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(54) **ULTRASOUND SYSTEM AND METHOD OF SELECTING SLICE IMAGE FROM THREE-DIMENSIONAL ULTRASOUND IMAGE**

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(52) **U.S. Cl.** **600/443**

(57) **ABSTRACT**

Various embodiments of ultrasound system and method of selecting a 2D slice image from a 3D ultrasound image are provided. One embodiment of the ultrasound system comprises: a 3D ultrasound image acquisition unit configured to acquire a 3D ultrasound image of a target object; a 2D slice image selection unit including a control volume unit, the 2D slice image selection unit being configured to be rotated and/or moved by an operator; and a processor coupled to the 3D ultrasound image acquisition unit and the 2D slice image selection unit. At least one selection plane is formed by the control volume unit as a reference plane to select at least one 2D slice image from the 3D ultrasound image. The processor is configured to extract at least one 2D slice image corresponding to the at least one selection plane from the 3D ultrasound image. The 3D ultrasound image or the at least one selection plane are rotated and/or moved together with the control volume unit.

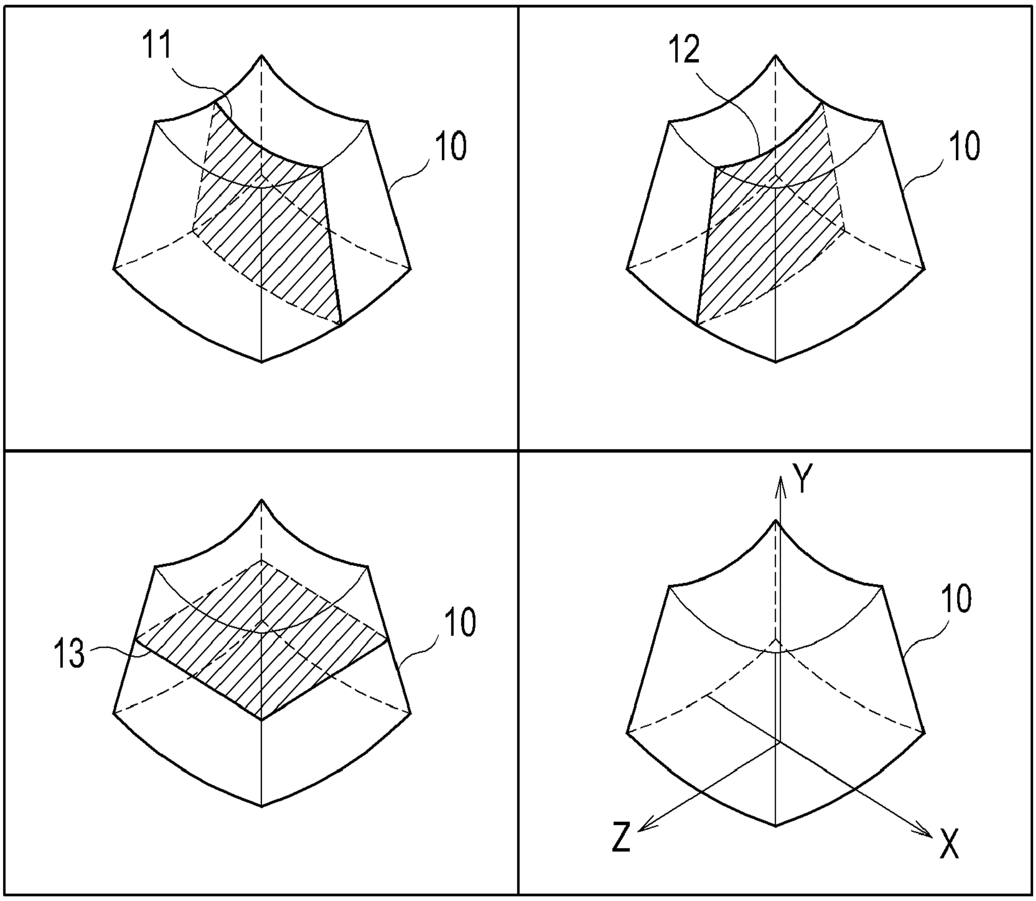


FIG. 1

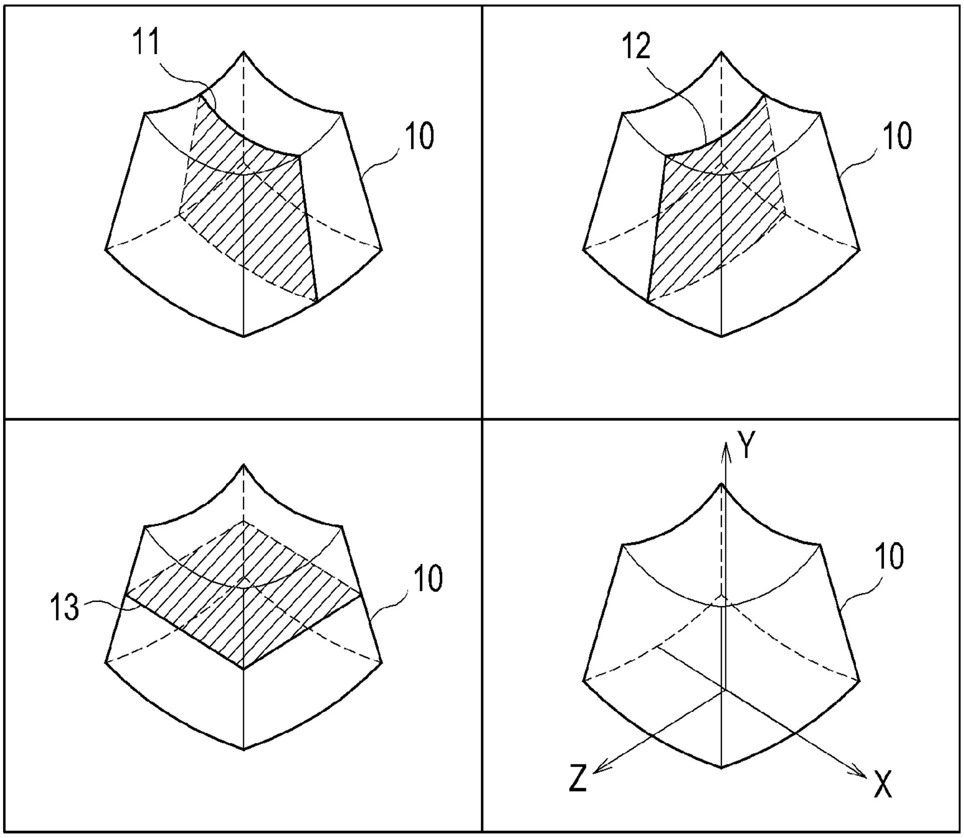


FIG. 2

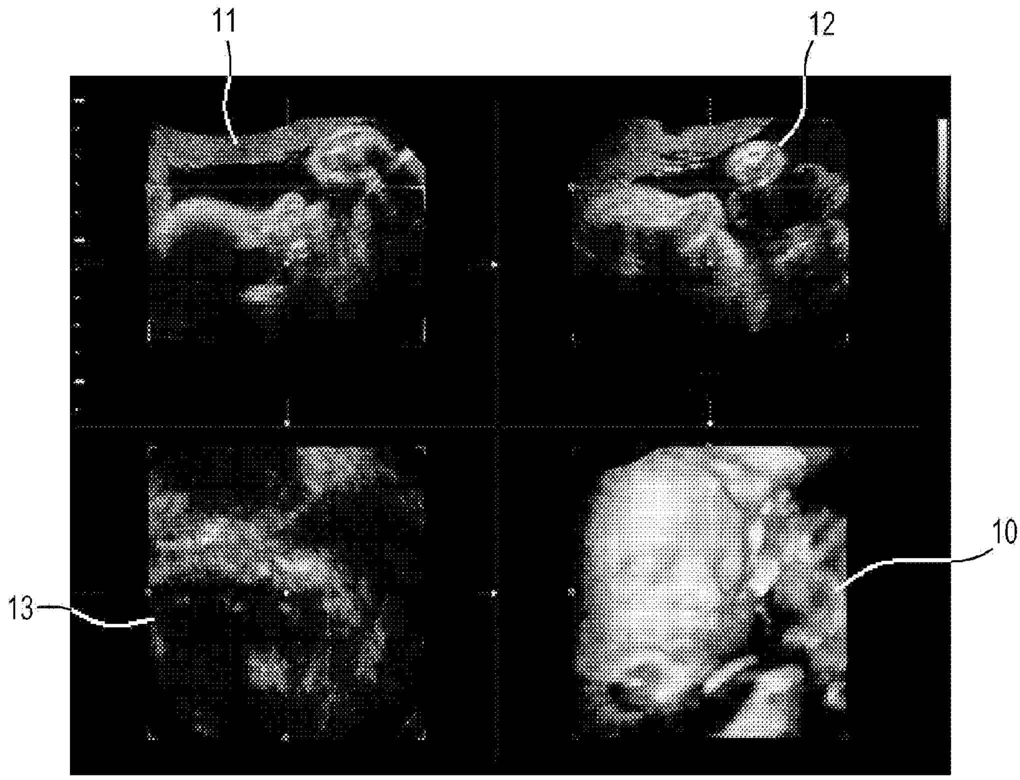


FIG. 3

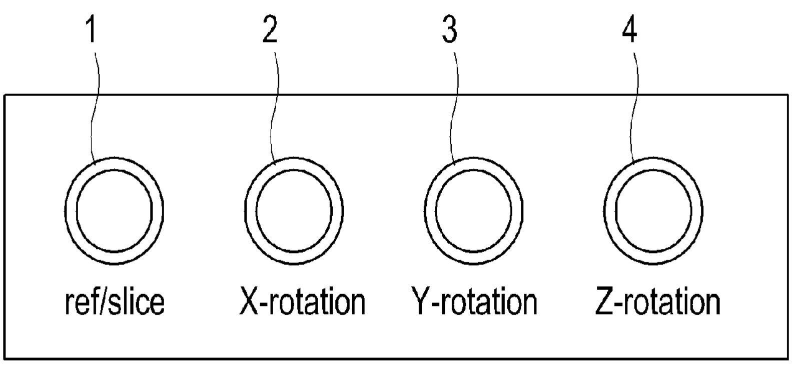


FIG. 4

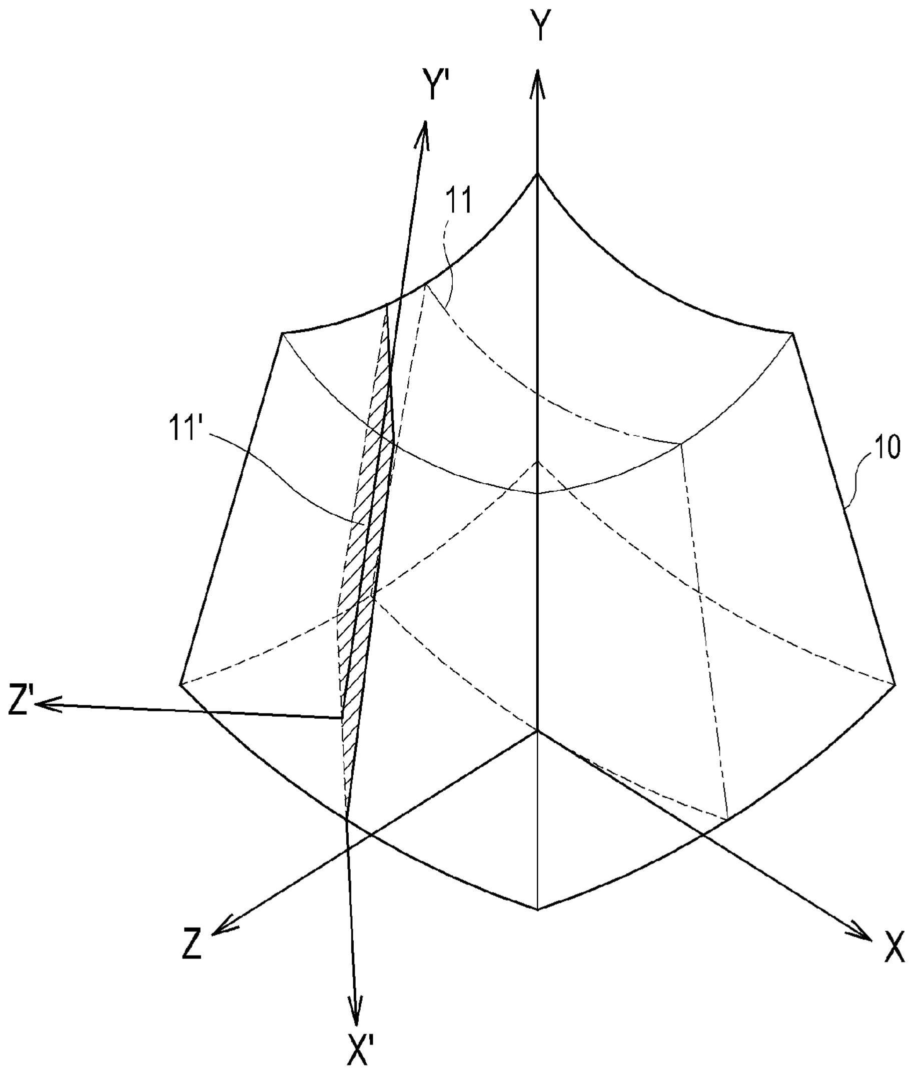


FIG. 5

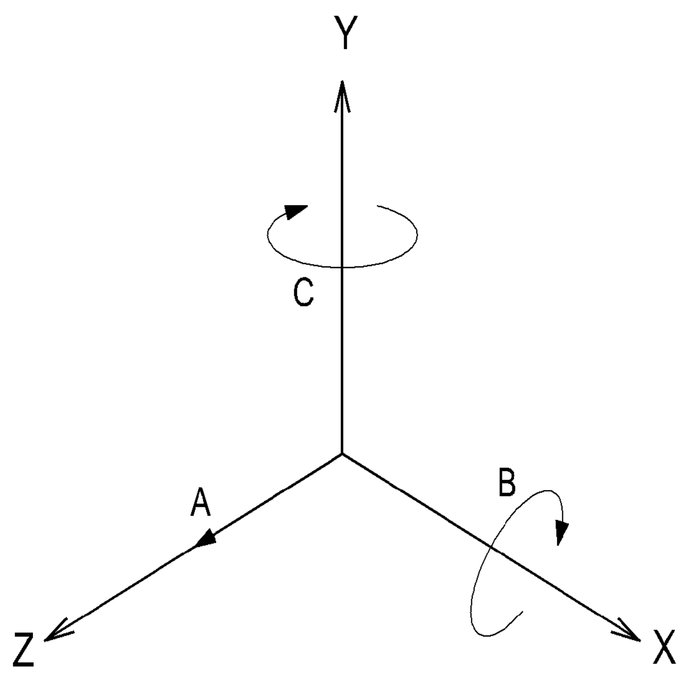

Y
C
A
B
Z
X

FIG. 6

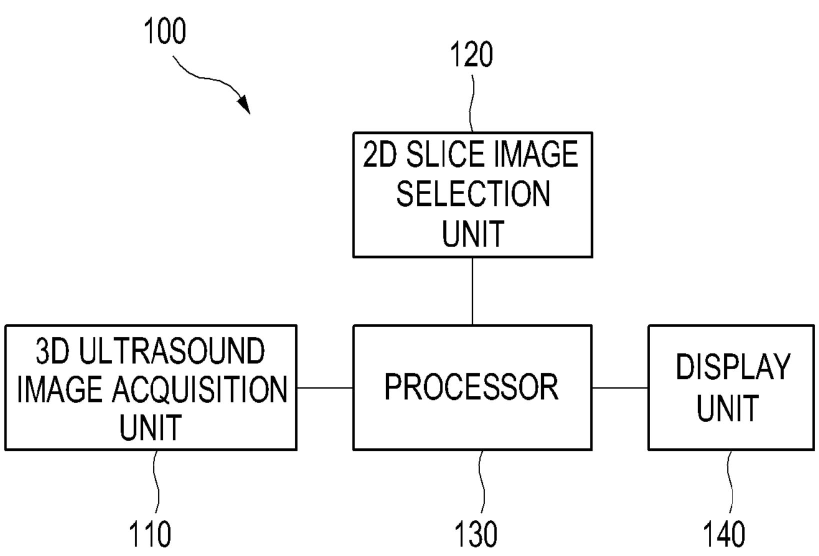

100
120
2D SLICE IMAGE SELECTION UNIT
3D ULTRASOUND IMAGE ACQUISITION UNIT
PROCESSOR
DISPLAY UNIT
110
130
140

FIG. 7

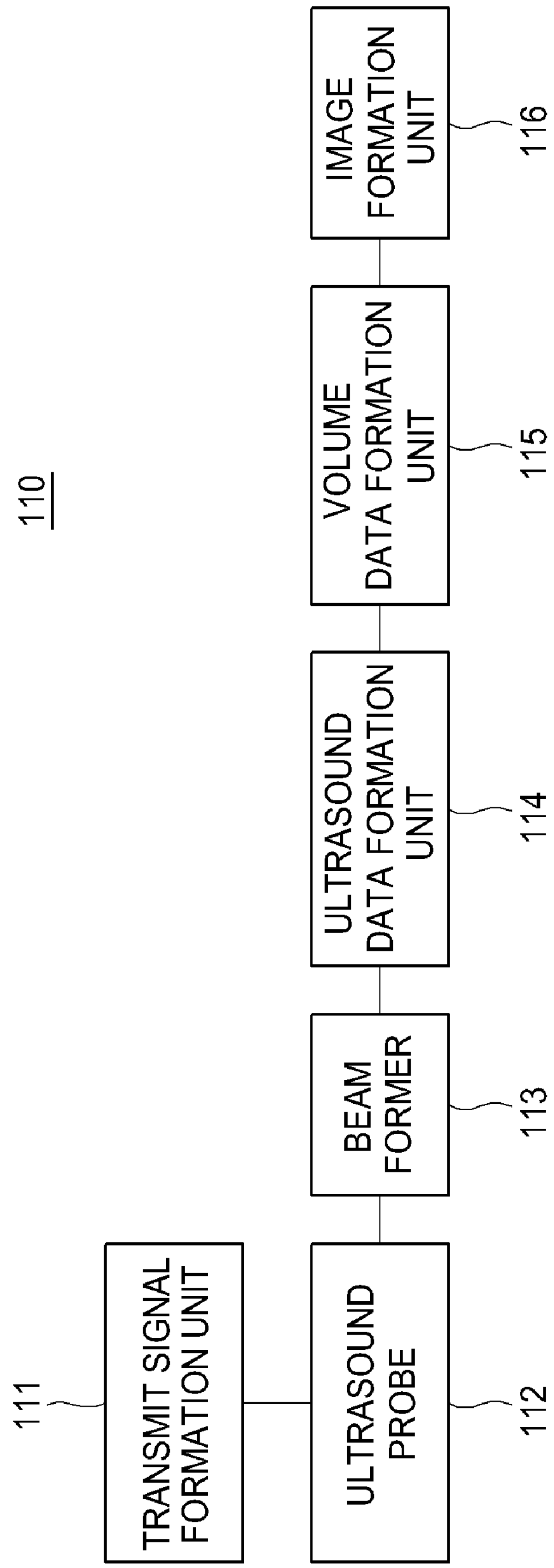

110
111
TRANSMIT SIGNAL FORMATION UNIT
112
ULTRASOUND PROBE
113
BEAM FORMER
114
ULTRASOUND DATA FORMATION UNIT
115
VOLUME DATA FORMATION UNIT
116
IMAGE FORMATION UNIT

