ("first receive signals") for a B-mode image. The first receive signals may include information associated with the scan lines, e.g., position information of the scan lines, position information of sampling points on the scan lines, data obtained at the sampling points and the like.

[0020] If the second control signal is inputted from the control unit 110, the transmit/receive unit 120 may be operable to transmit the ultrasound beam along the scan lines S_{10}-S_{56} belonging to the color box 220 in response to the second control signal and receive ultrasound echoes reflected from the target object to thereby form receive signals corresponding to the scan lines S_{10}-S_{56} ("second receive signals") for the C-mode image. The second receive signals may include information associated with the scan lines S_{10}-S_{56}, e.g., position information of the scan lines, position information of sampling points on the scan lines, data obtained from the sampling points and the like.

[0021] If the third control signal is inputted from the control unit 110, the transmit/receive unit 120 may be operable to transmit the ultrasound beam along the scan lines S_1, S_5, S_9, S_{13}, S_{17}, ..., S_{53}, S_{57} and S_{61} included in the first scan line group SG_1 and receive ultrasound echoes from the target object in response to the third control signal to thereby form receive signals corresponding to the scan lines included in the first scan line group SG_1 ("first scan line group receive signals"). The first scan line group receive signals may include information associated with the scan lines of the first scan line group SG_1, e.g., position information of the scan lines, position information of sampling points on the scan lines, data obtained from the sampling points and the like. Thereafter, if the second control signal is inputted, the transmit/receive unit 120 may be operable to transmit the ultrasound beam along the scan lines S_{10}-S_{56} within the color box 220 and receive ultrasound echoes reflected from the target object in response to the second control signal to thereby form new second receive signals for a C-mode image.

[0022] Subsequently, if the third control signal is inputted from the control unit 110, the transmit/receive unit 120 may be operable to transmit the ultrasound beam along the scan lines S_2, S_6, S_{10}, S_{14}, S_{18}, ..., S_{54}, S_{58} and S_{62} included in the second scan line group SG_2 and receive ultrasound echoes from the target object in response to the third control signal to thereby form receive signals corresponding to the scan lines included in the second scan line group SG_2 ("second scan line group receive signals"). The second scan line group receive signals may include information associated with the scan lines of the first scan line group SG2, e.g., position information of the scan lines, position information of sampling points on the scan lines, data obtained from the sampling points and the like. Thereafter, if the second control signal is inputted from the control unit 110, the transmit/receive unit 120 may be operable to transmit the ultrasound beam along the scan lines S_{10}-S_{56} within the color box 220 and receive ultrasound echoes reflected from the target object in response to the second control signal to thereby form new second receive signals.

[0023] Successively, if the third control signal is inputted from the control unit 110, the transmit/receive unit 120 may be operable to transmit the ultrasound beam along the scan lines S_3, S_7, S_{11}, S_{15}, S_{19}, ..., S_{55}, S_{59} and S_{63} included in the third scan line group SG_3 and receive ultrasound echoes from the target object in response to the third control signal to thereby form receive signals corresponding to the scan lines included in the third scan line group SG_3 ("third scan line group receive signals"). The third scan line group receive signals may include information associated with the scan lines of the third scan line group SG_3, e.g., position information of the scan lines, position information of sampling points on the scan lines, data obtained from the sampling points and the like. Thereafter, the transmit/receive unit 120 may be operable to transmit the ultrasound beam along the scan lines S_{10}-S_{56} within the color box 220 and receive ultrasound

echoes reflected from the target object in response to the second control signal to thereby form new second receive signals.

[0024] If the third control signal is inputted again from the control unit 110, the transmit/receive unit 120 may be operable to transmit the ultrasound beam along the scan lines S_4, S_8, S_{12}, S_{16}, S_{20}, ..., S_{56}, S_{60} and S_{64} included in the fourth scan line group SG_4 and receive ultrasound echoes from the target object in response to the third control signal to thereby form receive signals corresponding to the scan lines included in the fourth scan line group SG_4 ("fourth scan line group receive signals"). The fourth scan line group receive signals may include information associated with the scan lines of the fourth scan line group SG_4, e.g., position information of the scan lines, position information of sampling points on the scan lines, data obtained from the sampling points and the like. Thereafter, the transmit/receive unit 120 may be operable to transmit the ultrasound beam along the scan lines S_{10}-S_{56} within the color box 220 and receive ultrasound echoes reflected from the target object in response to the second control signal to thereby form new second receive signals. The transmit/receive unit 120 may be operable to repeat the above process until an end request is inputted.

[0025] In the meantime, if the fourth control signal is inputted from the control unit 110, the transmit/receive unit 120 may be operable to transmit the ultrasound beam along scan lines S_1-S_9 and S_{57}-S_{64}, which are not within the color box 220 among the scan lines S1-S64, and receive ultrasound echoes reflected from the target object to thereby form receive signals corresponding to the scan lines S_1-S_9 and S_{57}-S_{64} ("third receive signals"). In such a case, the third receive signals may contain information associated with the scan lines S_1-S_9 and S_{57}-S_{64}, i.e., position information of the scan lines, position information of sampling points on the scan lines, data obtained at the sampling points and the like. Thereafter, if the second control signal is inputted from the control unit 110, the transmit/receive unit 120 may be operable to transmit the ultrasound beam along the scan lines S_{10}-S_{56} within the color box 220 and receive ultrasound echoes reflected from the target object in response to the second control signal to thereby form new second receive signals. The transmit/receive unit 120 may be operable to repeat the above process until an end request is inputted from the control unit 110.

[0026] The storage unit 130 may sequentially store the first receive signals, the second receive signals, the first to fourth scan line group receive signals and the third receive signals.

[0027] The image processing unit 140 may be operable to extract the first receive signals from the storage unit 130 and form a B-mode image based on the first receive signals. The image processing unit may operable to extract the second receive signals from the storage unit 130 and form a C-mode image based on the extracted second receive signals. The image processing unit 140 may be operable to combine the B-mode image with the C-mode image to form a BC-mode image. Subsequently, the image processing unit 140 may be operable to extract the first scan line group receive signals and first receive signals in which first receive signals corresponding to the scan lines S_1, S_5, S_9, S_{13}, S_{17}, ..., S_{53}, S_{57} and S_{61} included in the first scan line group SG_1 are excluded, and then update the first receive signals with the extracted first scan line group receive signals. The image processing unit 140 may be operable to form a B-mode image 310 based on the updated first receive signals, as illustrated in FIG. 4. The image processing unit may extract the new second receive signals from the storage unit 130 and form a C-mode image based on the extracted second receive signals. Thereafter, the image processing unit 140 may be operable to combine the B-mode image 310 with the C-mode image to form a BC-mode image.

[0028] The image processing unit 140 may be operable to extract the second scan line group receive signals and first receive signals excepting the receive signals corresponding to the scan lines included in the second scan line group SG_2 to update the first receive signals. The image processing unit 140 may be operable to form a B-mode image 320 based on the updated first receive signals, as illustrated in FIG. 5. The image processing unit may extract the new second receive signals from the storage unit 130 and form a C-mode image based on the extracted new second receive signals. Thereafter, the image processing unit 140 may be operable to combine the B-mode image 320 with the C-mode image to form a BC-mode image.

[0029] The image processing unit 140 may be operable to extract the third scan line group receive signals and first receive signals in which the receive signals corresponding to the scan lines included in the third scan line group SG_3 are excluded to update the first receive signals. The image processing unit 140 may be operable to form a B-mode image 330 based on the updated first receive signals, as illustrated in FIG. 6. The image processing unit may extract the new second receive signals from the storage unit 130 and form a C-mode image based on the extracted second receive signals. Thereafter, the image processing unit 140 may be operable to combine the B-mode image 330 with the C-mode image to form a BC-mode image.

