(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 296 011 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
25.06.2014 Bulletin 2014/26

(51) Int Cl.:
G01S 15/89 *(2006.01)* ***G01S 7/52*** *(2006.01)*
A61B 8/08 *(2006.01)*

(21) Application number: **10173735.1**

(22) Date of filing: **23.08.2010**

(54) Ultrasound system and method for providing multiple plane images for a plurality of views

Ultraschallsystem und Verfahren zur Bereitstellung von Bildern mit mehreren Ebenen für verschiedene Ansichten

Système d'ultrasons et procédé de fourniture d'images de plans multiples pour une pluralité d'affichages

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR

(30) Priority: **03.09.2009 KR 20090083074**

(43) Date of publication of application:
16.03.2011 Bulletin 2011/11

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EP 2 296 011 B1

Description

TECHNICAL FIELD

[0001] The present disclosure generally relates to ultrasound systems, and more particularly to an ultrasound system and a method of providing multiple plane images for a plurality of views.

BACKGROUND

[0002] An ultrasound system has become an important and popular diagnostic tool since it has a wide range of applications. Specifically, due to its non-invasive and non-destructive nature, the ultrasound diagnostic system has been extensively used in the medical profession. Modem high-performance ultrasound diagnostic systems and techniques are commonly used to produce ultrasound images of internal features of an object (e.g., human organs).

[0003] Recently, the ultrasound system may provide a 3-dimensional ultrasound image showing clinical information such as spatial information, anatomical features and the like, which may not be provided through a 2-dimensional ultrasound image. To provide the 3-dimsional ultrasound image, the ultrasound system may transmit/receive ultrasound signals to/from a target object to form volume data. It may then perform rendering upon the volume data to thereby form the 3-dimensional ultrasound image of the target object.

[0004] Also, the ultrasound system may provide multiple plane images corresponding to a plurality of views for diagnosis of the target object (e.g., fetal brain). For example, the ultrasound system may provide plane images corresponding to a transthalamic plane, a transventicular plane and a transcerebellar plane associated with an axial view, plane images corresponding to a transthalamic plane, a transcerebellar plane, a transcaudate plane and a transfrontal plane associated with a coronal view, and plane images corresponding to a midsagittal plane, a left parasagittal plane and a right parasagittal plane associated with a sagittal view.

[0005] Conventionally, the multiple planes for the respective axial view, coronal view and sagittal view may be manually defined in the volume data. Thus, since it may be difficult to accurately define the corresponding planes in the volume data, desirable plane images may not be provided and a relatively long time to obtain the multiple plane image may be consumed.

[0006] The US 2005/251036 A1 discloses a system, method and medium for standardizing a manner of acquisition and display of ultrasound images. In one embodiment, a volumetric image of an organ is acquired in a standardized manner. Relationships such as formulas are utilized to automatically generate anatomical planes of interest within the volume that can be displayed independent of the user.

[0007] The US 2007/0249935 A1 discloses a diagnostic ultrasound system provided for automatically displaying multiple planes from a volume of interest. The system comprises a transducer for acquiring ultrasound data associated with a volume of interest having a target object therein. The system further comprises a user interface for designating a reference plane within the volume on interest. A processor module receives patient specific information representative of at least one of a shape and size of the target object and maps the reference plane and the ultrasound data into a 3D reference coordinate system. The processor module automatically calculates at least one plane of interest within the 3D reference coordinate system based on the reference plane and the patient specific information.

[0008] In the US 2006/034513 A1 standardized or preset views for a given application are used to assist in volumetric scanning and diagnosis. By displaying one or more images of a standard view during acquisition, the scan is guided to assure proper positioning of the volumetric scan. The location of a user identified view within the volume is used to determine the location of an additional view. The spatial interrelationship of the views within the standard or preset set of views allows generation of images for each of the views after the user identification of one of the views within the volume. Identification of landmarks associated with a view may be used for more efficient or accurate feature recognition, more likely providing images for the standard views.

SUMMARY

[0009] Embodiments of providing multiple plane images for a plurality of view in an ultrasound system are disclosed herein. An ultrasound system according to the invention as specified in claim 1 includes: an ultrasound data acquisition unit configured to transmit/receive ultrasound signals to/from a target object including a brain to form ultrasound data; and a processor configured to form volume data indicative of the target object by using the ultrasound data wherein the processor includes: a first plane setting section operable to set a reference plane containing a falx and a cerebrum in the volume data; a contour detecting section operable to detect a falx contour and a contour of the cerebrum in the reference plane and an entire contour of the brain in the volume data; a preprocessing section operable to normalize the volume data by using normalization reference data corresponding to the falx contour, the cerebrum contour and the entire contour of the fetal brain; and a second plane setting section operable to set multiple planes with respect to the reference plane in the normalized volume data, wherein the processor is further operable to form plane images corresponding to the respective multiple planes by using the normalized volume data.

[0010] A method of providing multiple plane images for a target object including a brain in an ultrasound system is specified in claim 8 and comprises: a) forming volume data indicative of a target object including a brain; b) setting a reference plane containing a falx and a cerebrum in the volume data; c) detecting a falx contour and a contour of a cerebrum in the reference plane and an entire contour of the brain in the volume data; d) normalizing the volume data by using normalization reference data corresponding to the falx contour, the cerebrum contour and the entire contour of the fetal brain; e) setting multiple planes with respect to the reference plane in the normalized volume data; and f) forming plane images corresponding to the respective multiple planes by using the normalized volume data.

[0011] The Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIG. 1 is a block diagram showing an illustrative embodiment of an ultrasound system.

FIG. 2 is a block diagram showing an illustrative embodiment of an ultrasound data acquisition unit.

FIG. 3 is a schematic diagram showing an example of obtaining frames.

FIG. 4 is a block diagram showing an illustrative embodiment of a processor.

FIG. 5 is a schematic diagram showing an example of volume data.

FIG. 6 is a diagram showing an illustrative embodiment of a graphic guide.

FIG. 7 is a schematic diagram showing an illustrative embodiment of setting a first transthalamic plane, a transventricular plane and a first trancerebellar plane as axial views.

FIG. 8 is a schematic diagram showing an illustrative embodiment of setting a second transthalamic plane, a second transcerebellar plane, a transcaudate plane and a transfrontal plane as coronal views.

FIG. 9 is a schematic diagram showing an illustrative embodiment of setting a midsagittal plane, a left parasagittal plane and a right parasagittal plane as sagittal views.

DETAILED DESCRIPTION

[0013] A detailed description is 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 embodiments of the present invention may readily suggest themselves to such skilled persons having the benefit of this disclosure.

[0014] FIG. 1 is a block diagram showing an illustrative embodiment of an ultrasound system. The ultrasound system 100 includes an ultrasound data acquisition unit 110, a user input unit 120, a processor 130 and a display unit 140.

[0015] The ultrasound data acquisition unit 110 is operable to transmit ultrasound signals to a target object and receive ultrasound signals reflected from the target object (i.e., echo signals) to thereby form ultrasound data corresponding to a plurality of frames F_i, wherein $1 \geq i \geq N$. Hereinafter, one embodiment will describe a fetus as the target object. However, the target object may not be limited thereto.

[0016] FIG. 2 is a block diagram showing an illustrative embodiment of the ultrasound data acquisition unit 110. The ultrasound data acquisition unit 110 includes a transmit signal forming section 111, an ultrasound probe 112 containing a plurality of transducer elements (not shown), a beam forming section 113 and a ultrasound data forming section 114.