FIG. 8

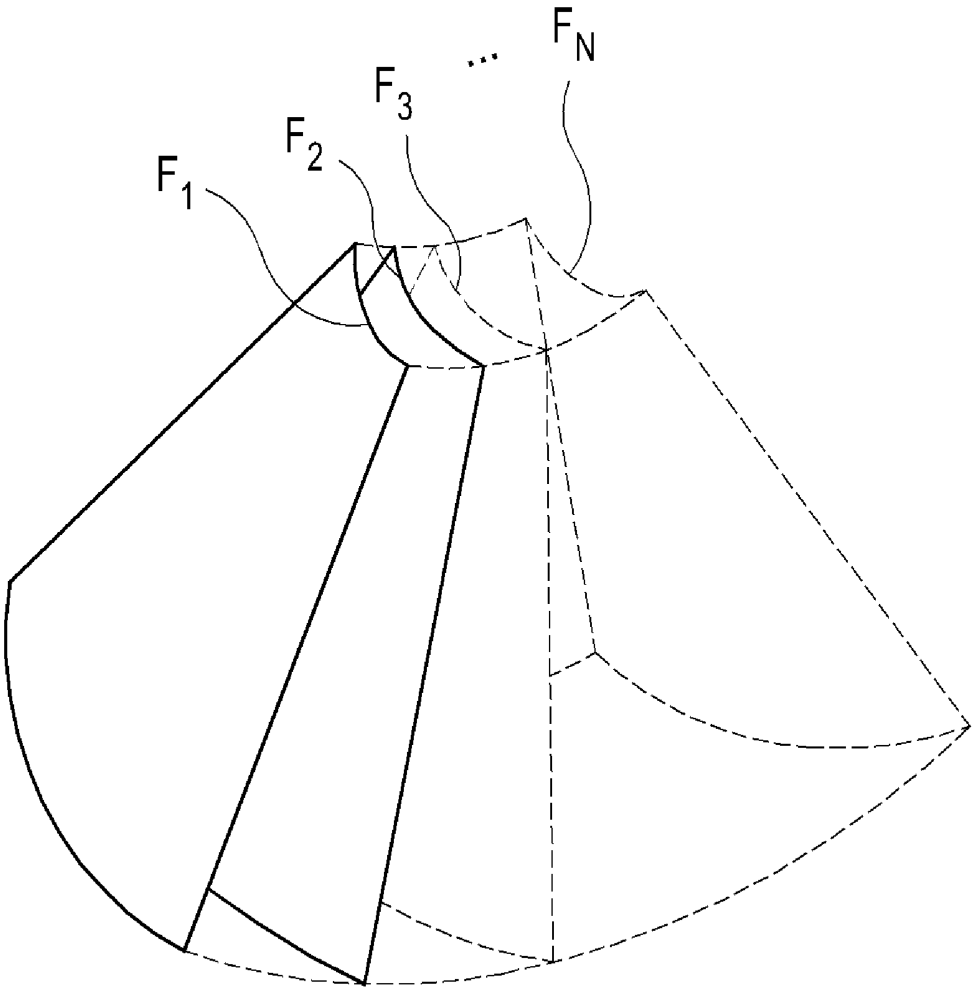


FIG. 9

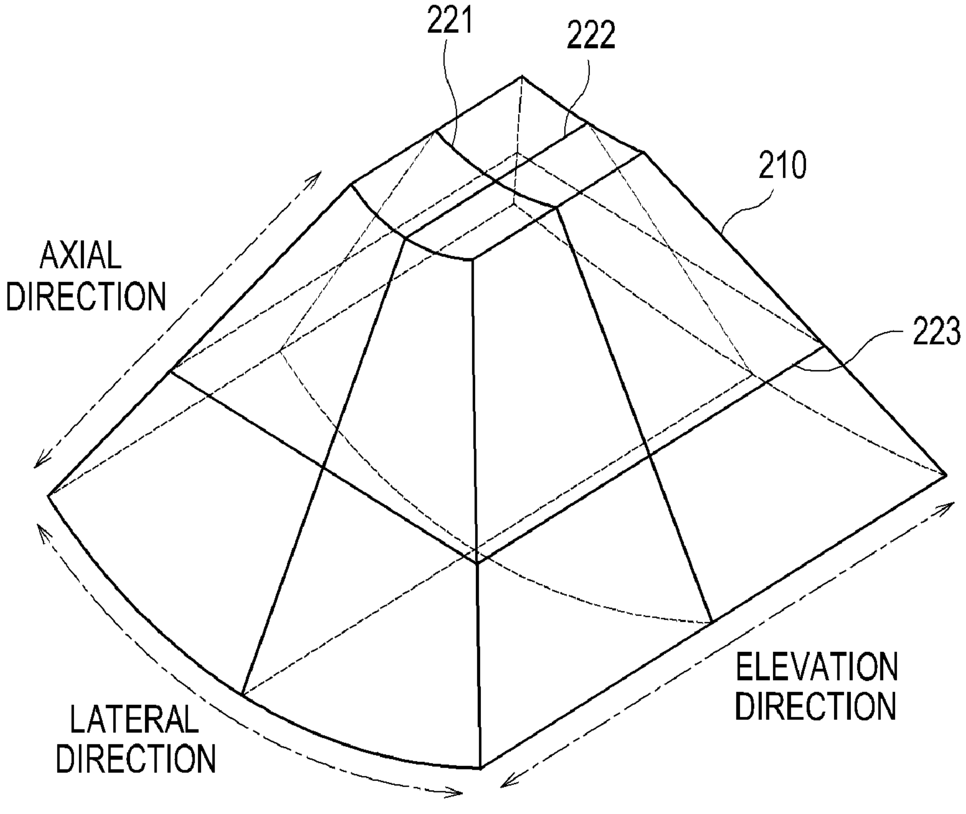

221
222
210
AXIAL DIRECTION
223
LATERAL DIRECTION
ELEVATION DIRECTION

FIG. 10

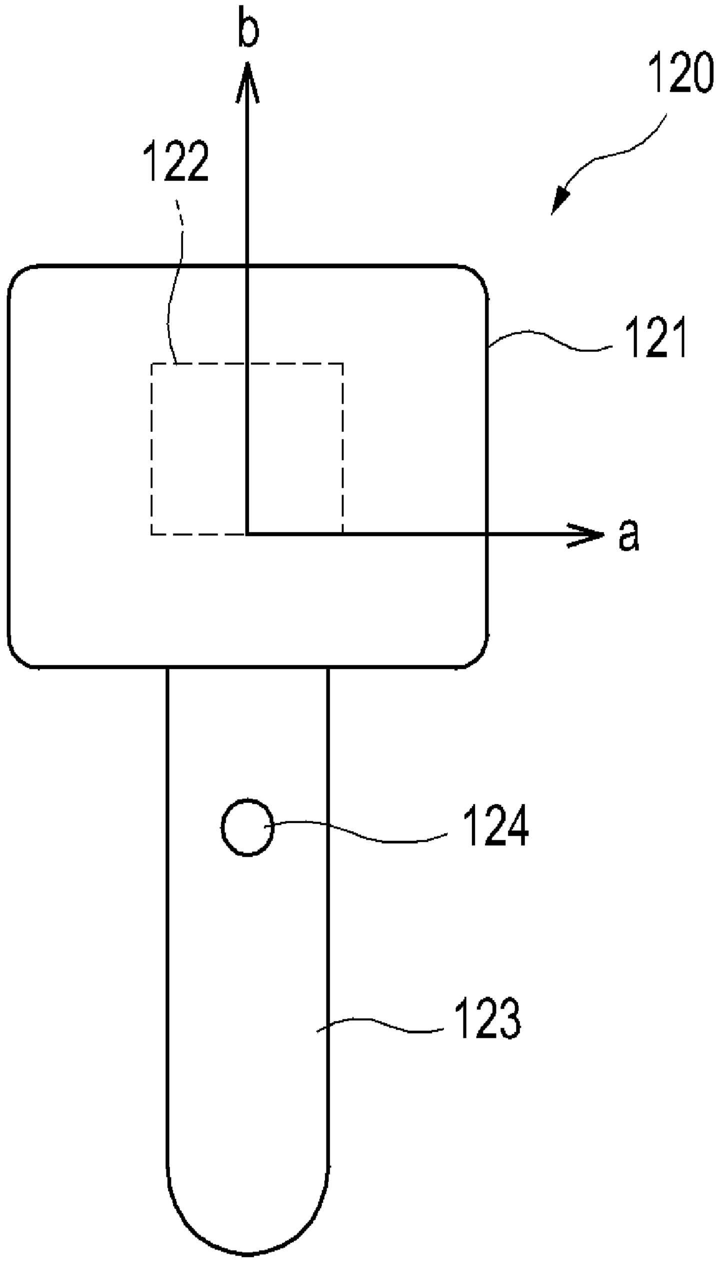


FIG. 11

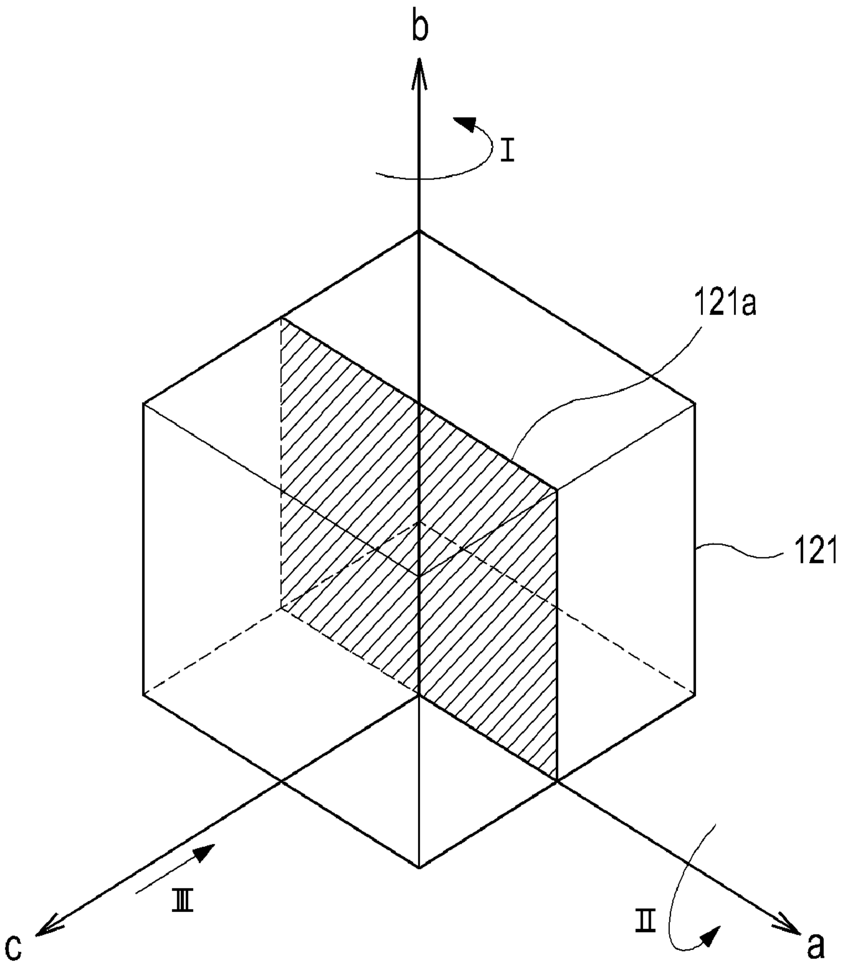


FIG. 12

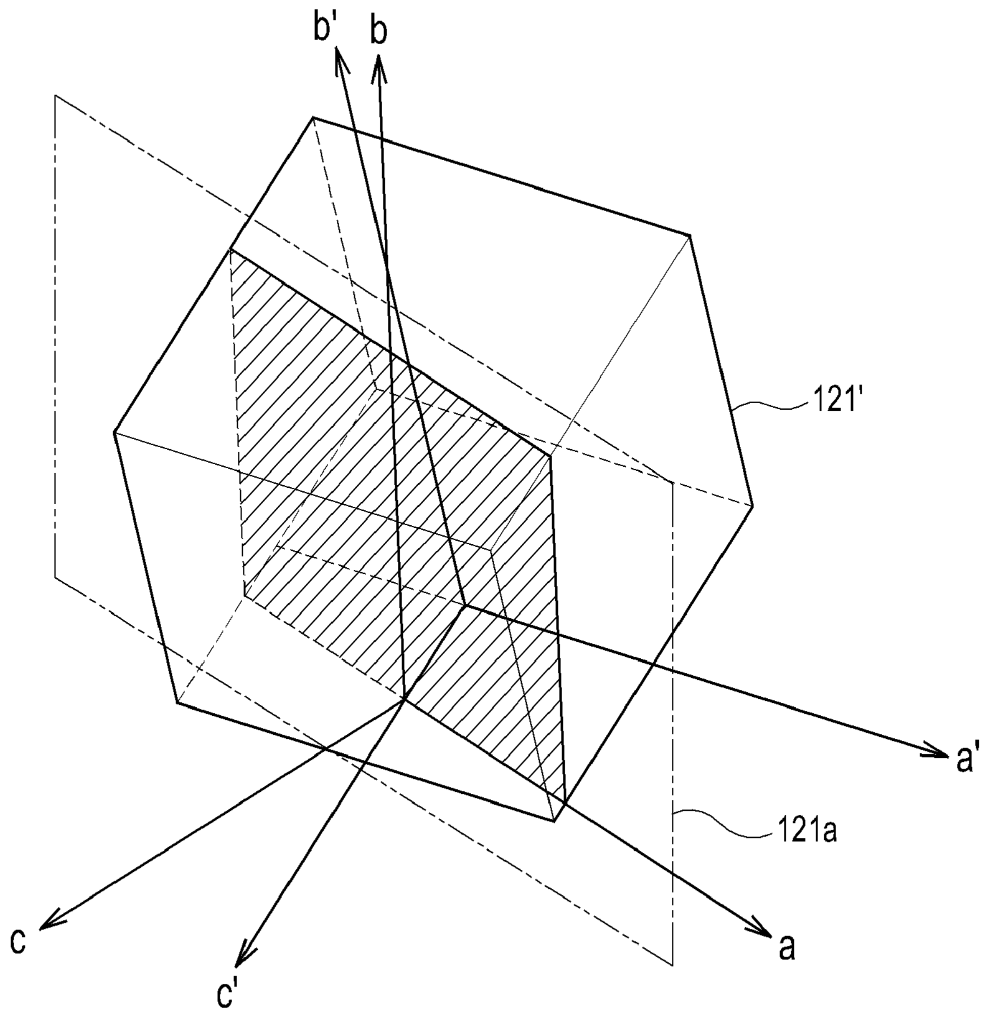


FIG. 13

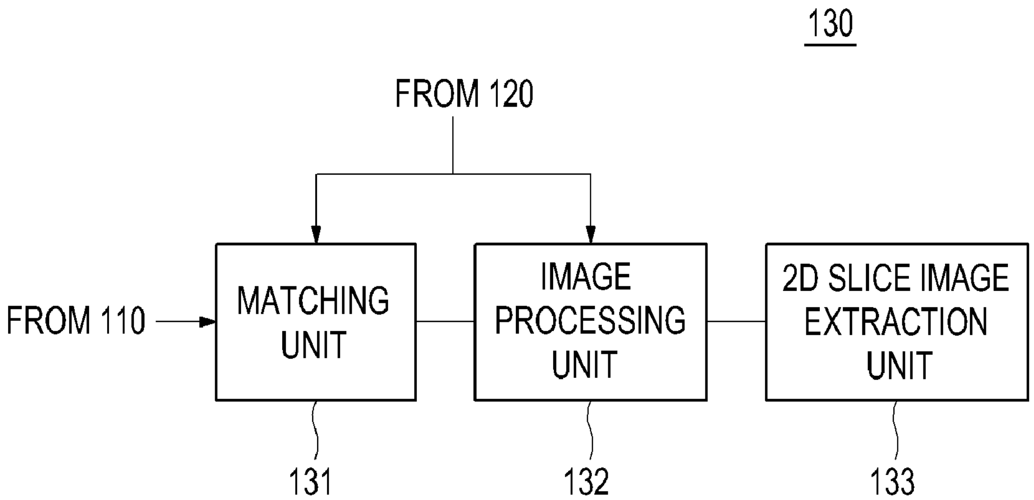

130
FROM 120
FROM 110
MATCHING UNIT
IMAGE PROCESSING UNIT