[0030] The image processing unit 140 may be operable to extract the fourth scan line group receive signals and first receive signals in which the receive signals corresponding to the scan lines included in the fourth scan line group SG_4 are excluded to update the first receive signals. The image processing unit 140 may be operable to form a B-mode image 340 based on the updated first receive signals, as illustrated in FIG. 7. The image processing unit may extract the new second receive signals from the storage unit 130 and form a C-mode image based on the extracted second receive signals. Thereafter, the image processing unit 140 may be operable to combine the B-mode image 340 with the C-mode image to form a BC-mode image. The image processing unit 140 may repeatedly carry out the above process

until an end request is inputted from the control unit 110.

[0031] In the meantime, the image processing unit 140 may extract the third receive signals and the first receive signals from the storage unit 130, and then from a B-mode image 350 based on the extracted third and first receive signals, as illustrated in FIG. 8. Thereafter, the image processing unit 140 may extract the second receive signals and form a C-mode image based on the extracted second receive signals. The image processing unit 140 may combine the B-mode image with the C-mode image to form a BC-mode image.

[0032] The display unit 150 may be operable to display the B-mode image and the BC-mode image formed in the image processing unit 140.

[0033] As mentioned above, since the time required to form the B-mode image may be reduce in accordance with the present invention, the frame rate of the BC-mode image may be improved. Thus, an ultrasound image of a rapidly moving target object may be clearly provided.

Claims

1. An ultrasound system (100), comprising:

a control unit (110) operable to generate a first control signal for a B-mode scan and a second control signal for a C-mode scan:
an input unit operable to receive color box (220) information for setting a color box (220);
a transmit/receive unit (120) responsive to the first and second control signals and operable to transmit ultrasound signals along a plurality of scan lines set in a target object and form receive signals based on the ultrasound echo signals reflected from the target object, said receive signals including first receive signals corresponding to the scan lines formed in response to the first control signal and second receive signals corresponding to the portion of scan lines within the color box (220) formed in response to the second control signal;
an image processing unit (140) operable to form a first B-mode image and a first C-mode image based on the first and second receive signals, and combine the first B-mode image with the first C-mode image to form a first BC-mode image,
wherein the control unit (110) is further operable to compute a time ratio of a first time required to form the first B-mode image to a second time required to form the first C-mode image, and determine whether the time ratio is greater or less than a critical value, and generate a third control signal for a B-mode scan along scan lines of one of the groups formed by dividing the plurality of scan lines into groups, and the second control signal if the time ratio is greater than the critical value, and generate a fourth control signal for a B-mode scan along scan lines, which are not within the color box (220), and the second control signal if the time ratio is less than the critical value;
wherein the receive signals further include scan line group receive signals formed in response to the third control signal and new second receive signals formed in response to the latest second control signal, or include third receive signals formed in response to the fourth control signal and new second receive signals formed in response to the latest second control signal, and the image processing unit (140) is further operable to form a second B-mode image and a second C-mode image based on the first receive signals and the scan line group receive signals, and on the new second receive signals when the time ratio is greater than the critical value, and based on the first receive signals, the third receive signals and the new second receive signals when the time ratio is less than the critical value and to combine the second B-mode image with the second C-mode image to form a second BC-mode image.

2. The ultrasound system (100) of Claim 1, further comprising a storage unit (130) to store the first, second and third receive signals.

3. The ultrasound system (100) of Claim 2, wherein the control unit (110) includes:

a time computing unit (111) configured to compute the first and second times;
a ratio computing unit (112) configured to compute the time ratio;
a determining unit (113) configured to check whether the time ratio is greater or less than the critical value, the determining unit (113) further being configured to generate first determination information when the time ratio is greater than the critical value and second determination information when the time ratio is less than the critical value;
a scan line group setting unit (114) configured to divide the scan lines into the plurality of scan line groups based on the time ratio, wherein each of the scan line groups include different scan lines; and

a control signal generating unit (115) configured to generate the third control signal for an alternate B-mode scan along scan lines of the respective scan line groups based on the first determination information and a fourth control signal based on the second determination information.

4. The ultrasound system (100) of Claim 3, wherein the receive signals further include scan line group receive signals formed in response to the third control signal, and the image processing unit (140) is further operable to update the first receive signals with the scan line group receive signals and form the second B-mode image based on the updated first receive signals,
wherein the control unit (110) is further operable to alternately generate the third control signal and the second control signal.

5. The ultrasound system (100) of Claim 3, wherein the ratio computing unit (112) computes the time ratio as the following equation.

$$\text{Time ratio} = \text{first time} / \text{second time}$$

6. A method of forming a BC-mode image, comprising:

generating a first control signal for a B-mode scan and a second control signal for a C-mode scan;
receiving color box (220) information for setting a color box (220) on the B-mode image;
transmitting ultrasound signals along a plurality of scan lines set in a target object and forming receive signals based on the ultrasound echo signals reflected from the target object, said receive signals including first receive signals corresponding to the scan lines formed in response to the first control signal and second receive signals corresponding to the portion of scan lines within the color box (220) formed in response to the second control signal;
forming a first B-mode image and a first C-mode image based on the first and second receive signals;
combining the first B-mode image with the first C-mode image to form a first BC-mode image;
computing a time ratio of a first time required to form the B-mode image to a second time required to form the C-mode image;
determining whether the time ratio is greater or less than a critical value;
generating a third control signal for a B-mode scan along scan lines of one of the groups formed by dividing the plurality of scan lines into groups, and the second control signal if the time radio is greater than the critical value, and generating a fourth control signal for a B-mode scan along scan lines, which are not within the color box (220), and the second control signal if the time ratio is less than the critical value;
transmitting ultrasound signals toward the target object based on the third and second control signals or the fourth and second control signals, and forming scan line group receive signals formed in response to the third control signal and new second receive signals formed in response to the latest second control signal, or third receive signals formed in response to the fourth control signal and new second receive signals formed in response to the latest second control signal;
forming a second B-mode image and a second C-mode image based on the first receive signals and the scan line group receive signals, and on the new second receive signals when the time ratio is greater than the critical value, and based on the first receive signals, the third receive signals and the new second receive signals when the time ratio is less than the critical value; and
combining the second B-mode image with the second C-mode image to form a second BC-mode image.

7. The method of Claim 6, further comprising storing the first, second and third receive signals.

8. The method of Claim 7, wherein the computing the time ratio comprises:

computing the first and second times; and
the time ratio of the first time to the second time,
wherein the determining whether the time ratio is greater or less than the critical value comprises
checking whether the time ratio is greater or less than the critical value;
if it is determined that the time ratio is greater than the critical value, generating first determination information, and if it is determined that the time ratio is less than the critical value, generating second determination information; and

dividing the scan lines into the plurality of scan line groups based on the time ratio, wherein each of the scan line groups include different scan lines; and
wherein the generating the third control signal or the fourth control signal comprises generating the third control signal for an alternate B-mode scan along scan lines of the respective scan line groups based on the first determination information and the fourth control signal based on the second determination information.

9. The method of Claim 8, wherein the receive signals further include scan line group receive signals formed in response to the third control signal, wherein the method further comprises updating the first receive signals with the scan line group receive signals, forming the second B-mode image based on the updated first receive signals, and alternately generating the third control signal and the second control signal.