[0017] The transmit signal forming section 111 is operable to produce transmit signals in consideration of positions of the transducer elements and predetermined focal points for forming a plurality of frames F_i, wherein $1 \leq i \geq N$, as shown in FIG. 3. Although the frames F_i are illustrated in a fan shape in FIG. 3, the shape of the frames F_i may not be limited thereto. The frames F_i may include brightness mode image frames.

[0018] The ultrasound probe 112, which is coupled to the transmit signal forming section 111, is operable to receive the transmit signals from the transmit signal forming section 111 and convert them into ultrasound signals, which travel into the target object. The ultrasound probe 112 is further operable to receive echo signals reflected from the target objet to thereby form receive signals. The ultrasound probe 112 includes a 3-dimensional probe, a 2-dimensional array probe and the like.

[0019] The beam forming section 113, which is coupled to the ultrasound probe 112, is operable to digitize the receive signals to obtain digital receive signals. The beam forming section 113 is further operable to apply delays to the digital receive signals in consideration of positions of the transducer elements and the focal points to thereby form receive-focused beams.

[0020] The ultrasound data forming section 114, which is coupled to the beam forming section 113, is operable to form ultrasound data indicative of the target object by using the receive-focused beams. Further, the ultrasound data forming section 114 is operable to perform a variety of signal processing such as gain adjustment, filtering, etc., upon the receive-focused beams.

[0021] Referring back to FIG. 1, the user input unit 120 may receive input information. The input information includes information on setup of reference planes ("reference plane setup information"). The user input unit 120 may be embodied with a control panel, a mouse, a key board and the like.

[0022] The processor 130 is operable to form volume data by using the ultrasound data provided from the ultrasound data acquisition unit 110. Further, the processor 130 is operable to set multiple sectional planes in the volume data and form multiple plane images corresponding to the respective section planes.

[0023] FIG. 4 is a block diagram showing an illustrative embodiment of the processor 130. The processor 130 includes a volume data forming section 131, a first section plane setting section 132, a contour detecting section 133, a preprocessing section 134, a second plane setting section 135 and an image forming section 136.

[0024] The volume data forming section 131 is operable to form volume data 210 by using the ultrasound data, which are provided from the ultrasound data acquisition unit 110, as shown in FIG. 5. The volume data include a plurality of voxels each having a brightness value. In FIG. 5, numeral references 221-223 may represent a sagittal view, a coronal view and an axial view, respectively, which are perpendicular to each other. Also, in FIG. 5, an axial direction represents a propagation direction of the ultrasound signals from a scan head of the ultrasound probe 112, a lateral direction represents a scanning direction of scan lines, which is a longitudinal direction of the transducer elements, and an elevation direction represents a swing direction of the transducer elements, which is a depth direction in a 3-dimensioanl ultrasound image.

[0025] The first plane setting section 132 is operable to set a reference plane in the volume data 210. In one embodiment, the first plane setting section 132 is operable to set the reference plane in response to the reference plane setup information, which is inputted through the user input unit 130. The reference plane is a transthalamic plane associated with the axial view ("first transthalamic plane").

[0026] The contour detecting section 133 is operable to detect a falx contour in the reference plane. The falx is a dura mater for separating cerebral hemispheres. The contour detecting section 133 is further operable to detect a contour of a cerebrum in the reference plane. Further, the contour detection section 133 is operable to detect an entire contour of a fetal brain in the volume data. The contour detection is achieved by using an edge mask such as Sobel, Prewitt, Robert, Canny or the like. Also, the contour may be detected based on eigenvalue differences using an edge structure tensor.

[0027] The preprocessing section 134 is operable to normalize the volume data by using the contour, the cerebrum contour and the entire contour of the fetal brain, which are detected on the contour detecting section 133. In one embodiment, the preprocessing unit 134 is operable to apply normalization reference data to the volume data for normalization thereof. The normalization reference data include a graphic guide, as showing in FIG. 6. The graphic guide includes a first guide line 311 for matching with the falx contour, a second guide line 312 for matching with the cerebrum contour and third guide lines 313 for matching with the entire contour of the fetal brain.

[0028] More particularly, the preprocessing section 134 is operable to match the first guide line 311 in the graphic guide 310 with the falx contour in the reference plane. While the first guide line 311 is matched with the falx contour, the preprocessing section 134 is operable to compare the second guide line 312 with the cerebrum contour and adjust a size of the volume data to match the cerebrum contour with the second guide line 312. For example, the preprocessing section 134 is operable to compare the second guide line 312 with the cerebrum contour. If it is determined that the cerebrum contour exceeds the second guide line 312 in at least one of axial, lateral and elevation directions, then the preprocessing section 134 adjusts the size of the volume data in the corresponding direction (i.e., reduction). On the other hand, if it is determined that the cerebrum contour is smaller than the second guide line 312 in at least one of axial, lateral and elevation directions, then the preprocessing section 134 adjusts the size of the volume data in the corresponding direction (i.e., enlargement).

[0029] The preprocessing section 134 is further operable to compare the third guide lines 313 with the entire contour of the fetal brain and adjust the size of the volume data for matching with the third guide lines 313 while the second guide line 312 is matched with the cerebrum contour. For example, if it is determined that the entire contour of the fetal brain exceeds the third guide lines 313 in an axial direction, then the preprocessing section 134 adjusts the size of the volume data in the axial direction (i.e., reduction). On the other hand, if it is determined that the entire contour of the fetal brain is smaller than the third guide lines 313 in an axial direction, then the preprocessing section 134 adjusts the size of the volume data in the axial direction (i.e., enlargement).

[0030] The second plane setting section 135 is operable to set a first transthalamic plane, a transventricular plane and a first transcerebellar plane with respect to the reference plane in the normalized volume data 230 as axial views. In one embodiment, the second plane setting section 135 sets the first transthalamic plane at an identical location to the reference plane, as shown in FIG. 7. The second plane setting section 135 moves the reference plane in the normalized volume data 230 in parallel to a first predetermined location to set the transventricular plane 412. That is, the transventricular plane 412 is set at the first predetermined location, which is spaced away from the first transthalamic plane 411 in parallel at a predetermined distance. The second plane setting section 135 is operable to rotate the reference plane at a first predetermined angle with respect to the transthalamic plane 411 to thereby set the first transcerebellar plane 413. That is, the first transcerebellar plane 413 is set at the location, which is rotated at the first predetermined angle with respect to the first transthalamic plane 411.

[0031] The second plane setting section 135 is operable to set a second transthalamic plane, a second transcerebellar plane, a transcaudate plane and a transfrontal plane with respect to the first transthalamic plane 411 in the normalized volume data 230 as coronal views. In one embodiment, the second plane setting section 135 is operable to rotate the reference plane perpendicularly in an axial direction with respect to the first transthalamic plane 411 in the normalized volume data 230 and rotate the reference plane, which is perpendicularly rotated, at a second predetermined angle to thereby set the second transthalamic plane 421. That is, the second transthalamic plane 421 is set at a location, which is rotated at a predetermined angle (90° - second predetermined angle) with respect to the first transthalamic plane 411.