2D SLICE IMAGE EXTRACTION UNIT
131
132
133

FIG. 14

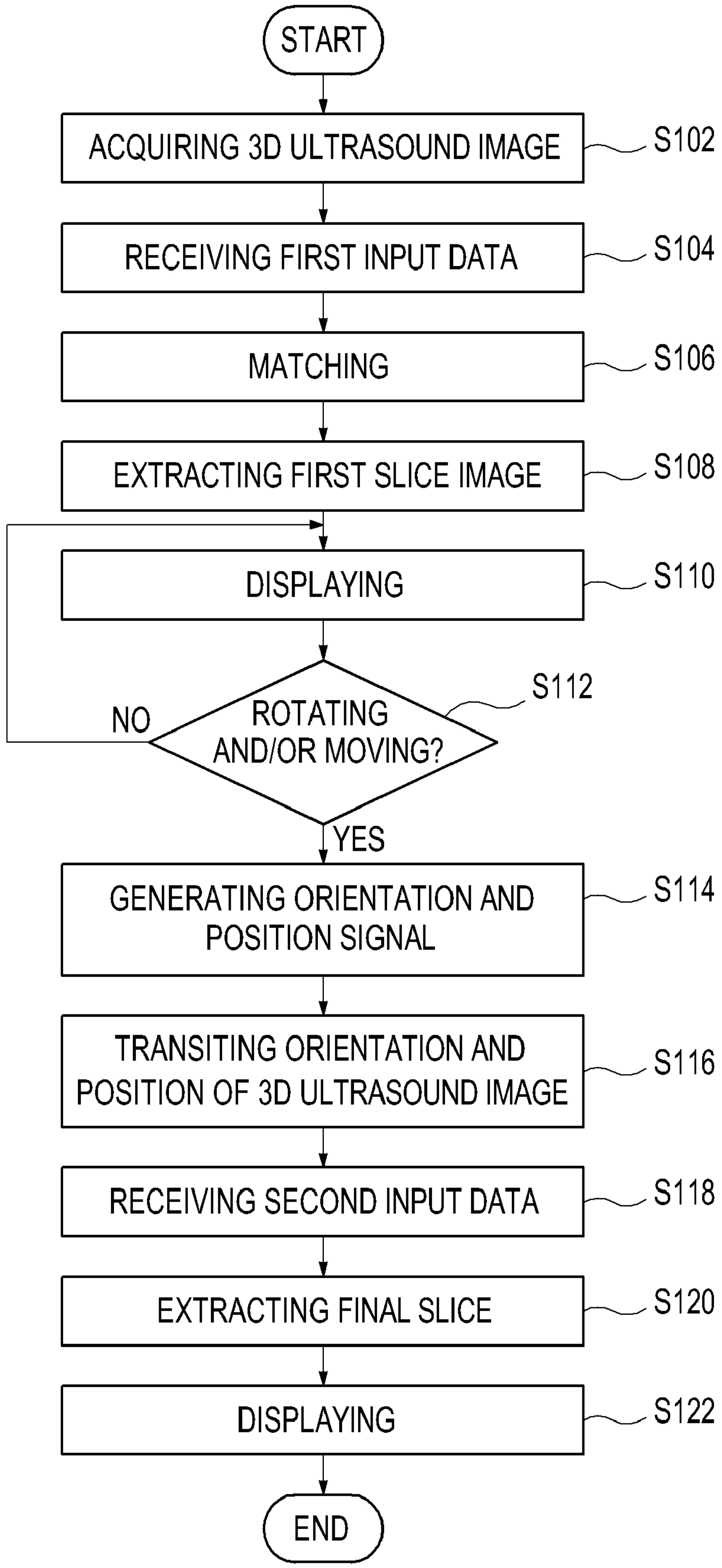

START
ACQUIRING 3D ULTRASOUND IMAGE
S102
RECEIVING FIRST INPUT DATA
S104
MATCHING
S106
EXTRACTING FIRST SLICE IMAGE
S108
DISPLAYING
S110
ROTATING AND/OR MOVING?
S112
NO
YES
GENERATING ORIENTATION AND POSITION SIGNAL
S114
TRANSITING ORIENTATION AND POSITION OF 3D ULTRASOUND IMAGE
S116
RECEIVING SECOND INPUT DATA
S118
EXTRACTING FINAL SLICE
S120
DISPLAYING
S122
END