10. The method of Claim 9, wherein the time ratio is computed as the following equation.

$$\text{Time ratio} = \text{first time} / \text{second time}.$$

Patentansprüche

1. Ultraschallsystem (100), welches Folgendes aufweist:

eine Steuereinheit (110), die dafür vorgesehen ist, ein erstes Steuersignal für einen B-Modus-Scan und ein zweites Steuersignal für einen C-Modus-Scan zu erzeugen;
eine Eingabeeinheit, die dafür vorgesehen ist, Informationen bezüglich einer Farbbox (220) zu empfangen, um eine Farbbox (220) einzustellen;
eine Übertragungs-/Empfangs-Einheit (120), die auf die ersten und zweiten Steuersignale reagiert und in der Lage ist, Ultraschallsignale entlang einer Vielzahl von in einem Zielobjekt eingestellten Scanlinien zu übertragen und Empfangssignale basierend auf den von dem Zielobjekt reflektierten Ultraschallechosignalen zu erzeugen, wobei die Empfangssignale erste Empfangssignale, die den als Reaktion auf das erste Steuersignal gebildeten Scanlinien entsprechen, und zweite Empfangssignale beinhalten, die denjenigen der Scanlinien innerhalb der Farbbox (220) entsprechen, die als Reaktion auf das zweite Steuersignal erzeugt wurden;
eine Bildverarbeitungseinheit (140), die dafür vorgesehen ist, ein erstes B-Modus-Bild und ein erstes C-Modus-Bild basierend auf den ersten und zweiten Empfangssignalen zu erzeugen und das erste B-Modus-Bild mit dem ersten C-Modus-Bild zu kombinieren, um ein erstes BC-Modus-Bild zu erzeugen,
wobei die Steuereinheit (110) des Weiteren dafür vorgesehen ist, ein Zeitverhältnis zwischen einer ersten Zeit, die erforderlich ist, um das erste B-Modus-Bild zu erzeugen, und einer zweiten Zeit zu berechnen, die erforderlich ist, um das erste C-Modus-Bild zu erzeugen, und zu ermitteln, ob das Zeitverhältnis größer oder kleiner als ein kritischer Wert ist, und ein drittes Steuersignal für einen B-Modus-Scan entlang von Scanlinien von einer der Gruppen zu erzeugen, die durch Teilen der Vielzahl von Scanlinien in Gruppen gebildet wurde, und
das zweite Steuersignal zu erzeugen, wenn das Zeitverhältnis größer als der kritische Wert ist, und ein viertes Steuersignal für einen B-Modus-Scan entlang von Scanlinien zu erzeugen, die sich nicht innerhalb der Farbbox (220) befinden, und das zweite Steuersignal zu erzeugen, wenn das Zeitverhältnis kleiner als der kritische Wert ist;
wobei die Empfangssignale des Weiteren Scanliniengruppenempfangssignale, die als Reaktion auf das dritte Steuersignal erzeugt wurden, und neue zweite Empfangssignale beinhalten, die als Reaktion auf das letzte zweite Steuersignal erzeugt wurden, oder dritte Empfangssignale, die als Reaktion auf das vierte Steuersignal gebildet wurden, und neue zweite Empfangssignale beinhalten, die als Reaktion auf das letzte zweite Steuersignal erzeugt wurden, und wobei die Bildverarbeitungseinheit (140) des Weiteren dafür vorgesehen ist, ein zweites B-Modus-Bild und ein zweites C-Modus-Bild basierend auf den ersten Empfangssignalen und den Scanliniengruppenempfangssignalen und auf den neuen zweiten Empfangssignalen zu erzeugen, wenn das Zeitverhältnis größer als der kritische Wert ist, und basierend auf den ersten Empfangssignalen, den dritten Empfangssignalen und den neuen zweiten Empfangssignalen, wenn das Zeitverhältnis kleiner als der kritische Wert ist, und das zweite B-Modus-Bild mit dem zweiten C-Modus-Bild zu kombinieren, um ein zweites BC-Modus-Bild zu erzeugen.

2. Ultraschallsystem (100) nach Anspruch 1, welches des Weiteren eine Speichereinheit (130) aufweist, um die ersten, zweiten und dritten Empfangssignale zu speichern.

3. Ultraschallsystem (100) nach Anspruch 2, wobei die Steuereinheit (110) Folgendes aufweist:

eine Zeitberechnungseinheit (111), die dafür vorgesehen ist, die ersten und zweiten Zeiten zu berechnen;
eine Verhältnisberechnungseinheit (112), die dafür vorgesehen ist, das Zeitverhältnis zu berechnen;
eine Ermittlungseinheit (113), die dafür vorgesehen ist, zu prüfen, ob die das Zeitverhältnis größer oder kleiner als der kritische Wert ist, wobei die Ermittlungseinheit (113) des Weiteren dafür vorgesehen ist, erste Ermittlungsinformationen zu erzeugen, wenn das Zeitverhältnis größer als der kritische Wert ist,
und zweite Ermittlungsinformationen zu erzeugen, wenn das Zeitverhältnis kleiner als der kritische Wert ist;
eine Scanliniengruppenfestlegungseinheit (114), die dafür vorgesehen ist, die Scanlinien in die Vielzahl von Scanliniengruppen basierend auf dem Zeitverhältnis einzuteilen, wobei jede der Scanliniengruppen unterschiedliche Scanlinien beinhalten; und
eine Steuersignalerzeugungseinheit (115), die dafür vorgesehen ist, das dritte Steuersignal für einen alternierenden B-Modus-Scan entlang von Scanlinien der jeweiligen Scanliniengruppen basierend auf den ersten Ermittlungsinformationen, und ein viertes Steuersignal basierend auf den zweiten Ermittlungsinformationen zu erzeugen.

4. Ultraschallsystem (100) nach Anspruch 3, wobei die Empfangssignale des Weiteren Scanliniengruppenempfangssignale beinhalten, die als Reaktion auf das dritte Steuersignal gebildet wurden, und wobei die Bildverarbeitungseinheit (140) des Weiteren dafür vorgesehen ist, die ersten Empfangssignale mit den Scanliniengruppenempfangssignalen zu aktualisieren und das zweite B-Modus-Bild basierend auf den aktualisierten ersten Empfangssignalen zu erzeugen, wobei die Steuereinheit (110) des Weiteren dafür vorgesehen ist, die dritten Steuersignale und die zweiten Steuersignale abwechselnd zu erzeugen.

5. Ultraschallsystem (100) nach Anspruch 3, wobei die Verhältnisberechnungseinheit (112) das Zeitverhältnis als die folgende Gleichung berechnet:

Zeitverhältnis = erste Zeit/zweite Zeit.

6. Verfahren zum Erzeugen eines BG-Modus-Bilds, welches folgendes aufweist:

Erzeugen eines ersten Steuersignals für einen B-Modus-Scan und eines zweiten Steuersignals für einen C-Modus-Scan;
Empfangen von Informationen bezüglich einer Farbbox (220) zum Einstellen einer Farbbox (220) auf dem B-Modus-Bild;
Übertragen von Ultraschallsignalen entlang einer Vielzahl von Scanlinien, die in einem Zielobjekt eingestellt sind, und Erzeugen von Empfangssignalen basierend auf den Ultraschallechosignalen, die von dem Zielobjekt reflektiert wurden, wobei die Empfangssignale erste Empfangssignale, die den als Reaktion auf das erste Steuersignal erzeugten Scanlinien entsprechen, und zweite Empfangssignale beinhalten, die dem Abschnitt der Scanlinien innerhalb der Farbbox (220) entsprechen, die als Reaktion auf das zweite Steuersignal erzeugt wurden;
Erzeugen eines ersten B-Modus-Bilds und eines ersten C-Modus-Bilds basierend auf den ersten und zweiten Empfangssignalen;
Kombinieren des ersten B-Modus-Bilds mit dem ersten C-Modus-Bild, um ein erstes BC-Modus-Bild zu erzeugen;
Berechnen eines Zeitverhältnisses zwischen einer ersten Zeit, die erforderlich ist, um das B-Modus-Bild zu erzeugen, und einer zweiten Zeit, die erforderlich ist, um das C-Modus-Bild zu erzeugen;
Ermitteln, ob das Zeitverhältnis größer oder kleiner als ein kritischer Wert ist;
Erzeugen eines dritten Steuersignals für einen B-Modus-Scan entlang von Scanlinien von einer der Gruppen, die durch Teilen der Vielzahl von Scanlinien in Gruppen gebildet wurde, und des zweiten Steuersignals, wenn das Zeitverhältnis größer als der kritische Wert ist, und Erzeugen eines vierten Steuersignals für einen B-Modus-Scan entlang von Scanlinien, die sich nicht innerhalb der Farbbox (220) befinden, und des zweiten Steuersignals, wenn das Zeitverhältnis kleiner als der kritische Wert ist;
Übertragen von Ultraschallsignalen in Richtung des Zielobjekts basierend auf den dritten und zweiten Steuersignalen oder den vierten und zweiten Steuersignalen, und Erzeugen von Scanliniengruppenempfangssignalen, die als Reaktion auf das dritte Steuersignal erzeugt wurden, und neuer zweiter Empfangssignale, die als Reaktion auf das letzte zweite Steuersignal erzeugt wurden, oder dritter Empfangssignale, die als Reaktion auf das vierte Steuersignal erzeugt wurden, und neuer zweiter Empfangssignale, die als Reaktion auf das letzte zweite Steuersignal erzeugt wurden;

Erzeugen eines zweiten B-Modus-Bilds und eines zweiten C-Modus-Bilds basierend auf den ersten Empfangssignalen und den Scanliniengruppenempfangssignalen und auf den neuen zweiten Empfangssignalen, wenn das Zeitverhältnis größer als der kritische Wert ist, und basierend auf den ersten Empfangssignalen, den dritten Empfangssignalen und den neuen zweiten Empfangssignalen, wenn das Zeitverhältnis kleiner als der kritische Wert ist; und Kombinieren des zweiten B-Modus-Bilds mit dem zweiten C-Modus-Bild, um ein zweites BC-Modus-Bild zu erzeugen.