[0032] The second plane setting section 135 is operable to move the reference plane in parallel to a second predetermined location, which is spaced away from the second transthalamic plane 421 in the normalized volume data 230 by a predetermined distance to thereby set the second transcerebellar plane 422. That is, the second transcerebellar plane 422 is set at the second location, which is spaced away from the second transthalamic plane 421 in parallel.

[0033] The second plane setting section 135 is operable to move the reference plane in parallel to a third predetermined location, which is spaced away from the second transthalamic plane 421 in the normalized volume data 230 by a predetermined distance to thereby set the transcaudate plane 423. That is, the transcaudate plane 423 is set at the third predetermined location, which is spaced away from the second transthalamic plane 421 in parallel.

[0034] The second plane setting section 135 is operable to move the reference plane in parallel to a fourth predetermined location, which is spaced away from the second transcaudate plane 423 in the normalized volume data 230 by a predetermined distance to thereby set the transfrontal plane 424. That is, the transfrontal plane 424 is set at the fourth predetermined location, which is spaced away from the second transcaudate plane 423 in parallel.

[0035] The second plane setting section 135 is operable to set a midsagittal plane, a left parasagittal plane and a right parasagittal plane with respect to the first transthalamic plane. In one embodiment, the second plane setting section 135 is operable to rotate the reference plane perpendicularly with respect to the first transthalamic plane 411 in the normalized volume data 230 to thereby set the midsagittal plane 431, as shown in FIG. 9. The second plane setting section 135 is operable to rotate the reference plane at a third predetermined angle with respect to the midsagittal plane 431 to thereby set the left parasagittal plane 432. That is, the left parasagittal plane 432 is set at a location, which is rotated at the third predetermined angle with respect to the midsagittal plane 431. The second plane setting section 135 is operable to rotate the reference plane at a fourth predetermined angle with respect to the midsagittal plane 431 to thereby set the right parasagittal plane 433. That is, the right parasagittal plane 433 is set at a location, which is rotated at the fourth predetermined angle with respect to the midsagittal plane 431 and which is rotated at an angle (third predetermined angle + fourth predetermined angle) with respect to the left parasagittal plane 432.

[0036] The image forming section 136 is operable to form plane images corresponding to the respective multiple planes, which are set in the second plane setting section 135, i.e., the first transthalamic plane 411, transventricular plane 412, the first transcerebellar plane 413, the second transthalamic plane 421, the second transcerebellar plane 422, the second transcaudate plane 423, the transfrontal plane 424, the midsagittal plane 431, the left parasagittal plane 432 and the right parasagittal plane 433. The image forming section 136 is further operable to perform rendering upon the volume data to form a 3-dimensional ultrasound image.

[0037] Referring back to FIG. 1, the display unit 140 displays the multiple plane images provided from the processor 130. In one embodiment, the multiple plane images are displayed with being classified by views. Also, the plane image of the first transthalamic plane, which is matched with the graphic guide, is displayed with other plane images. Further, the display unit 140 displays the 3-dimensional ultrasound image.

Claims

1. An ultrasound system (100), comprising:

an ultrasound data acquisition unit (110) configured to transmit/receive ultrasound signals to/from a target object including a brain to form ultrasound data; and

a processor (130) configured to form volume data indicative of the target object by using the ultrasound data,

characterized in that the processor (130) includes:

a first plane setting section (132) configured to set a reference plane containing a falx and a cerebrum in the volume data;

a contour detecting section (133) configured to detect a falx contour and a contour of the cerebrum in the reference plane and an entire contour of the brain in the volume data;

a preprocessing section (134) configured to normalize the volume data by using normalization reference data corresponding to the falx contour, the cerebrum contour and the entire contour of the fetal brain; and

a second plane setting section (135) configured to set multiple planes with respect to the reference plane in the normalized volume data,

wherein the processor (130) is further configured to form plane images corresponding to the respective multiple planes by using the normalized volume data.

2. The ultrasound system (100) of Claim 1, wherein the processor (130) further includes a volume data forming section (131) configured to form the volume data.

3. The ultrasound system (100) of Claim 1, further comprising a user input unit (120) for receiving input information to set the reference plane in the volume data.

4. The ultrasound system (100) of Claim 1, wherein the normalization reference data include a first guide line (311) for matching with the falx contour, a second guide line (312) for matching with the cerebrum contour and third guide lines (313) for matching with the entire contour of the fetal brain.

5. The ultrasound system (100) of Claim 1, wherein the second plane setting section (135) is configured to:

set a first transthalamic plane by referring to the reference plane in the normalized volume data;
move the reference plane in the normalized volume data to a first predetermined location to set the transventricular plane; and
rotate the reference plane at a first predetermined angle with respect to the transthalamic plane to thereby set the first transcerebellar plane in the normalized volume data as axial views.

6. The ultrasound system (100) of Claim 5, wherein the second plane setting section (135) is further configured to:

rotate the reference plane perpendicularly in a first direction with respect to the first transthalamic plane in the normalized volume data and then rotate the perpendicularly-rotated reference plane at a second predetermined angle to thereby set the second transthalamic plane;
move the reference plane to a second predetermined location with respect to the second transthalamic plane in the normalized volume data to thereby set the second transcerebellar plane;
move the reference plane to a third predetermined location with respect to the second transthalamic plane in the normalized volume data to thereby set the transcaudate plane; and
move the reference plane to a fourth predetermined location with respect to the second transcaudate plane in the normalized volume data to thereby set the transfrontal plane, as coronal views.

7. The ultrasound system (100) of Claim 6, wherein the second plane setting section (135) is further configured to:

rotate the reference plane perpendicularly with respect to the first transthalamic plane in the normalized volume data to thereby set the midsagittal plane;
rotate the reference plane at a third predetermined angle with respect to the midsagittal plane to thereby set the left parasagittal plane; and
rotate the reference plane at a foruth predetermined angle with respect to the midsagittal plane to thereby set the right parasagittal plane.

8. A method of providing multiple plane images for a target object including a brain in an ultrasound system (100), comprising:

a) forming volume data indicative of a target object including a brain; **characterized by**
b) setting a reference plane containing a falx and a cerebrum in the volume data;
c) detecting a falx contour and a contour of a cerebrum in the reference plane and an entire contour of the brain in the volume data;
d) normalizing the volume data by using normalization reference data corresponding to the falx contour, the cerebrum contour and the entire contour of the fetal brain;
e) setting multiple planes with respect to the reference plane in the normalized volume data; and
f) forming plane images corresponding to the respective multiple planes by using the normalized volume data.

9. The method of Claim 8, further comprising inputting information to set the reference plane in the volume data.

10. The method of Claim 8, wherein the normalization reference data include a first guide line (311) for matching with the falx contour, a second guide line (312) for matching with the cerebrum contour and third guide lines (313) for matching with the entire contour of the fetal brain.

11. The method of Claim 8, wherein the step e) includes:

setting a first transthalamic plane by referring to the reference plane in the normalized volume data;
moving the reference plane in the normalized volume data to a first predetermined location to set the transventricular plane; and
rotating the reference plane at a first predetermined angle with respect to the transthalamic plane to thereby set the first transcerebellar plane in the normalized volume data, as axial views.