FIG. 15

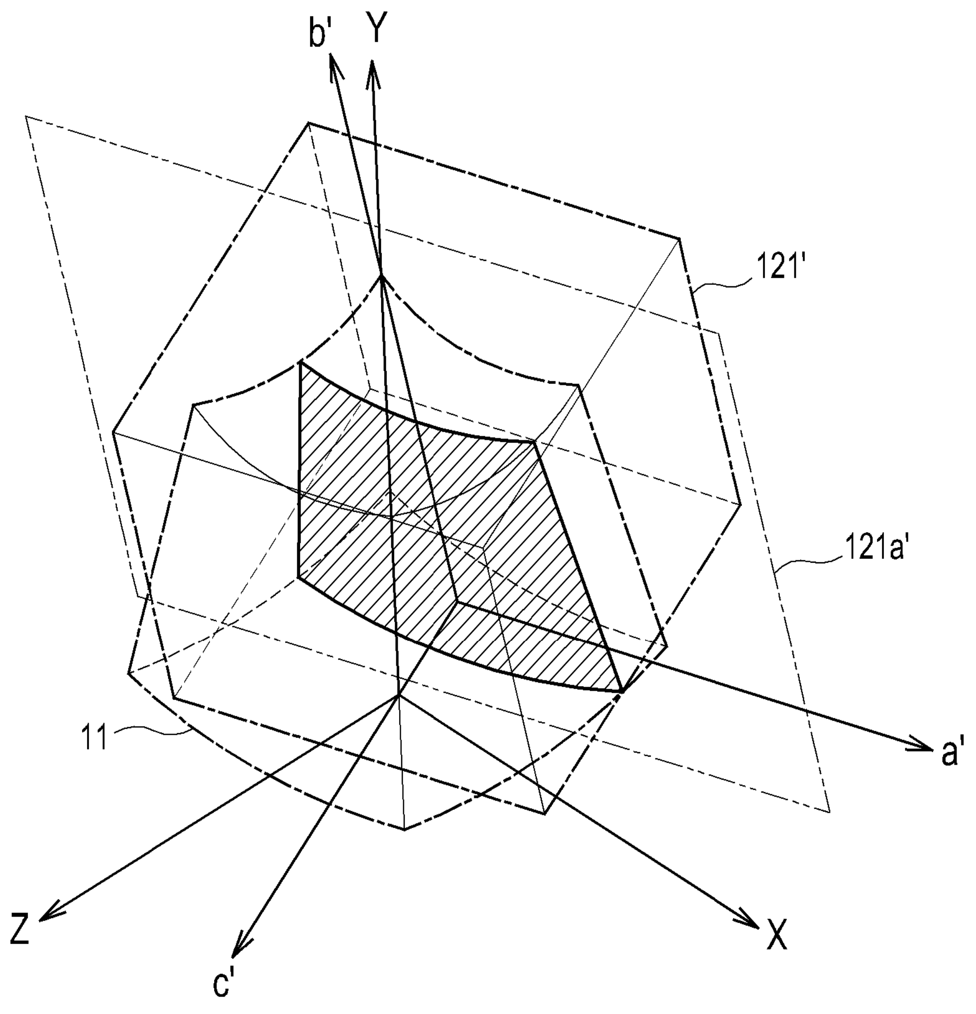
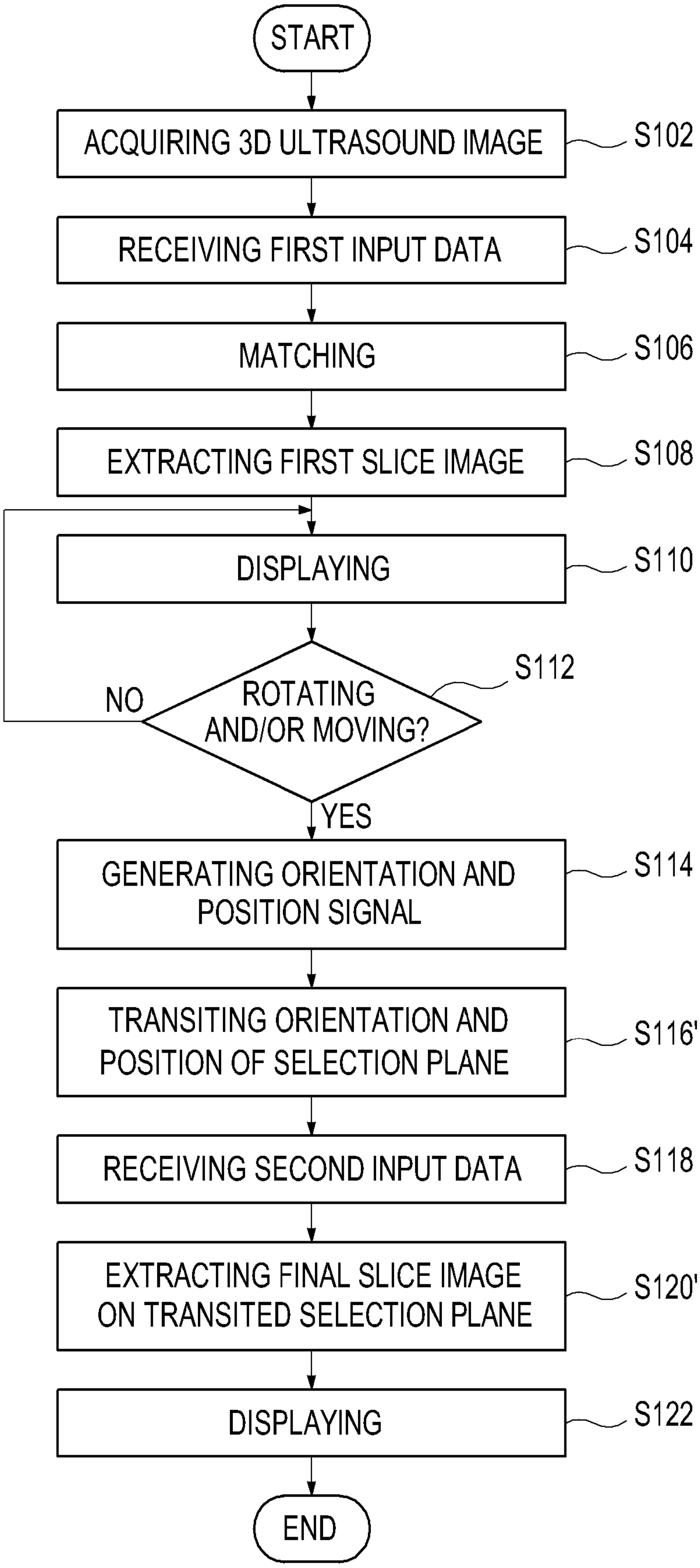


FIG. 16


START
ACQUIRING 3D ULTRASOUND IMAGE
S102
RECEIVING FIRST INPUT DATA
S104
MATCHING
S106
EXTRACTING FIRST SLICE IMAGE
S108
DISPLAYING
S110
ROTATING AND/OR MOVING?
S112
NO
YES
GENERATING ORIENTATION AND POSITION SIGNAL
S114
TRANSITING ORIENTATION AND POSITION OF SELECTION PLANE
S116'
RECEIVING SECOND INPUT DATA
S118
EXTRACTING FINAL SLICE IMAGE ON TRANSITED SELECTION PLANE
S120'
DISPLAYING
S122
END

ULTRASOUND SYSTEM AND METHOD OF SELECTING SLICE IMAGE FROM THREE-DIMENSIONAL ULTRASOUND IMAGE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Korean Patent Application No. 10-2009-0124913 filed on Dec. 15, 2009 and Korean Patent Application No. 10-2010-0121158 filed on Dec. 1, 2010, the entire disclosures of which are incorporated herein by reference.

BACKGROUND

[0002] The present disclosure generally relates to ultrasound systems, and more particularly to an ultrasound system having an apparatus for selecting a slice image of a three-dimensional ultrasound image through a control volume unit and a method of selecting a two-dimensional slice image of the three-dimensional ultrasound image.

[0003] Three-dimensional ultrasound probes may acquire three-dimensional volume images (hereinafter referred to as 3D ultrasound images) by steering and triggering transducer elements to emit ultrasound signals and receiving echo ultrasound signals reflected from a target object. Such 3D ultrasound image may be changed in its representation according to a steering way of the transducer elements in the 3D ultrasound probe. Referring to FIG. **1**, there is shown an exemplary 3D ultrasound image **10** acquired through steered transducer elements of a conventional ultrasound probe. As shown in FIG. **1**, the 3D ultrasound image **10** obtained by the conventional ultrasound probe may correspond to transmitting/receiving regions of the ultrasound signal. Thus, an upper portion of the 3D ultrasound image **10** may be represented in a shape similar to a curved shape of a rectangular tracing a steered path of the transducer elements so that the 3D ultrasound image **10** may be a trapezoid (e.g., frustum) having a lower portion wider than the upper portion.