7. Verfahren nach Anspruch 6, welches des Weiteren das Speichern der ersten, zweiten und dritten Empfangssignale aufweist.

8. Verfahren nach Anspruch 7, wobei das Berechnen des Zeitverhältnisses Folgendes aufweist:

Berechnen der ersten und zweiten Zeiten; und
des Zeitverhältnisses der ersten Zeit zu der zweiten Zeit,
wobei das Ermitteln, ob das Zeitverhältnis größer oder kleiner als der kritische Wert ist, das Prüfen, ob das Zeitverhältnis größer oder kleiner als der kritische Wert ist, beinhaltet;
wenn ermittelt wird, dass das Zeitverhältnis größer als der kritische Wert ist, Erzeugen erster Ermittlungsinformationen, und wenn ermittelt wird, dass das Zeitverhältnis kleiner als der kritische Wert ist, Erzeugen zweiter Ermittlungsinformationen; und
Einteilen der Scanlinien in die Vielzahl von Scanliniengruppen basierend auf dem Zeitverhältnis,
wobei jede der Scanliniengruppen unterschiedliche Scanlinien beinhaltet; und
wobei das Erzeugen des dritten Steuersignals oder des vierten Steuersignals das Erzeugen des dritten Steuersignals für einen alternierenden B-Modus-Scan entlang von Scanlinien der jeweiligen Scanliniengruppen basierend auf den ersten Ermittlungsinformationen und des vierten Steuersignals basierend auf den zweiten Ermittlungsinformationen umfasst.

9. Verfahren nach Anspruch 8, wobei die Empfangssignale des Weiteren Scanliniengruppenempfangssignale beinhalten, die als Reaktion auf das dritte Steuersignal gebildet wurden, wobei das Verfahren des Weiteren das Aktualisieren der ersten Empfangssignale mit den Scanliniengruppenempfangssignalen, das Erzeugen des zweiten B-Modus-Bilds basierend auf den aktualisierten ersten Empfangssignalen und das abwechselnde Erzeugen der dritten Steuersignale und der zweiten Steuersignale beinhaltet.

10. Verfahren nach Anspruch 9, wobei das Zeitverhältnis als die folgende Gleichung berechnet wird:

$$\text{Zeitverhältnis} = \text{erste Zeit} / \text{zweite Zeit}.$$

Revendications

1. Système ultrasonique (100) comportant :

une unité de commande (110) agencée pour générer un premier signal de commande pour un balayage en mode B et un second signal de commande pour un balayage en mode C;
une unité d'entrée agencée pour recevoir des informations de boîte de couleurs (220) pour définir une boîte de couleurs (220) ;
une unité de transmission/réception (120) en réponse aux premiers et aux seconds signaux de commande et agencée pour transmettre des signaux ultrasoniques le long d'une pluralité de lignes de balayage définies dans un objet cible et former des signaux de réception basés sur les signaux d'écho ultrasoniques réfléchis par l'objet cible, lesdits signaux de réception incluant les premiers signaux de réception correspondant aux lignes de balayage formées en réponse au premier signal de commande et des seconds signaux de réception correspondant à la portion des lignes de balayage à l'intérieur de la boîte de couleurs (220), constituée en réponse au second signal de commande ;
une unité de traitement d'image (140) agencée pour former une première image en mode B et une première image en mode C, basées sur les premier et seconds signaux de réception, et pour combiner la première image en mode B avec la première image en mode C en vue de former une première image en mode BC,
dans lequel l'unité de commande (110) est en outre agencée pour calculer un premier ratio de temps d'une

première durée nécessaire pour former la première image en mode B par rapport à une seconde durée nécessaire pour former la première image en mode C, et pour déterminer si le ratio de temps est supérieur ou inférieur à une valeur critique, et générer un troisième signal de commande pour un balayage en mode B le long de lignes de balayage d'un des groupes formé par la division d'une pluralité de lignes de balayage dans des groupes, et le second signal de commande, si le ratio de temps est supérieur à la valeur critique, et générer un quatrième signal de commande pour un balayage en mode B le long de lignes de balayage, qui ne sont pas dans la boîte des couleurs (220), et un second signal de commande, lorsque le ratio de temps est inférieur à la valeur critique ;
dans lequel les signaux de réception comportent en outre des signaux de réception d'un groupe de lignes de balayage formé en réponse au troisième signal de commande et de nouveaux seconds signaux de réception formés en réponse au dernier second signal de commande, ou inclut des troisièmes signaux de réception formés en réponse au quatrième signal de commande et des nouveaux seconds signaux de réception formés en réponse au dernier second signal de réception,
et l'unité de traitement d'image (140) est en outre agencée pour former une seconde image en mode B et une seconde image en mode C basées sur les premiers signaux de réception et les signaux de réception du groupe de lignes de balayage, et sur les nouveaux seconds signaux de réception,
lorsque le ratio de temps est supérieur à la valeur critique, et basés sur les premiers signaux de réception, les troisièmes signaux de réception et les nouveaux seconds signaux de réception, lorsque le ratio de temps est inférieur à la valeur critique, et pour combiner la seconde image en mode B avec la seconde image en mode C en vue de former une image en mode BC.

2. Système ultrasonique (100) selon la revendication 1, comprenant en outre une unité de stockage (130) pour mémoriser les premiers, seconds et troisièmes signaux de réception.

3. Système ultrasonique (100) selon la revendication 2, dans lequel l'unité de commande (110) comporte :

une unité de calcul du temps (111) configurée pour calculer la première et la seconde durées ;
une unité de calcul du ratio (112) de temps configurée pour calculer le ratio de temps ;
une unité de détermination (113) configurée pour déterminer lequel des ratio est supérieur ou inférieur à la valeur critique, l'unité de détermination (113) étant en outre configurée pour générer des premières informations de détermination lorsque le ratio de temps est supérieur à la valeur critique et des secondes informations de détermination lorsque le ratio de temps est inférieur à la valeur critique ;
une unité de fixation (114) de groupe de lignes de balayage configurée pour diviser les lignes de balayage en une pluralité de groupes de lignes de balayage basée sur le ratio de temps,
dans lequel chaque groupe de lignes de balayage comprend différentes lignes de balayage ; et
une unité de génération de signal (115) pour générer le troisième signal de commande pour un balayage alternatif en mode B le long des lignes de balayage des groupes respectifs de lignes de balayage basés sur les premières informations de détermination et un quatrième signal de commande basé sur les secondes informations de détermination.

4. Système ultrasonique (100) selon la revendication 3, dans lequel les signaux de réception comprennent en outre des signaux de réception de groupe de lignes de balayage, formés en réponse au troisième signal de commande, et l'unité de traitement d'image (140) est en outre agencée pour actualiser les premiers signaux de réception avec les signaux de réception de groupe de lignes de balayage et former la seconde image en mode B basée sur les premiers signaux de réception actualisés,
dans lequel l'unité de commande (110) est en outre agencée pour générer alternativement le troisième signal de commande et le second signal de commande.