12. The method of Claim 11, wherein the step e) further

includes:

rotating the reference plane perpendicularly in a first direction with respect to the first transthalamic plane in the normalized volume data and then rotating the perpendicularly-rotated reference plane at a second predetermined angle to thereby set the second transthalamic plane;
moving the reference plane to a second predetermined location with respect to the second transthalamic plane in the normalized volume data to thereby set the second transcerebellar plane;
moving the reference plane to a third predetermined location with respect to the second transthalamic plane in the normalized volume data to thereby set the transcaudate plane; and
moving the reference plane to a fourth predetermined location with respect to the second transcaudate plane in the normalized volume data to thereby set the transfrontal plane, as coronal views.

13. The method of Claim 12, wherein the step e) further includes:

rotating the reference plane perpendicularly with respect to the first transthalamic plane in the normalized volume data to thereby set the midsagittal plane;
rotating the reference plane at a third predetermined angle with respect to the midsagittal plane to thereby set the left parasagittal plane; and
rotating the reference plane at a fourth predetermined angle with respect to the midsagittal plane to thereby set the right parasagittal plane.

Patentansprüche

1. Ultraschallsystem (100), umfassend:

eine Ultraschalldatenakquisitionseinheit (110), die zur Übertragung/zum Empfang von Ultraschallsignalen an ein/von einem Zielobjekt, einschließlich eines Gehirns, konfiguriert ist, um Ultraschalldaten zu erstellen; und
einen Prozessor (130), der dazu konfiguriert ist, durch die Verwendung der Ultraschalldaten das Zielobjekt betreffende Volumendaten zu erstellen, **dadurch gekennzeichnet, dass** der Prozessor (130) Folgendes einschließt:

einen ersten Ebenenfestlegungsteil (132), der dazu konfiguriert ist, eine Referenzebene festzulegen, welche eine Falx und ein Cerebrum in den Volumendaten enthält;
einen Konturerfassungsteil (133), der dazu konfiguriert ist, eine Falx-Kontur und eine Kontur des Cerebrums in der Referenzebene und eine gesamte Kontur des Gehirns in den Volumendaten zu erfassen;
einen Vorverarbeitungsteil (134), der dazu konfiguriert ist, die Volumendaten durch die Verwendung von Normalisierungsreferenzdaten, welche der FalxKontur, der Cerebrum-Kontur und der gesamten Kontur des fetalen Gehirns entsprechen, zu normalisieren; und
einen zweiten Ebenenfestlegungsteil (135), der dazu konfiguriert ist, mehrere Ebenen in Bezug auf die Referenzebene in den normalisierten Volumendaten festzulegen,
wobei der Prozessor (130) ferner dazu konfiguriert ist, durch die Verwendung der normalisierten Volumendaten Ebenenbilder zu erstellen, die den jeweiligen mehreren Ebenen entsprechen.

2. Ultraschallsystem (100) nach Anspruch 1, wobei der Prozessor (130) ferner einen Volumendatenerstellungsteil (131) einschließt, der dazu konfiguriert ist, die Volumendaten zu erstellen.

3. Ultraschallsystem (100) nach Anspruch 1, ferner umfassend eine Benutzereingabeeinheit (120) zur Aufnahme von Eingabeinformationen, um die Referenzebene in den Volumendaten festzulegen.

4. Ultraschallsystem (100) nach Anspruch 1, wobei die Normalisierungsreferenzdaten eine erste Führungslinie (311) zum Zuordnen zur Falx-Kontur, eine zweite Führungslinie (312) zum Zuordnen zur Cerebrum-Kontur und dritte Führungslinien (313) zum Zuordnen zur gesamten Kontur des fetalen Gehirns einschließen.

5. Ultraschallsystem (100) nach Anspruch 1, wobei der zweite Ebenenfestlegungsteil (135) zu Folgendem konfiguriert ist:

Festlegen einer ersten transthalamischen Ebene durch Referenzieren auf die Referenzebene in den normalisierten Volumendaten;
Bewegen der Referenzebene in den normalisierten Volumendaten an einen ersten vorbestimmten Ort zum Festlegen der transventrikulären Ebene; und
Rotieren der Referenzebene in einem ersten vorbestimmten Winkel in Bezug auf die transthalamische Ebene, um dabei die erste transzerebelläre Ebene in den normalisierten Volumendaten als axiale Ansichten festzulegen.

6. Ultraschallsystem (100) nach Anspruch 5, wobei der zweite Ebenenfestlegungsteil (135) ferner zu Folgendem konfiguriert ist:

Rotieren der Referenzebene lotrecht in einer ersten Richtung in Bezug auf die erste transthalamische Ebene in den normalisierten Volumendaten und
anschließendes Rotieren der lotrecht rotierten Referenzebene in einem zweiten vorbestimmten Winkel, um dabei die zweite transthalamische Ebene festzulegen;
Bewegen der Referenzebene an einen zweiten vorbestimmten Ort in Bezug auf die zweite transthalamische Ebene in den normalisierten Volumendaten, um dabei die zweite transzerebelläre Ebene festzulegen;
Bewegen der Referenzebene an einen dritten vorbestimmten Ort in Bezug auf die zweite transthalamische Ebene in den normalisierten Volumendaten, um dabei die transkaudale Ebene festzulegen; und
Bewegen der Referenzebene an einen vierten vorbestimmten Ort in Bezug auf die zweite transkaudale Ebene in den normalisierten Volumendaten, um dabei die transfrontale Ebene als koronale Ansichten festzulegen.

7. Ultraschallsystem (100) nach Anspruch 6, wobei der zweite Ebenenfestlegungsteil (135) ferner zu Folgendem konfiguriert ist:

Rotieren der Referenzebene lotrecht in Bezug auf die erste transthalamische Ebene in den normalisierten Volumendaten, um dabei die Mediansagittalebene festzulegen;
Rotieren der Referenzebene in einem dritten vorbestimmten Winkel in Bezug auf die Mediansagittalebene, um dabei die linke Parasagittalebene festzulegen; und
Rotieren der Referenzebene in einem vierten vorbestimmten Winkel in Bezug auf die Mediansagittalebene, um dabei die rechte Parasagittalebene festzulegen.

8. Verfahren zur Bereitstellung von Bildern mit mehreren Ebenen für ein Zielobjekt, einschließlich eines Gehirns, in einem Ultraschallsystem (100), umfassend:

a) Erstellen von Volumendaten, die das Zielobjekt, einschließlich eines Gehirns, betreffen;
durch Folgendes gekennzeichnet:
b) Festlegen einer Referenzebene, welche eine Falx und ein Cerebrum in den Volumendaten enthält;
c) Erfassen einer Falx-Kontur und einer Kontur eines Cerebrums in der Referenzebene und einer gesamten Kontur des Gehirns in den Volumendaten;
d) Normalisieren der Volumendaten durch die Verwendung von Normalisierungsreferenzdaten, welche der Falx-Kontur, der Cerebrum-Kontur und der gesamten Kontur des fetalen Gehirns entsprechen;
e) Festlegen von mehreren Ebenen in Bezug auf die Referenzebene in den normalisierten Volumendaten; und
f) Erstellen von Ebenenbildern, die den jeweiligen mehreren Ebenen entsprechen, durch die Verwendung der normalisierten Volumendaten.

9. Verfahren nach Anspruch 8, ferner umfassend das Eingeben von Informationen zum Festlegen der Referenzebene in den Volumendaten.

10. Verfahren nach Anspruch 8, wobei die Normalisierungsreferenzdaten eine erste Führungslinie (311) zum Zuordnen zur Falx-Kontur, eine zweite Führungslinie (312) zum Zuordnen zur Cerebrum-Kontur und dritte Führungslinien (313) zum Zuordnen zur gesamten Kontur des fetalen Gehirns einschließen.