[0004] A cross-section of the 3D ultrasound image **10** may be obtained in the form of a two-dimensional (2D) ultrasound image (i.e., 2D slice image) at a region of interest (ROI) of a target object (not shown), which may be selected by an operator. FIG. **1** shows a Z-axis reference plane **11**, an X-axis reference plane **12** and a Y-axis reference plane **13**. Referring to FIG. **2**, there are shown 2D slice images obtained on the respective reference planes **11**, **12** and **13** and a 3D ultrasound image. To display a 2D slice image at an ROI of the 3D ultrasound image, the reference planes **11**, **12** and **13** should be moved to coordinates corresponding to the ROI. For example, the operator may select the reference planes **11**, **12** and **13** to move and rotate the selected planes to obtain a 2D slice image at the ROI of the 3D ultrasound image. The operator may perform a diagnosis for the target object through the obtained 2D slice image.

[0005] Referring to FIG. **3**, there is shown a schematic diagram of a control panel to select a 2D slice image at an ROI of the 3D ultrasound image. As shown in FIG. **3**, the control panel may include a ref/slice button **1**, an X-rotation button **2**, a Y-rotation button **3** and a Z-rotation button **4**. The ref/slice button **1** may be configured to select one of the reference planes **11**, **12** and **13** and move the selected one in its corresponding axis direction. The X-rotation button **2** may be configured to rotate the selected reference plane centering on an X-axis. The Y-rotation button **3** may be configured to rotate the selected reference plane centering on a Y-axis. The Z-rotation button **4** may be configured to rotate the selected reference plane centering on a Z-axis.

[0006] For example, selecting a 2D slice image **11'** shown in FIG. **4** may be accomplished through the following procedure. First, the operator may move the reference plane **11** on the Z-axis toward an arrow A, as shown in FIG. **5**, by using the ref/slice button **1**. Then, the operator may rotate the reference plane **11** centering on the X-axis toward an arrow B, as shown in FIG. **5**, by using the X-rotation button **2**. Lastly, the operator may rotate the reference plane **11** centering on the Y-axis toward an arrow C, as shown in FIG. **5**, by using the Y-rotation button **3**. Thereafter, it becomes possible to obtain the selected 2D slice image **11'** transited from the reference plane **11** according to the aforementioned procedure. Such operations described above, however, require a plurality of key manipulations, which may be time-consuming and become complicated tasks to the operator. Moreover, it may be difficult to obtain a precise 2D slice image, i.e., a slice image, from the 3D ultrasound image through the aforementioned manual operation.

SUMMARY

[0007] Various embodiments of an ultrasound system having an apparatus for selecting a slice image of a 3D ultrasound image and a method of selecting a 2D slice image from a 3D ultrasound image are provided. In one embodiment of the present disclosure, by way of non-limiting example, the ultrasound system comprises: a 3D ultrasound image acquisition unit configured to acquire a 3D ultrasound image of a target object; a 2D slice image selection unit including a control volume unit, the 2D slice image selection unit being configured to be rotated and/or moved by an operator; and a processor coupled to the 3D ultrasound image acquisition unit and 2D slice image selection unit. At least one selection plane is formed by the control volume unit as a reference plane for selecting at least one 2D slice image from the 3D ultrasound image. The processor is configured to extract at least one 2D slice image corresponding to the at least one selection plane from the 3D ultrasound image. The 3D ultrasound image or the at least one selection plane are rotated and/or moved together with the control volume unit.

[0008] The at least one selection plane may be fixed while the control volume unit and the 3D ultrasound image are rotated and/or moved together. Further, the processor matches a coordinate system of the control volume unit to a coordinate system of the 3D ultrasound image to rotate and/or move the 3D ultrasound image and the control volume unit together relative to the at least one selection plane. Alternatively, the 3D ultrasound image may be fixed while the control volume unit and the at least one selection plane are rotated and/or moved together, and the processor matches a coordinate system of the control volume unit to a coordinate system of the at least one selection plane to rotate and/or move the at least one selection plane and the control volume unit together relative to the 3D ultrasound image.

[0009] The shape of the control volume unit corresponds to the shape of the 3D ultrasound image.

[0010] The 2D slice image selection unit may include: an orientation and position recognition unit mounted on the control volume unit; a grip coupled to the control volume unit; and an operation button formed on the grip. The orientation and position recognition unit is configured to detect the rotation and/or movement of the control volume unit to form an orientation and position signal of the control volume unit. The operation button is configured to receive input data for operations of the 2D slice image selection unit from the operator.

[0011] The orientation and position recognition unit may include a sensor that is configured to detect the rotation and/or movement of the control volume unit to form detection signals. Further, the processor may be configured to generate the orientation and position signal of the control volume unit based on the detection signals.

[0012] The processor may include: a matching unit configured to match the coordinate system of the control volume unit to the coordinate system of the 3D ultrasound image; an image processing unit configured to change the orientation and position of the 3D ultrasound image or the at least one selection plane corresponding to the changed orientation and position of the control volume unit based on the orientation and position signal; and a 2D slice image extraction unit configured to extract at least one 2D slice image corresponding to the at least one selection plane from the 3D ultrasound image.

[0013] If the operation button receives input data of a first operation, then the matching unit matches the coordinate system of the control volume unit to the coordinate system of the 3D ultrasound image. If the operation button receives input data of a second operation, then the 2D slice image extraction unit extracts the at least one 2D slice image corresponding to the at least one selection plane from the 3D ultrasound image.

[0014] Further, in one embodiment of the present disclosure, the method of selecting a 2D slice image from a 3D ultrasound image comprises the following steps: a) acquiring a 3D ultrasound image of a target object; b) matching a coordinate system of the 3D ultrasound image to a coordinate system of a control volume unit configured to be moved and/or rotated by an operator, wherein at least one selection plane is formed by the control volume unit as a reference plane for selecting at least one 2D slice image from the 3D ultrasound image; c) detecting orientation and position of the control volume unit; d) rotating and/or moving the 3D ultrasound image or the at least one selection plane together with the control volume unit; and e) extracting at least one 2D slice image corresponding to the at least one selection plane from the 3D ultrasound image.

[0015] The at least one selection plane may be fixed while the control volume unit and the 3D ultrasound image are rotated and/or moved together. Otherwise, the 3D ultrasound image is fixed while the control volume unit and the at least one selection plane are rotated and/or moved together.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. **1** is an exemplary a three-dimensional (3D) ultrasound image acquired through steered transducer elements of a conventional ultrasound probe.

[0017] FIG. **2** is 2D slice images obtained on respective reference planes and a 3D ultrasound image by using the conventional ultrasound probe.

[0018] FIG. **3** is a front view of a conventional control panel for selecting a 2D slice image from the 3D ultrasound image.

[0019] FIG. **4** is a diagram for illustrating a selection process of a 2D slice image from the 3D ultrasound image.

[0020] FIG. **5** is a diagram for illustrating a transition process of coordinates during the selection process shown in FIG. **4**.

[0021] FIG. **6** is a schematic block diagram of an ultrasound system in accordance with an embodiment of the present disclosure.

[0022] FIG. **7** is a schematic block diagram of a 3D ultrasound image acquisition unit in the ultrasound system in accordance with an embodiment of the present disclosure.

[0023] FIG. **8** is a schematic diagram showing a scan direction of 2D slice images of the 3D ultrasound image in accordance with an embodiment of the present disclosure.

[0024] FIG. **9** is an illustrative embodiment showing volume data in accordance with the present disclosure.

[0025] FIG. **10** is a side view of a 2D slice image selection unit in accordance with an embodiment of the present disclosure.

[0026] FIG. **11** is an illustrative embodiment of the orientation and position transition of a control volume unit in the 2D slice image selection unit in accordance with the present disclosure.

[0027] FIG. **12** is an illustrative embodiment of the transited coordinates system of the control volume unit in accordance with the present disclosure.

[0028] FIG. **13** is a schematic block diagram of a processor in accordance with an embodiment of the present disclosure.

[0029] FIG. **14** is a flow chart showing a process of selecting a 2D slice image from the 3D ultrasound image using the 2D slice image selection unit in accordance with one embodiment of the present disclosure.

[0030] FIG. **15** is a diagram for illustrating a selection process of a 2D slice image from the 3D ultrasound image in accordance with another embodiment of the present disclosure.

[0031] FIG. **16** is a flow chart showing a process of selecting a 2D slice image from the 3D ultrasound image using the 2D slice image selection unit in accordance with another embodiment of the present disclosure.

DETAILED DESCRIPTION

[0032] A detailed description may be provided with reference to the accompanying drawings. One of ordinary skill in the art may realize that the following description is illustrative only and is not in any way limiting. Other illustrative embodiments may readily suggest themselves to such skilled persons having the benefit of this disclosure.

[0033] Referring to FIG. **6**, there is shown a schematic block diagram of an ultrasound system **100** in accordance with an embodiment of the present disclosure. As shown in FIG. **6**, the ultrasound system **100** may comprise a three-dimensional (3D) ultrasound image acquisition unit **110**, a 2D slice image selection unit **120**, a processor **130** and a display unit **140**.

[0034] The 3D ultrasound image acquisition unit **110** may be configured to transmit ultrasound signals to a target object and receive reflected ultrasound signals, i.e., ultrasound echo signals, from the target object to acquire ultrasound data thereof. The organization of the 3D ultrasound image acquisition unit **110** will be described later with reference to FIG. **7**.