5. Système ultrasonique (100) selon la revendication 3, dans lequel l'unité de calcul (112) du ratio de temps calcule le ratio de temps avec l'équation suivante :

$$\text{Ratio de temps} = \text{première durée/seconde durée.}$$

6. Procédé pour former une image en mode BC, consistant à :

générer un premier signal de commande pour un balayage en mode B et un second signal de commande pour

un balayage en mode C ;
recevoir des informations de boîte de couleurs (220) pour définir une boîte de couleurs (220) sur l'image en mode B ;
transmettre des signaux ultrasoniques le long d'une pluralité de lignes de balayage dans un objet cible et former des signaux de réception basés sur les signaux ultrasoniques d'écho réfléchis par l'objet cible, lesdits signaux de réception comportant des premiers signaux de réception correspondant aux lignes de balayage formées en réponse au premier signal de commande et des seconds signaux de réception correspondant à la portion de lignes de balayage à l'intérieur de la boîte de couleurs (220), formés en réponse au second signal de commande ;
former une première image en mode B et une première image en mode C basées sur les premiers et seconds signaux de réception ;
combiner la première image en mode B avec la première image en mode C en vue de former une première image en mode BC,
calculer un ratio de temps d'une première durée nécessaire pour former l'image en mode B par rapport à une seconde durée nécessaire pour former l'image en mode C ;
déterminer si le ratio de temps est supérieur ou inférieur à une valeur critique ;
générer un troisième signal de commande pour un balayage en mode B le long de lignes de balayage d'un des groupes formés par la division d'une pluralité de lignes de balayage dans des groupes, et le second signal de commande, si le ratio de temps est supérieur à la valeur critique, et générer un quatrième signal de commande pour un balayage en mode B le long de lignes de balayage qui ne sont pas dans la boîte des couleurs (220), et le second signal de commande, lorsque le ratio de temps est inférieur à la valeur critique ;
transmettre les signaux ultrasoniques vers l'objet cible, basés sur les troisièmes et seconds signaux de commande ou les quatrièmes et seconds signaux de commande et former des signaux de réception de groupes de lignes de balayage formés en réponse au troisième signal de commande et des nouveaux seconds signaux de réception formés en réponse au dernier second signal de commande, ou des troisièmes signaux de réception formés en réponse au quatrième signal de commande et des nouveaux seconds signaux de réception formés en réponse au dernier signal de commande ;
former une seconde image en mode B et une seconde image en mode C basées sur les premiers signaux de réception et les signaux de réception de groupe de lignes de balayage, et sur les nouveaux seconds signaux de réception, lorsque le ratio de temps est supérieur à la valeur critique, et basés sur les premiers signaux de réception, les troisièmes signaux de réception et les nouveaux seconds signaux de réception lorsque le ratio de temps est inférieur à la valeur critique ; et
combiner la seconde image en mode B avec le seconde image en mode C pour constituer une seconde image en mode BC.

7. Procédé selon la revendication 6, comprenant en outre le stockage des premiers, des seconds et des troisièmes signaux de réception.

8. Procédé selon la revendication 7, dans lequel le calcul du ratio de temps comporte le calcul de la première durée et de la seconde durée,
et le calcul du ratio de la première durée par rapport à la seconde durée,
dans lequel déterminer si le ratio de temps est supérieur ou inférieur consistant à la valeur critique, consiste à vérifier si le ratio de temps est supérieur ou inférieur à la valeur critique ;
s'il est établi que le ratio de temps est supérieur à la valeur critique, générer des premières informations de détermination, et
s'il est établi que le ratio de temps est inférieur à la valeur critique, générer des secondes informations de détermination; et
diviser les lignes de balayage en une pluralité de groupes de lignes de balayage basée sur le ratio de temps,
dans lequel chaque groupe de lignes de balayage comprend différentes lignes de balayage, et
dans lequel la génération du troisième signal de commande ou du quatrième signal de commande comprend la génération du troisième signal de commande pour un balayage alternatif en mode B le long des lignes de balayage des groupes correspondants de lignes de balayage basés sur la première information de détermination et le quatrième signal de commande basé sur la seconde information de détermination.

9. Procédé selon la revendication 8, dans lequel les signaux de réception comprennent en outre des signaux de réception de groupes de lignes de balayage formés en réponse aux troisièmes signaux de commande, dans lequel le procédé comprend en outre l'actualisation des premiers signaux de réception avec les signaux de réception de groupe de lignes de balayage pour former la seconde image en mode B, basée sur les premiers signaux de réception actualisés et alternativement la génération du troisième signal de commande et du second signal de commande.

10. Procédé selon la revendication 9, dans lequel le ratio de temps est calculé avec l'équation suivante :

Ratio de temps = première durée/seconde durée.