11. Verfahren nach Anspruch 8, wobei der Schritt e) Folgendes einschließt:

Festlegen einer ersten transthalamischen Ebene durch Referenzieren auf die Referenzebene in den normalisierten Volumendaten;
Bewegen der Referenzebene in den normalisierten Volumendaten an einen ersten vorbestimmten Ort zum Festlegen der transventrikulären Ebene; und
Rotieren der Referenzebene in einem ersten vorbestimmten Winkel in Bezug auf die transthalamische Ebene, um dabei die erste transzerebelläre Ebene in den normalisierten Volumendaten als axiale Ansichten festzulegen.

12. Verfahren nach Anspruch 11, wobei der Schritt e) ferner Folgendes einschließt:

Rotieren der Referenzebene lotrecht in einer ersten Richtung in Bezug auf die erste transthalamische Ebene in den normalisierten Volumendaten und
anschließendes Rotieren der lotrecht rotierten Referenzebene in einem zweiten vorbestimmten Winkel, um dabei die zweite transthalamische Ebene festzulegen;
Bewegen der Referenzebene an einen zweiten vorbestimmten Ort in Bezug auf die zweite transthalamische Ebene in den normalisierten Volumendaten, um dabei die zweite transzerebelläre Ebene festzulegen;
Bewegen der Referenzebene an einen dritten vorbestimmten Ort in Bezug auf die zweite tran-

sthalamische Ebene in den normalisierten Volumendaten, um dabei die transkaudale Ebene festzulegen; und
Bewegen der Referenzebene an einen vierten vorbestimmten Ort in Bezug auf die zweite transkaudale Ebene in den normalisierten Volumendaten, um dabei die transfrontale Ebene festzulegen, und zwar als koronale Ansichten.

13. Verfahren nach Anspruch 12, wobei der Schritt e) ferner Folgendes einschließt:

Rotieren der Referenzebene lotrecht in Bezug auf die erste transthalamische Ebene in den normalisierten Volumendaten, um dabei die Mediansagittalebene festzulegen;
Rotieren der Referenzebene in einem dritten vorbestimmten Winkel in Bezug auf die Mediansagittalebene, um dabei die linke Parasagittalebene festzulegen; und
Rotieren der Referenzebene in einem vierten vorbestimmten Winkel in Bezug auf die Mediansagittalebene, um dabei die rechte Parasagittalebene festzulegen.

Revendications

1. Système ultrasonique (100) comportant :

une unité d'acquisition de données ultrasoniques (110) configurée pour transmettre/recevoir des signaux ultrasoniques vers un objet cible incluant un cerveau, pour former des données ultrasoniques;
un processeur (130) configuré pour former des données de volume correspondant à l'objet cible en utilisant les données ultrasoniques, **caractérisé en ce que** le processeur (130) comporte :

une première section de détermination de plan (132) configurée pour déterminer un plan de référence contenant une faux et une cervelle dans les données de volume ;
une section de détection de contour (133) configurée pour détecter un contour de faux et un contour de cervelle dans le plan de référence et un contour entier du cerveau dans les données de volume ;
une unité de traitement (134) pour normaliser les données de volume en utilisant une référence de normalisation correspondant au contour de la faux, au contour de la cervelle et au contour entier du cerveau du foetus, et
une seconde section de détermination de plan (135) configurée pour déterminer plusieurs plans par rapport au plan de référence dans les données de volume normalisées,

dans lequel le processeur (130) est en outre configuré pour former des images planes correspondant aux plans multiples respectifs en utilisant les données de volume normalisées.

2. Système ultrasonique (100) selon la revendication 1, dans lequel le processeur (130) comporte en outre une section (131) de formation d'images de volume configurée pour former les données de volume.

3. Système ultrasonique (100) selon la revendication 1, comprenant en outre une unité d'entrée utilisateur (120) pour recevoir des informations entrantes pour déterminer le plan de référence dans les données de volume.

4. Système ultrasonique (100) selon la revendication 1, dans lequel la référence de normalisation comprend une première directive (311) pour trouver le contour de la faux, une deuxième directive(312) pour trouver le contour de la cervelle et une troisième directive (313) pour trouver le contour du cerveau entier du foetus.

5. Système ultrasonique (100) selon la revendication 1, dans lequel la seconde unité de détermination d'un plan (135) est configurée pour :

déterminer un premier plan transthalamique en se référant au plan de référence dans les données de volume normalisées ;
déplacer le plan de référence dans les données de volume normalisées vers une première localisation pour déterminer le plan transventriculaire ; et
déplacer le plan de référence selon un premier angle prédéterminé par rapport au plan transthalamique pour déterminer ainsi le premier plan transcérébral dans les données de volume normalisées comme vues axiales.

6. Système ultrasonique (100) selon la revendication 5, dans lequel la seconde unité de détermination d'un plan (135) est en outre configurée pour :

tourner le plan de référence perpendiculairement dans une première direction par rapport au premier plan transthalamique dans les données de volume normalisées, et ensuite tourner le plan de référence tourné perpendiculairement selon un second angle prédéterminé pour ainsi déterminer le second plan transthalamique ;
déplacer le plan de référence dans une seconde localisation prédéterminée par rapport au second plan transthalamique dans les données de

volume normalisées pour ainsi déterminer le second plan transcérébral ;
déplacer le plan de référence dans une troisième localisation prédéterminée par rapport au second plan transthalamique dans les données de volume normalisées pour ainsi déterminer le second plan transcaudal ; et
déplacer le plan de référence dans une troisième localisation prédéterminée par rapport au second plan transcaudal dans les données de volume normalisées pour ainsi déterminer le plan transfrontal comme vues coronales.

7. Système ultrasonique (100) selon la revendication 6, la seconde section de détermination d'un plan (135) est en outre configurée pour :

tourner le plan de référence perpendiculairement par rapport au premier plan transthalamique dans les données de volume normalisées pour ainsi déterminer le plan sagittal médian;
tourner le plan de référence selon un troisième angle prédéterminé par rapport au plan sagittal médian pour ainsi déterminer le plan parasagittal gauche ; et
tourner le plan de référence selon un quatrième angle prédéterminé par rapport au plan sagittal médian pour ainsi déterminer le plan parasagittal droit.

8. Procédé pour réaliser plusieurs images planes d'un objet cible comportant un cerveau au moyen d'un système ultrasonique (100), comprenant :

a) la création de données de volume correspondant à l'objet cible comprenant un cerveau ;
caractérisé par
b) la détermination d'un plan de référence contenant une faux et une cervelle dans les données de volume ;
c) la détection du contour de la faux et du contour de la cervelle dans le plan de référence et le contour entier du cerveau dans les données de volume ;
d) la normalisation des données de volume en utilisant une référence de normalisation correspondant au contour de la faux, au contour de la cervelle et au contour entier du cerveau du foetus ;
e) la détermination de plusieurs plans par rapport au plan de référence dans les données de volume normalisées, et
f) la formation d'images planes correspondant aux plans multiples respectifs en utilisant les données de volume normalisées.

9. Procédé selon la revendication 8, comportant en outre l'imputation d'informations pour déterminer le plan de référence dans les données de volume.