[0035] Referring to FIG. **7**, there is shown a schematic block diagram of the 3D ultrasound image acquisition unit **110** in accordance with an embodiment of the present disclosure. As shown in FIG. **7**, the 3D ultrasound image acquisition unit **110** may comprise a transmit signal formation unit **111**, an ultrasound probe **112** having a plurality of transducer elements (not shown), a beam former **113**, an ultrasound data formation unit **114**, a volume data formation unit **115** and an image formation unit **116**.

[0036] The transmit signal formation unit **111** may be configured to form transmit signals in consideration of positions and focusing points of the transducer elements. The transmit signal formation unit **111** may be configured to form the transmit signals sequentially and repeatedly. Thus, the transmit signal formation unit **111** may be configured to form the transmit signals for obtaining image frames F_i ($1 \leqq i \leqq N$, N being an integer) as shown in FIG. **8**. In FIG. **8**, the image frames F_i ($1 \leqq i \leqq N$) are represented in the form of a fan-shaped image frame, although they are not limited thereto.

[0037] In response to the transmit signals from the transmit signal formation unit **111**, the ultrasound probe **112** may be configured to convert the transmit signals into corresponding ultrasound signals and transmit them to the target object. The ultrasound probe **112** may be further configured to receive ultrasound echo signals reflected from the target object to form receive signals. The receive signals may be analog signals. The ultrasound probe **112** may be configured to transmit the ultrasound signals and receive the ultrasound echo signals to form the receive signals in response to the transmit signals from the transmit signal formation unit **111**. In an exemplary embodiment, the ultrasound probe **112** may include at least one of a 3D mechanical probe, a 2D array probe and the like.

[0038] In response to the receive signals from the ultrasound probe **112**, the beam former **113** may be configured to convert the receive signals from analog to digital to form digital signals corresponding thereto. The beam former **113** may be further configured to receive-focus the digital signals in consideration of the positions and focusing points of the transducer elements in the ultrasound probe **112** to form a receive-focus beam.

[0039] The ultrasound data formation unit **114** may be configured to form ultrasound data based on the receive-focus beam from the beam former **113**. For example, the ultrasound data formation unit **114** may be configured to form the ultrasound data corresponding to the respective frames F_i ($1 \leqq i \leqq N$) shown in FIG. **8** based on the receive-focus beam provided from the beam former **113**.

[0040] The volume data formation unit **115** may be configured to form volume data **210** shown in FIG. **9** based on the ultrasound data from the ultrasound data formation unit **114**. The volume data may comprise the frames F_i ($1 \leqq i \leqq N$) and include a plurality of voxels with brightness values. In an exemplary embodiment, as shown in FIG. **9**, reference numbers **221** to **223** indicate cross-sections, which are crossed at right angles. Also, as shown in FIG. **9**, an axial direction indicates a propagation direction of the ultrasound signals starting from the transducer elements of the ultrasound probe **112**, a lateral direction represents a scan line direction of the ultrasound signals, and an elevation direction depicts a depth direction of a 3D ultrasound image.

[0041] The image formation unit **116** may be configured to render the volume data from the volume data formation unit **115** to form a 3D ultrasound image. In an exemplary embodiment, rendering of the image formation unit **116** may include ray-casting rendering, surface rendering and the like.

[0042] Referring back to FIG. **6**, the 2D slice image selection unit **120** may be configured to select cross-sections, i.e., 2D slice images, of the 3D ultrasound image from the 3D ultrasound image acquisition unit **110** by the processor **130**. A detailed description of the 2D slice image selection unit **120** will be made with reference to FIG. **10**.

[0043] Referring to FIG. **10**, there is shown a side view of the 2D slice image selection unit **120**. As shown in FIG. **10**, the 2D slice image selection unit **120** may include a control volume unit **121**, an orientation and position recognition unit **122**, a grip **123** and an operation button **124**, which is configured to receive input data from the operator for the operations of the 2D slice image selection unit.

[0044] The operation button **124** may be provided on the grip **123** to receive input data from the operator. For example, the input data may include first and second input data, the first input data containing data for matching the coordinates of the control volume unit to that of the 3D ultrasound image and the second input data containing data for selecting a final 2D slice image.

[0045] As shown in FIG. **11**, the control volume unit **121** may be positioned on the Cartesian coordinate system with an a-axis, a b-axis and a c-axis, which are crossed at right angles. In FIG. **11**, a reference numeral **121***a* represents a selection plane to select a 2D slice image from the 3D ultrasound image, wherein at least one selection plane may be formed by the control volume unit as a reference plane to select at least one 2D slice image from the 3D ultrasound image.

[0046] In case that the operator rotates the control volume unit **121** centering on the b-axis (represented in FIG. **11** as an arrow I) and centering on the a-axis (represented in FIG. **11** as an arrow II), and/or moves it toward a direction of the c-axis (represented in FIG. **11** as an arrow III), the orientation and position of the control volume unit **121** may be transited to that of a control volume unit **121'** as shown in FIG. **12**. Since the orientation and position of the selection plane **121***a* may be fixed on the Cartesian coordinate system, the relative coordinate system of the selection plane **121***a* to the 3D ultrasound image **121** may be changed according to the operator's operation.

[0047] In an exemplary embodiment, the control volume unit **121** may have the shape of, for example, a rectangular solid. In another embodiment, the control volume unit **121** may have a fan shape similar to a shape of the 3D ultrasound image, which may have curved top and bottom portions. With the fan shape, the operator may intuitively match the 3D ultrasound image to the control volume unit **121**.

[0048] The orientation and position recognition unit **122** may be mounted within the control volume unit **121** to recognize the orientation and position thereof. In an exemplary embodiment, the processor **130** may be connected to the 3D ultrasound image acquisition unit **110** and the 2D slice image selection unit **120**, and the orientation and position recognition unit **122** may include a sensor (not shown) configured to detect the rotation and/or movement of the control volume unit **121** to form detection signals corresponding to the rotation and/or movement thereof. The processor **130** may form orientation and position signals for determining the orientation and/or position of the control volume unit **121** based on the detection signals from the sensor. The sensor may comprise a device that detects the rotation and/or movement of the control volume unit **121**. For example, the sensor may include an inertial sensor, a gyro sensor, an acceleration sensor and the like. Further, the processor **130** may include a micro controller unit (MCU) to form the orientation and position signals for determining the orientation and/or position of the control volume unit **121** based on the detection signals from the sensor.

[0049] The grip **123** may have a shape of a stick that is projected from one surface of the control volume unit **121**. Such a shape may allow the operator to seize the grip **123** and change the orientation and/or position of the control volume unit **121** of 2D slice image selection unit **120**.

[0050] Referring back to FIG. **6**, in an exemplary embodiment, the processor **130** may be connected to the 2D slice image selection unit **120** through wireless communication channels. The processor **130** may be configured to match the coordinate system of the 3D ultrasound image from the 3D ultrasound image acquisition unit **110** to that of the control volume unit **121**. The processor **130** may be configured to extract a slice corresponding to the selection plane **121***a* from the 3D ultrasound image. A detailed description of the processor **130** will be made with reference to FIG. **13**.

[0051] Referring to FIG. **13**, there is shown a schematic block diagram of the processor **130** in accordance with an embodiment of the present disclosure. As shown in FIG. **13**, the processor **130** may include a matching unit **131**, an image processing unit **132** and a 2D slice image extraction unit **133**. The matching unit **131** may be configured to match the coordinate system of the control volume unit **121** to that of the 3D ultrasound image in response to first input data from the 2D slice image selection unit **120**.

[0052] In response to an orientation and position signal from the 2D slice image selection unit **120**, the image processing unit **132** may be configured to transit the orientation and position of the 3D ultrasound image (i.e., moving and rotating of the 3D ultrasound image) to correspond them to the orientation and position of the control volume unit **121**, which are changed according to the orientation and position signal. For example, as shown in FIG. **12**, the image processing unit **132** may match the a'-, b'- and c'-axes of the control volume unit **121'** to the X-, Y- and Z-axes of the 3D ultrasound image **10** of FIG. **4**, in response to the orientation and position signal. This is so that the orientation and position of the 3D ultrasound image may be transited. As such, the coordinate system of the selection plane **121***a* may correspond to the coordinate system of the slice of the 2D slice image **11'** to be displayed, as shown in FIG. **4**. Thus, the operator may select any one 2D slice image from the 3D ultrasound image by rotating and moving the control volume unit **121**.

[0053] The operation button **124** may be provided on the grip **123** to activate operations. In an exemplary embodiment, the operations may include a first operation defined as the first input data and a second operation defined as the second input data. For example, when the operation button **124** is activated in response to the first operation (i.e., the first input data is provided), the matching unit **131** may match the coordinate system of the control volume unit **121** to that of the 3D ultrasound image **10**. When the operation button **124** is activated in response to the second operation (i.e., the second input data is provided), the 2D slice image extraction unit **133** may extract a 2D slice image on a slice corresponding to the fixed selection plane **121***a* from the 3D ultrasound image **10**.

[0054] Referring back to FIG. **6**, the display unit **140** may be configured to display the 3D ultrasound image from the 3D ultrasound image acquisition unit **110**. Further, the display unit **140** may be configured to display the selected 2D slice image from the 3D ultrasound image.

[0055] Referring to FIG. **14**, there is shown a flow chart illustrating a process of selecting the 2D slice image from the 3D ultrasound image using the 2D slice image selection unit in accordance with an embodiment of the present disclosure. As shown in FIG. **14**, the 3D ultrasound image acquisition unit **110** may transmit ultrasound signals to a target object and receive ultrasound echo signals reflected therefrom to acquire a 3D ultrasound image of the target object (S**102**).