FIG. 1

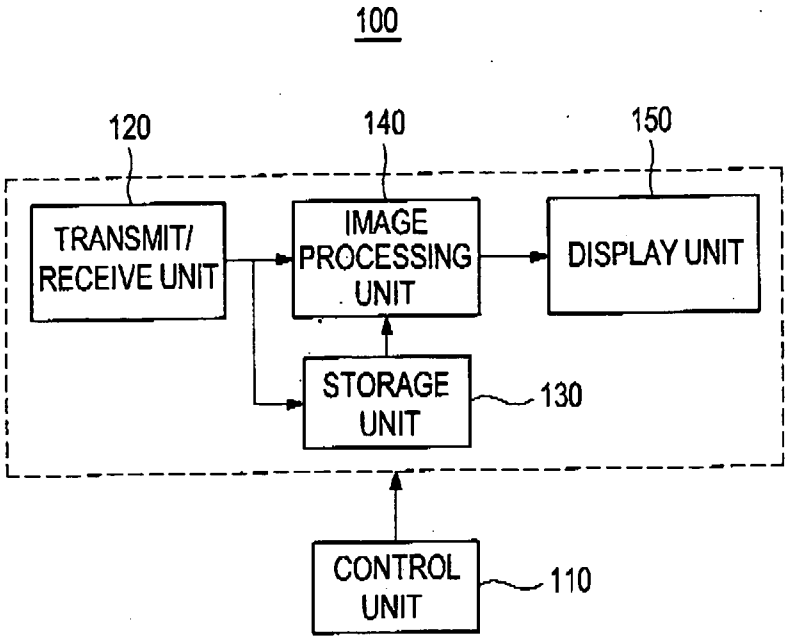

100
120
140
150
TRANSMIT/ RECEIVE UNIT
IMAGE PROCESSING UNIT
DISPLAY UNIT
STORAGE UNIT
130
CONTROL UNIT
110

FIG. 2

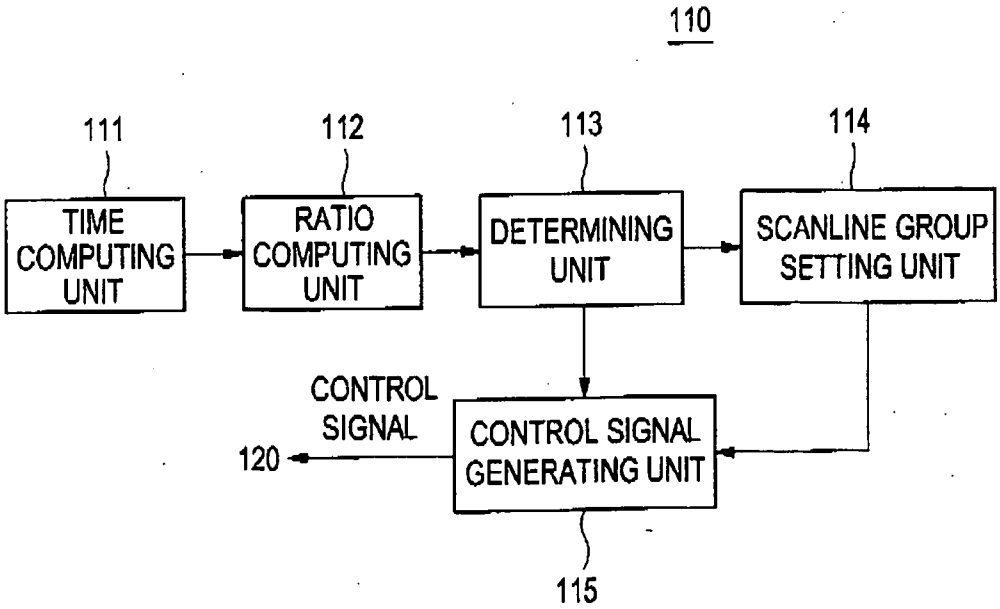
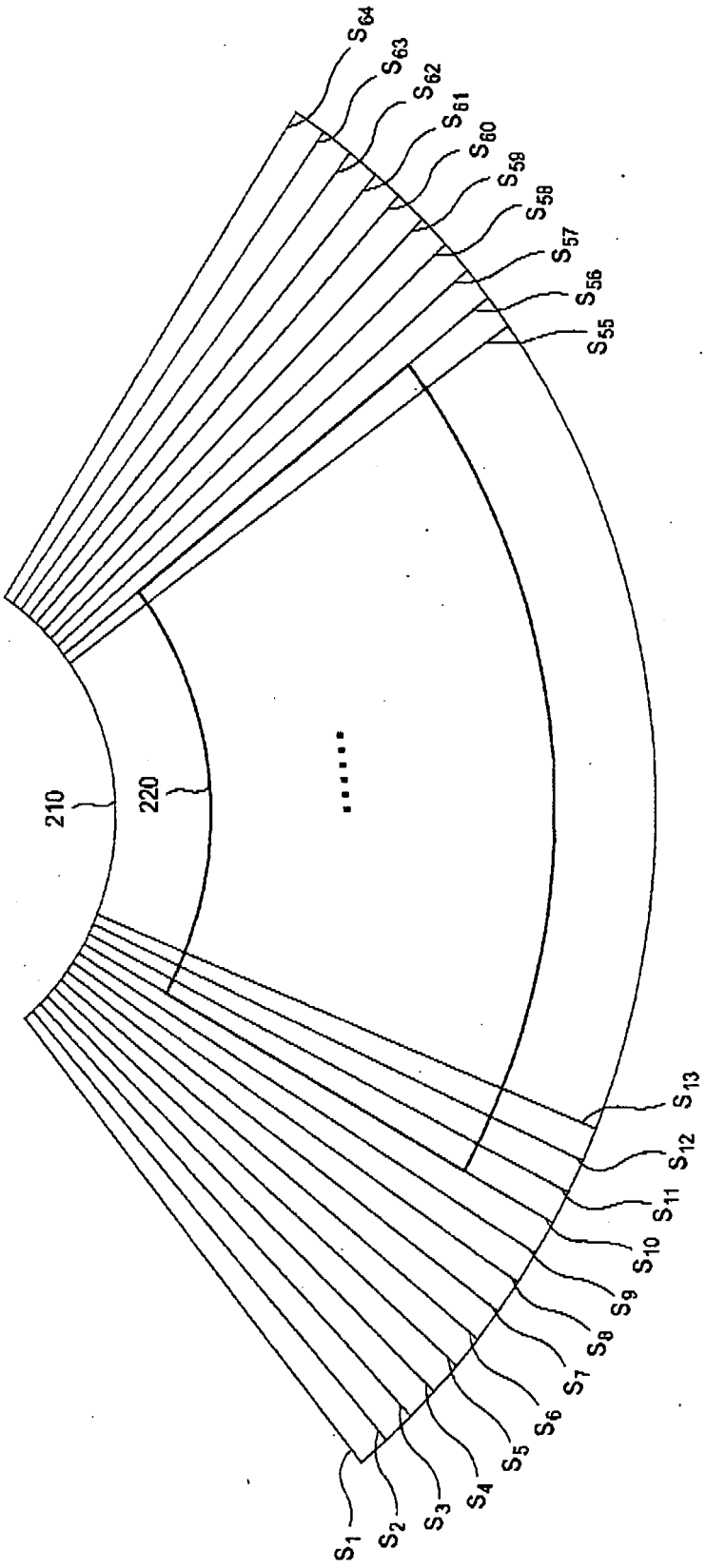

110
111
112
113
114
TIME COMPUTING UNIT
RATIO COMPUTING UNIT
DETERMINING UNIT
SCANLINE GROUP SETTING UNIT
CONTROL SIGNAL
120
CONTROL SIGNAL GENERATING UNIT
115

FIG. 3


210
220
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S64

FIG. 4

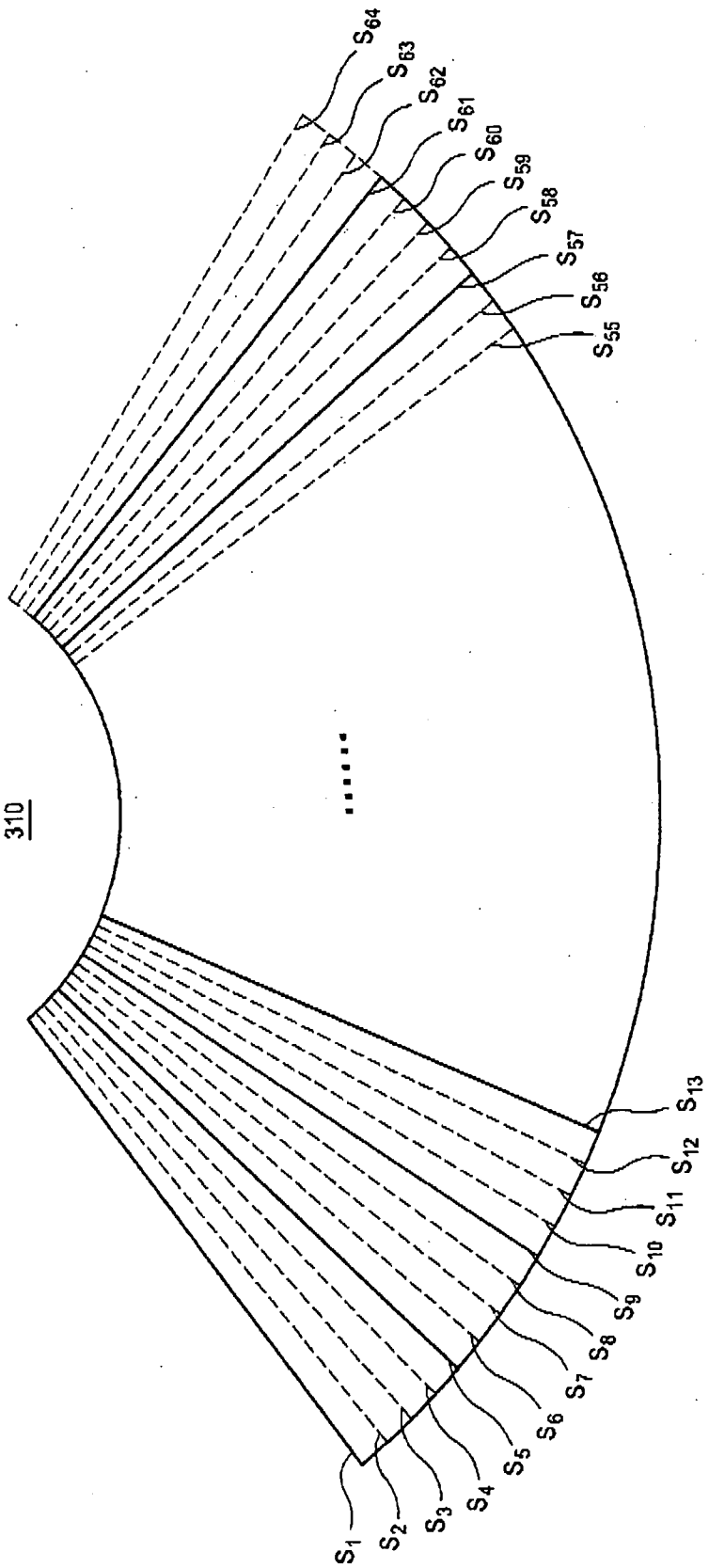
310
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FIG. 5