10. Procédé selon la revendication 8, dans lequel les données de référence de normalisation comprennent une première directive (311) pour trouver le contour de la faux, une deuxième directive (312) pour trouver le contour de la cervelle et une troisième directive (313) pour trouver le contour du cerveau entier du foetus.

11. Procédé selon la revendication 8, dans lequel l'étape e) comporte :

la détermination d'un premier plan transthalamique en se référant au plan de référence dans les données de volume normalisées ;
le déplacement du plan de référence dans les données de volume normalisées vers une première localisation pour déterminer le plan transventriculaire ; et
la rotation du plan de référence selon un premier angle prédéterminé par rapport au plan transthalamique pour déterminer ainsi le premier plan transcérébral dans les données de volume normalisées comme vues axiales.

12. Procédé selon la revendication 11, dans lequel l'étape e) comporte en outre:

la rotation du plan de référence perpendiculairement dans une première direction par rapport au premier plan transthalamique dans les données de volume normalisées, et ensuite la rotation du plan de référence tourné perpendiculairement selon un second angle prédéterminé pour ainsi déterminer le second plan transthalamique ;
le déplacement du plan de référence dans une second localisation prédéterminée par rapport au second plan transthalamique dans les données de volume normalisées pour ainsi déterminer le second plan transcérébral ;
le déplacement du plan de référence dans une troisième localisation prédéterminée par rapport au second plan transthalamique dans les données de volume normalisées pour ainsi déterminer le second plan transcaudal ; et
le déplacement du plan de référence dans une troisième localisation prédéterminée par rapport au second plan transcaudal dans les données de volume normalisées pour ainsi déterminer le plan transfrontal comme vues coronales.

13. Procédé selon la revendication 12, dans lequel l'étape e) comporte en outre:

la rotation du plan de référence perpendiculairement par rapport au premier plan transthala-

mique dans les données de volume normalisées pour ainsi déterminer le plan sagittal médian;
la rotation du plan de référence selon un troisième angle prédéterminé par rapport au plan sagittal médian pour ainsi déterminer le plan para sagittal gauche ; et
la rotation du plan de référence selon un quatrième angle prédéterminé par rapport au plan sagittal médian pour ainsi déterminer le plan para sagittal droit.

FIG. 1

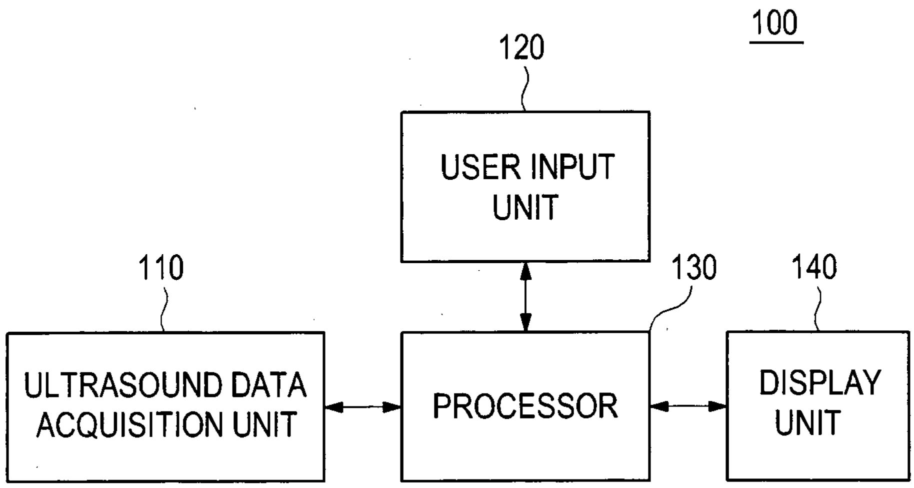

100
120
USER INPUT UNIT
110
130
140
ULTRASOUND DATA ACQUISITION UNIT
PROCESSOR
DISPLAY UNIT

FIG. 2

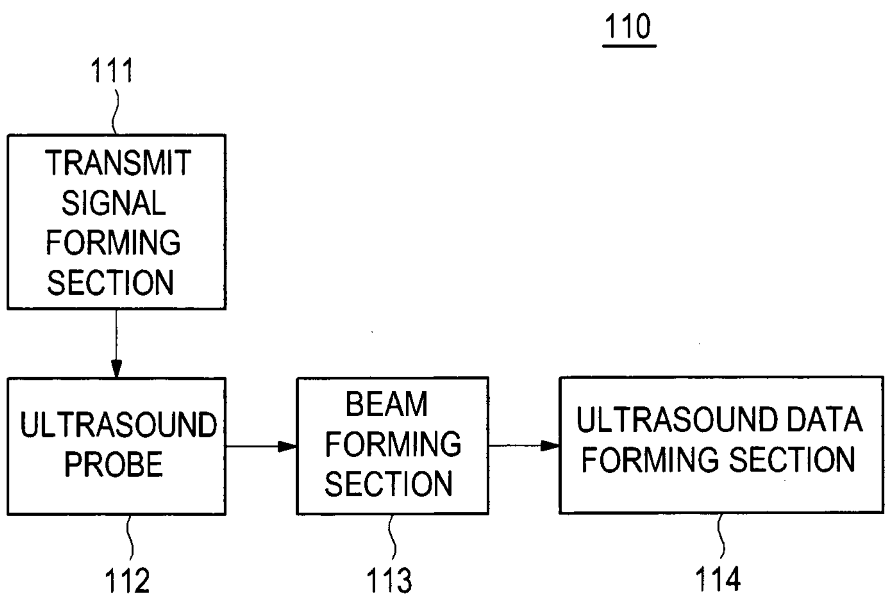

110
111
TRANSMIT SIGNAL FORMING SECTION
ULTRASOUND PROBE
BEAM FORMING SECTION
ULTRASOUND DATA FORMING SECTION
112
113
114