[0056] When a first operation of the operation button **124** is activated (i.e., the first input data is provided from the operator) (S**104**), the matching unit **131** of the processor **130** may match the coordinate system of the control volume unit **121** to that of the 3D ultrasound image (S**106**). The 2D slice image extraction unit **133** may extract a first 2D slice image corresponding to the selection plane **121***a* from the 3D ultrasound image of which the coordinate system is matched to that of the control volume unit **121** (S**108**). The display unit **140** may display the matched 3D ultrasound image and the first 2D slice image (S**110**).

[0057] The processor **130** may decide whether or not the operator rotates and/or moves the control volume unit **121** due to the detection signals from the orientation and position recognition unit **122** (S**112**). If it is determined that the control volume unit **121** is moved and/or rotated, then the processor **130** may form an orientation and position signal, which represents the amount of rotation and/or movement of the control volume unit **121** (S**114**). Otherwise, if it is determined that the control volume unit **121** is not moved and/or rotated, then the processor **130** may not form the orientation and position signal.

[0058] In response to the orientation and position signal, the image processing unit **132** may transit the orientation and position of the 3D ultrasound image to the changed orientation and position of the control volume unit **121** (S**116**).

[0059] When a second operation of the operation button **124** is activated (i.e., the second input data is provided from the operator) (S**118**), the 2D slice image extraction unit **133** may extract a final 2D slice image corresponding to the selection plane **121***a* from the transited 3D ultrasound image (S**120**). Thereafter, the display unit **140** may display the final 2D slice image from the transited 3D ultrasound image (S**122**).

[0060] Although the matching the control volume unit **121** to the 3D ultrasound image **10** is described in the exemplary embodiment, it may be possible that the coordinate system of the 3D ultrasound image **10** shown in FIG. **4** is fixed and the changed coordinate system of the control volume unit **121**, i.e., a'-, b'- and c'-axes, can be matched to the coordinate system of the selected plane corresponding to the slice of the 2D slice image **11'** to be displayed, i.e., X'-, Y'- and Z'-axes.

[0061] FIG. **15** is a schematic view showing a slice selecting process to acquire a 2D slice image at an arbitrary slice according to another embodiment of the present disclosure. In the previous embodiment, the orientation and position of the control volume unit **121** and those of the 3D ultrasound image **10** are changed relative to the selection plane **121***a*. However, in this embodiment, the coordinate system of the 3D ultrasound image **10** with X-axis, Y-axis and Z-axis is fixed, while the control volume unit **121'** and selection plane **121***a'* can be moved or rotated relative to the 3D ultrasound image with coordinates a'-axis, b'-axis and c'-axis, which represents the changed orientation and position of the control volume unit **121**, as shown in FIG. **15**. In this embodiment, the elements such as the matching unit can be removed since the selection plane moves and rotates with the control volume unit together. Further, the 3D ultrasound image is fixed and a 2D slice image on a slice corresponding to the selection plane **121***a'* can be extracted therefrom.

[0062] In this embodiment, in response to the orientation and position signal, the processor **130** may transit the orientation and position of the selection plane **121***a*' as shown in FIG. **15**. Thus, the process to selecting a 2D slice image from the 3D ultrasound image may be slightly changed. As shown in FIG. **16**, in response to the orientation and position signal, the image processing unit **132** may transit the orientation and position of the selection plane **121***a* to the changed orientation and position of the control volume unit **121** (S**116**'). Further, when a second operation of the operation button **124** is activated (i.e., the second input data is provided from the operator) (S**118**), the 2D slice image extraction unit **133** may extract a final 2D slice image on a slice corresponding to the transited selection plane **120***a*' from the 3D ultrasound image (S**120**').

[0063] According to the embodiments described above, there is a selection plane to select a 2D slice image. However, there may be a plurality of selection planes to select a plurality 2D slice images at one time.

[0064] According to the present disclosure, the operator can change the orientation and position of the 3D ultrasound image by changing the orientation or position of the control volume unit. Thus, the operator can easily select a slice to be displayed by using the control volume unit without performing any complex button operation.

[0065] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that various other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, numerous variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

What is claimed is:

1. An ultrasound system, comprising:

a 3D ultrasound image acquisition unit configured to acquire a 3D ultrasound image of a target object;

a 2D slice image selection unit including a control volume unit, the 2D slice image selection unit being configured to be rotated and/or moved by an operator, wherein at least one selection plane is formed by the control volume unit as a reference plane for selecting at least one 2D slice image from the 3D ultrasound image; and

a processor coupled to the 3D ultrasound image acquisition unit and the 2D slice image selection unit, the processor being configured to extract at least one 2D slice image corresponding to the at least one selection plane from the 3D ultrasound image;

wherein the 3D ultrasound image or the at least one selection plane is rotated and/or moved together with the control volume unit.

2. The ultrasound system of claim **1**, wherein the at least one selection plane is fixed while the control volume unit and the 3D ultrasound image are rotated and/or moved together, and wherein the processor matches a coordinate system of the control volume unit to a coordinate system of the 3D ultrasound image to rotate and/or move the 3D ultrasound image and the control volume unit together relative to the at least one selection plane.

3. The ultrasound system of claim **2**, wherein a shape of the control volume unit corresponds to a shape of the 3D ultrasound image.

4. The ultrasound system of claim **2**, wherein the 2D slice image selection unit includes:

an orientation and position recognition unit mounted on the control volume unit, the orientation and position recognition unit being configured to detect the rotation and/or movement of the control volume unit to form an orientation and position signal of the control volume unit;

a grip coupled to the control volume unit; and

an operation button formed on the grip, the operation button being configured to receive input data for operations of the 2D slice image selection unit from the operator.

5. The ultrasound system of claim **4**, wherein the orientation and position recognition unit includes a sensor configured to detect the rotation and/or movement of the control volume unit to form detection signals, and

wherein the processor is further configured to generate the orientation and position signal of the control volume unit based on the detection signals.

6. The ultrasound system of claim **5**, wherein the processor includes:

a matching unit configured to match the coordinate system of the control volume unit to the coordinate system of the 3D ultrasound image;

an image processing unit configured to change the orientation and position of the 3D ultrasound image corresponding to the changed orientation and position of the control volume unit based on the orientation and position signal; and

a 2D slice image extraction unit configured to extract the at least one 2D slice image corresponding to the at least one selection plane from the 3D ultrasound image.

7. The ultrasound system of claim **6**, wherein if the operation button receives input data of a first operation, then the matching unit matches the coordinate system of the control volume unit to the coordinate system of the 3D ultrasound image, and

if the operation button receives input data of a second operation, then the 2D slice image extraction unit extracts the at least one 2D slice image corresponding to the at least one selection plane from the 3D ultrasound image.

8. The ultrasound system of claim **1**, wherein the 3D ultrasound image is fixed while the control volume unit and the at least one selection plane are rotated and/or moved together, and wherein the processor matches a coordinate system of the control volume unit to a coordinate system of the at least one selection plane to rotate and/or move the at least one selection plane and the control volume unit together relative to the 3D ultrasound image.

9. The ultrasound system of claim **8**, wherein the 2D slice image selection unit includes:

an orientation and position recognition unit mounted on the control volume unit, the orientation and position recognition unit being configured to detect the rotation and/or movement of the control volume unit to form an orientation and position signal of the control volume unit;

a grip coupled to the control volume unit; and

an operation button formed on the grip, the operation button being configured to receive input data for operations of the 2D slice image selection unit from the operator.

10. The ultrasound system of claim **9**, wherein the orientation and position recognition unit includes a sensor configured to detect the rotation and/or movement of the control volume unit to form detection signals, and

wherein the processor is further configured to generate the orientation and position signal of the control volume unit based on the detection signals.

11. The ultrasound system of claim **10**, wherein the processor includes:

a matching unit configured to match the coordinate system of the control volume unit to the coordinate system of the at least one selection plane;

an image processing unit configured to change the orientation and position of the at least one selection plane corresponding to the changed orientation and position of the control volume unit based on the orientation and position signal; and

a 2D slice image extraction unit configured to extract the at least one 2D slice image corresponding to the at least one selection plane from the 3D ultrasound image.

12. The ultrasound system of claim **11**, wherein if the operation button receives input data of a first operation, then the matching unit matches the coordinate system of the control volume unit to the coordinate system of the at least one selection plane, and

if the operation button receives input data of a second operation, then the 2D slice image extraction unit extracts the at least one 2D slice image corresponding to the at least one selection plane from the 3D ultrasound image.

13. A method of selecting at least one 2D slice image from a 3D ultrasound image, comprising:

a) acquiring a 3D ultrasound image of a target object;

b) matching a coordinate system of the 3D ultrasound image to a coordinate system of a control volume unit configured to be moved and/or rotated by an operator, wherein at least one selection plane is formed by the control volume unit as a reference plane for selecting at least one 2D slice image from the 3D ultrasound image;

c) detecting an orientation and position of the control volume unit;

d) rotating and/or moving the 3D ultrasound image or the at least one selection plane together with the control volume unit; and

e) extracting at least one 2D slice image corresponding to the at least one selection plane from the 3D ultrasound image.

14. The method of claim **13**, wherein the at least one selection plane is fixed while the control volume unit and the 3D ultrasound image are rotated and/or moved together.

15. The method of claim **13**, wherein the 3D ultrasound image is fixed while the control volume unit and the at least one selection plane are rotated and/or moved together.

* * * * *

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摘要(译)

提供了超声系统的各种实施例和从3D超声图像中选择2D切片图像的方法。超声系统的一个实施例包括：3D超声图像获取单元，被配置为获取目标对象的3D超声图像; 2D切片图像选择单元，包括控制体积单元，2D切片图像选择单元，被配置为由操作者旋转和/或移动;处理器耦合到3D超声图像获取单元和2D切片图像选择单元。控制体积单元形成至少一个选择平面作为参考平面，以从3D超声图像中选择至少一个2D切片图像。处理器被配置为从3D超声图像提取与至少一个选择平面相对应的至少一个2D切片图像。 3D超声图像或至少一个选择平面与控制体积单元一起旋转和/或移动。