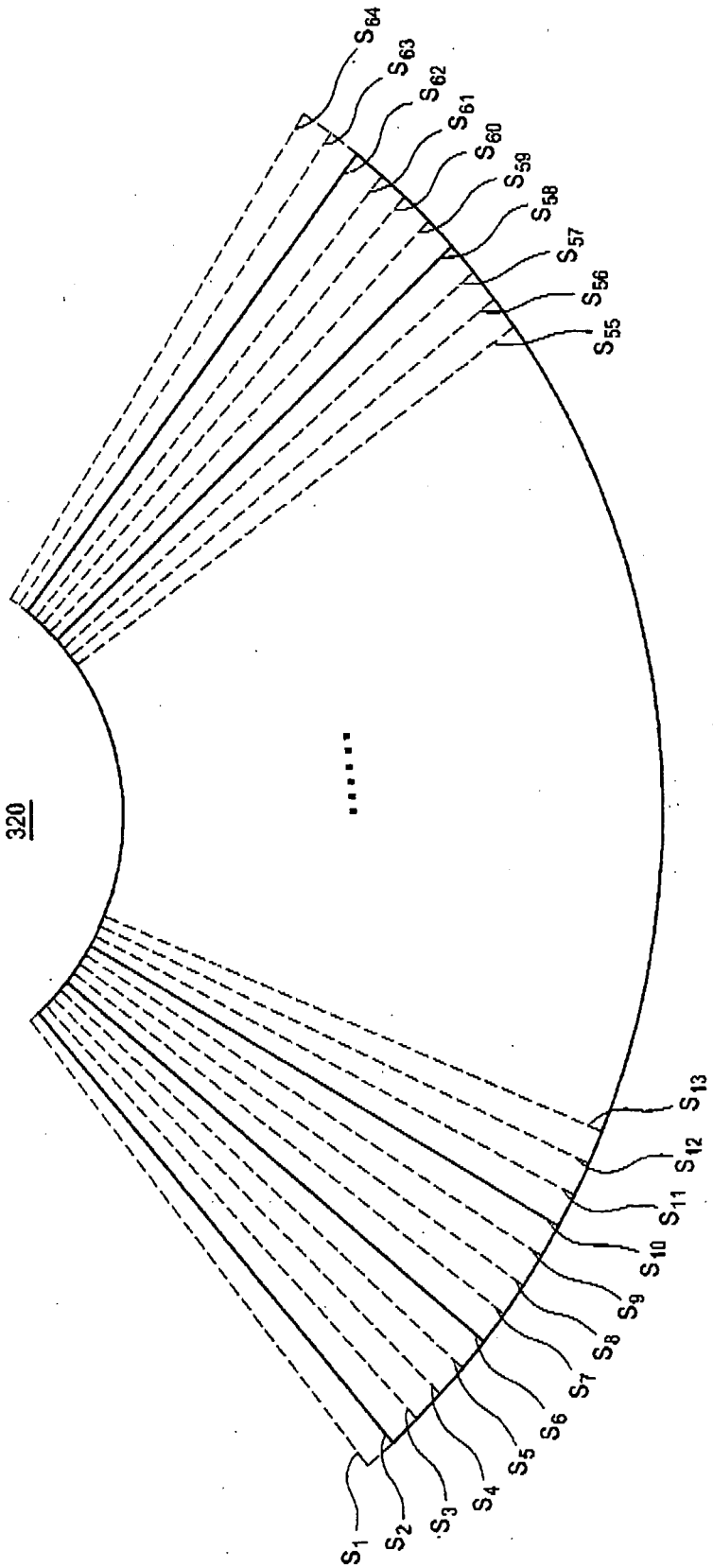
320
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FIG. 6

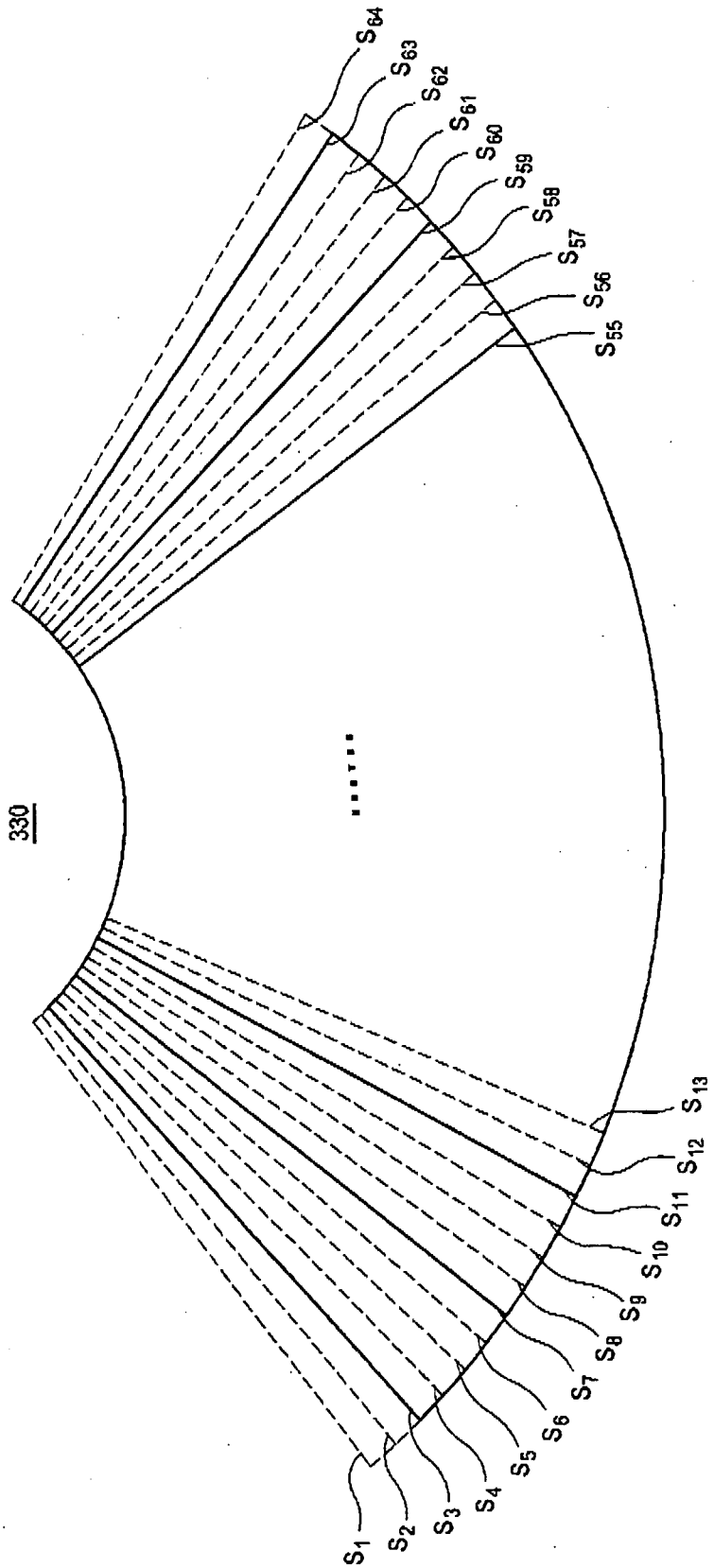
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FIG. 7