FIG. 3

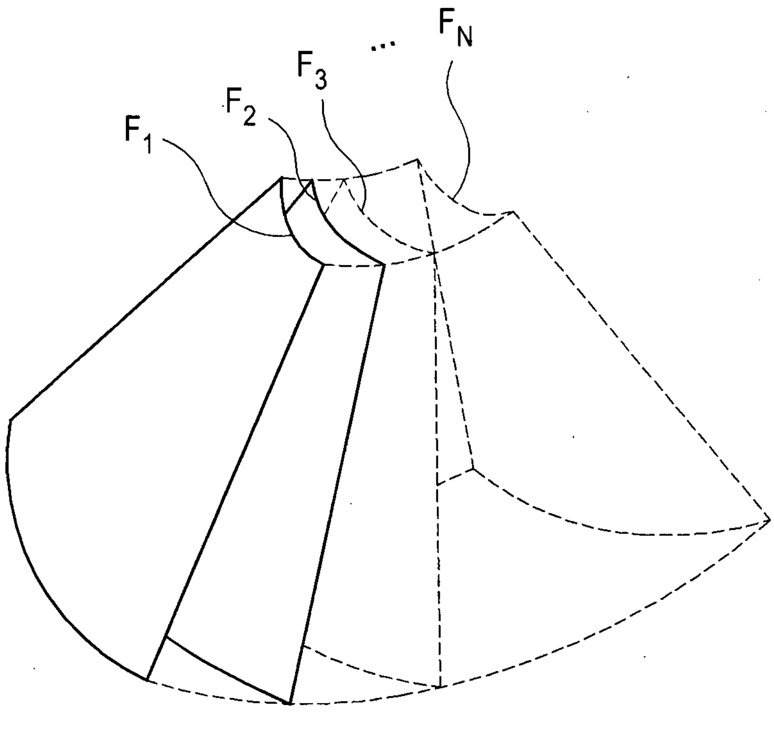


FIG. 4

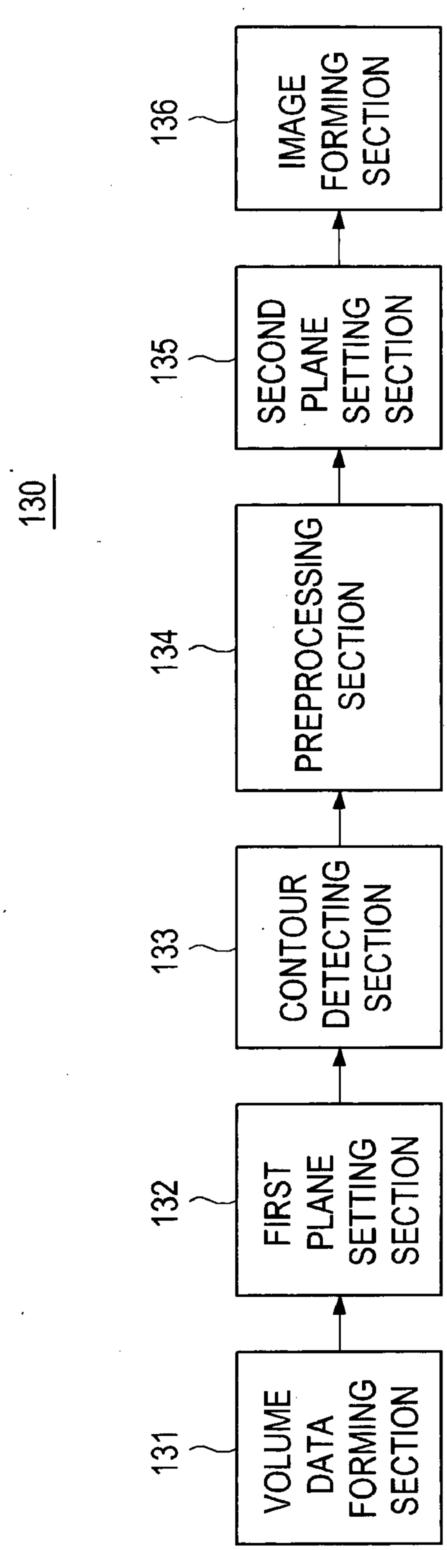

130
131
VOLUME DATA FORMING SECTION
132
FIRST PLANE SETTING SECTION
133
CONTOUR DETECTING SECTION
134
PREPROCESSING SECTION
135
SECOND PLANE SETTING SECTION
136
IMAGE FORMING SECTION