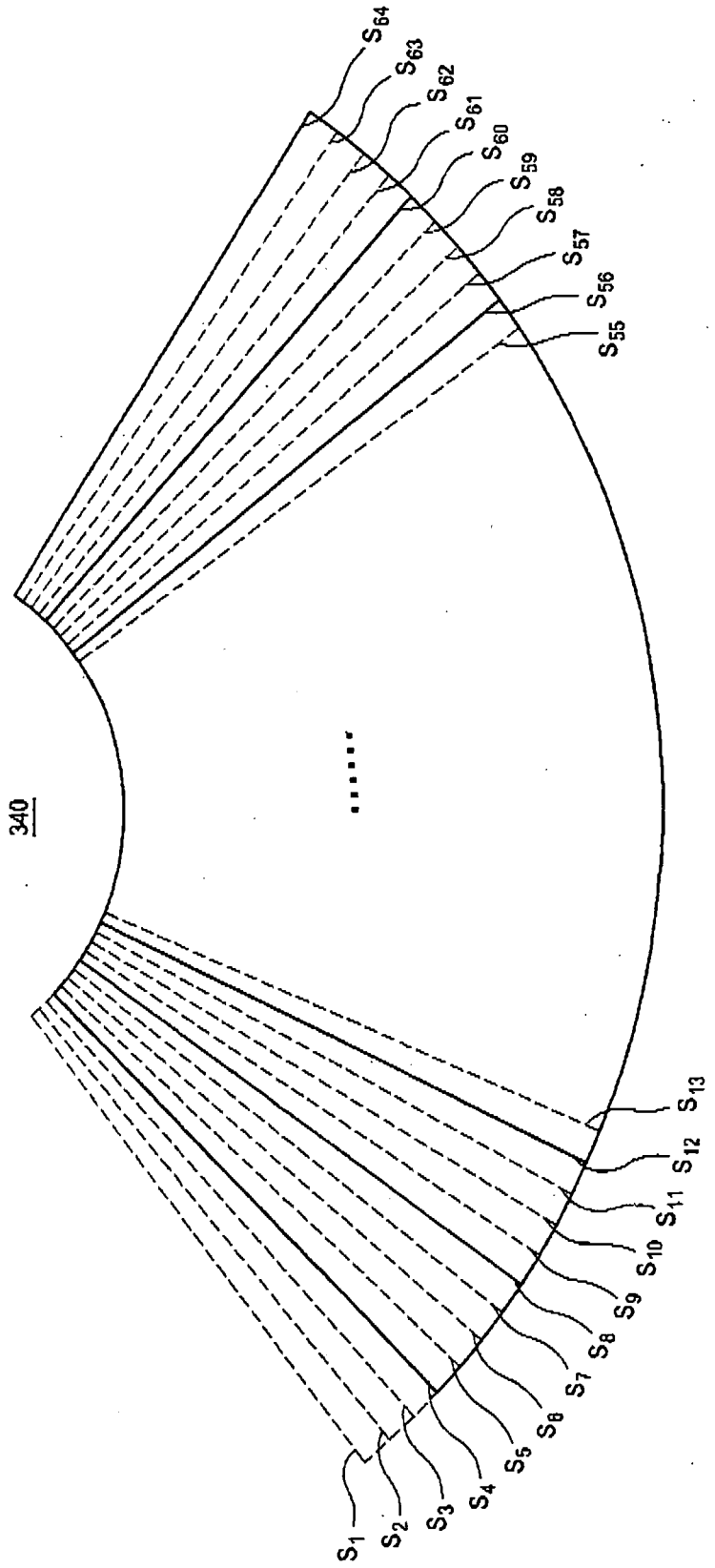
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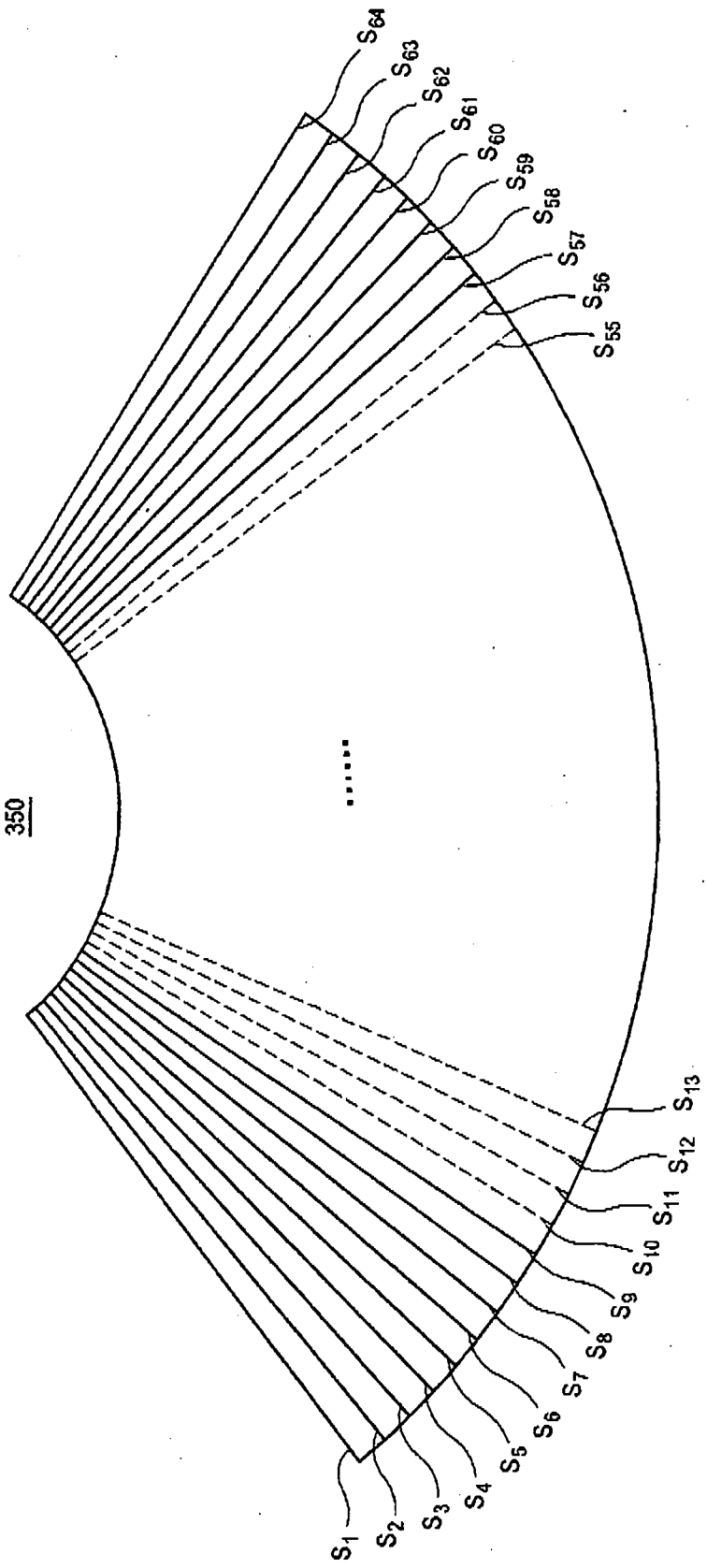
FIG. 8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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 6139501 A **[0005]**
- WO 2004106969 A2 **[0006]**
- US 6537217 B1 **[0007]**

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- **KIRKHORN J et al.** A new technique for improved spatial resolution in high frame rate color Doppler imaging. *2003 IEEE Ultrasonics Symposium Proceedings,* 05 October 2003, vol. 2, 1947-1950 **[0008]**

专利名称(译)	超声系统和形成BC模式图像的方法		
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外部链接	Espacenet		

摘要(译)

超声系统技术领域本发明涉及超声系统。控制器产生用于B模式扫描的第一控制信号和用于C模式扫描的第二控制信号。发送/接收单元沿着设置在目标对象中的多条扫描线发送超声信号，并基于该控制信号形成接收信号。从目标物体反射的超声回波信号。接收信号包括对应于扫描线的第一接收信号和对应于彩色盒内的一部分扫描线的第二接收信号。图像处理单元基于第一和第二接收信号形成B模式图像和C模式图像，并将B模式图像与C模式图像组合以形成BC模式图像。控制单元计算形成B模式图像所需的第一时间与形成C模式图像所需的第二时间的时间比，并产生用于沿扫描线的B模式扫描的第三控制信号，不在彩盒内，根据时间比例形成第三接收信号。图像处理单元基于第三接收信号和第二信号形成B模式图像。