FIG. 5

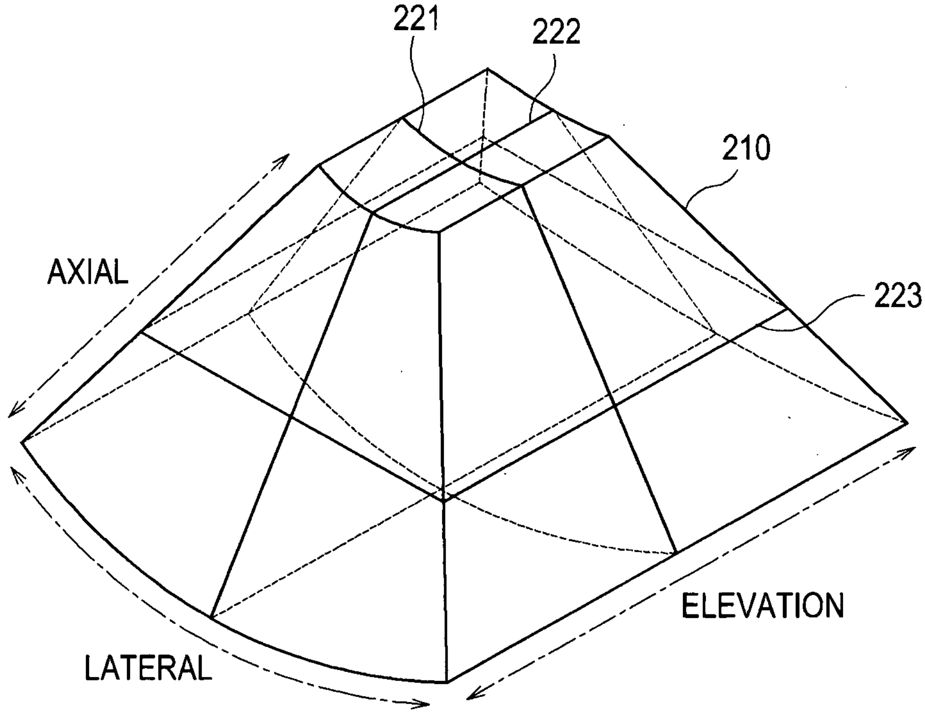


FIG. 6

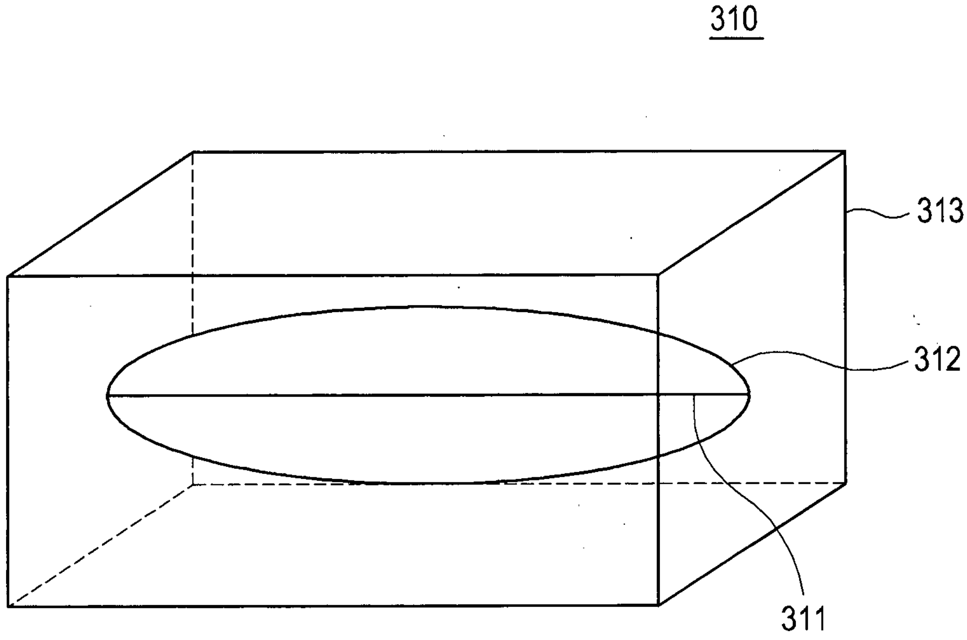


FIG. 7

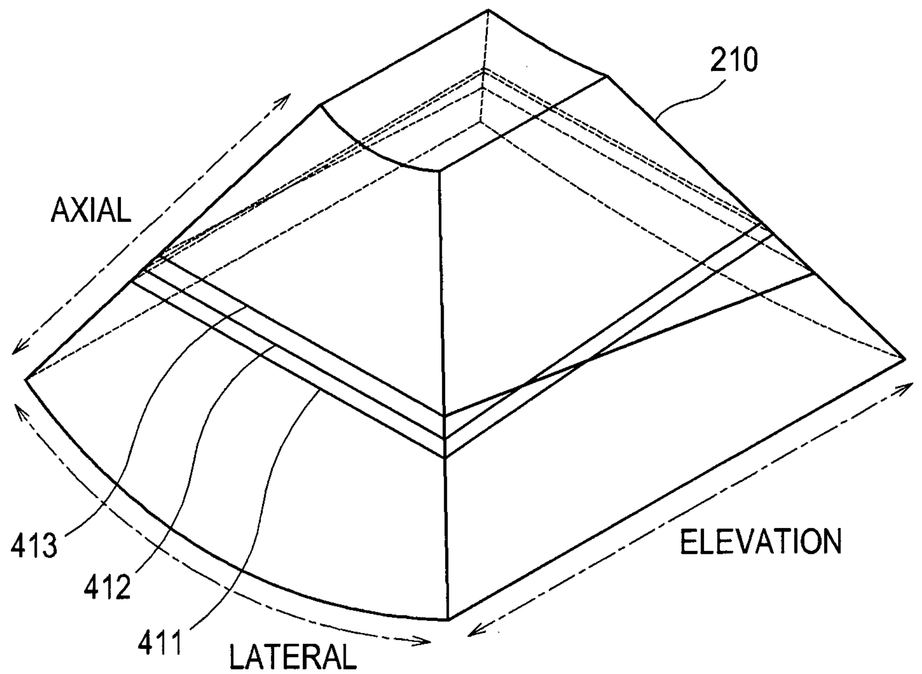


FIG. 8

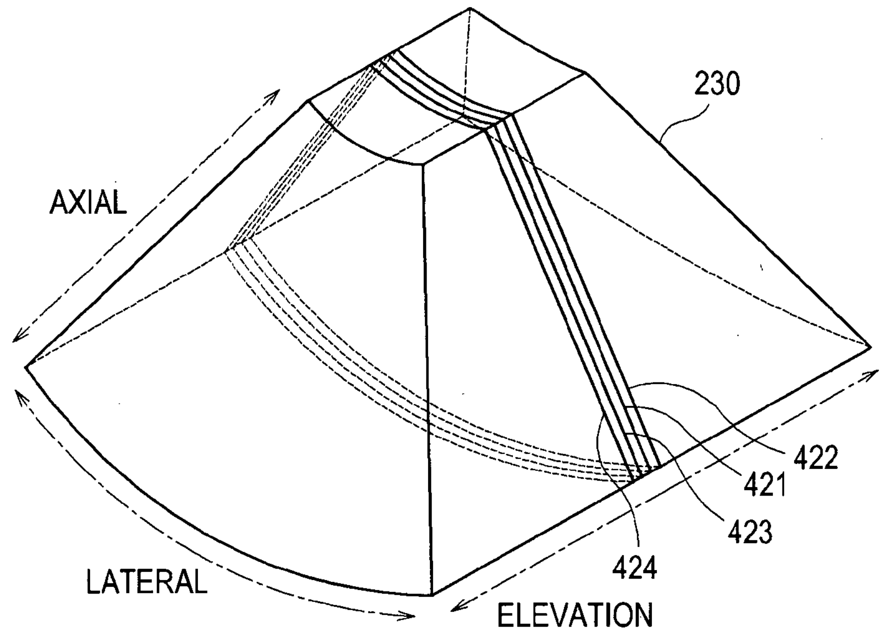
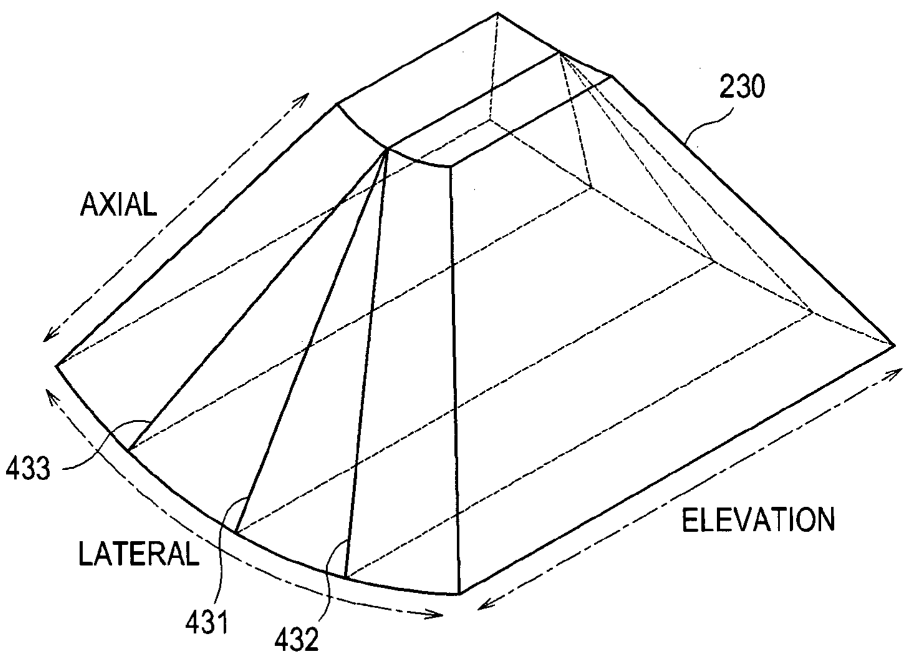

230
AXIAL
422
421
423
424
LATERAL
ELEVATION

FIG. 9


230
AXIAL
433
LATERAL
431
432
ELEVATION

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2005251036 A1 **[0006]**
- US 20070249935 A1 **[0007]**
- US 2006034513 A1 **[0008]**

专利名称(译)	超声系统和方法，用于为多个视图提供多个平面图像		
公开(公告)号	[EP2296011B1](EP2296011B1)	公开(公告)日	2014-06-25
申请号	EP2010173735	申请日	2010-08-23
申请(专利权)人(译)	MEDISON CO.，LTD.		
当前申请(专利权)人(译)	三星MEDISON CO.，LTD.		
[标]发明人	LEE YUN HEE		
发明人	LEE, YUN HEE		
IPC分类号	G01S15/89 G01S7/52 A61B8/08		
CPC分类号	G01S15/8993 A61B8/0808 A61B8/0866 A61B8/483 A61B8/523 G01S7/52063		
代理机构(译)	SCHMID，WOLFGANG		
优先权	1020090083074 2009-09-03 KR		
其他公开文献	EP2296011A2 EP2296011A3		
外部链接	Espacenet		

摘要(译)

公开了用于在超声系统中形成目标对象的多个平面图像的实施例。处理器通过使用超声数据形成指示目标对象的体数据。处理器用于：在体数据中设置参考平面;在体积数据中检测参考平面中的镰刀轮廓和大脑轮廓以及大脑的整个轮廓;通过使用镰刀轮廓，大脑轮廓和胎儿大脑的整个轮廓来标准化体积数据;并在体数据中相对于参考平面设置多个平面。处理器通过使用体数据形成与各个多个平面相对应的平面图像。

FIG. 1

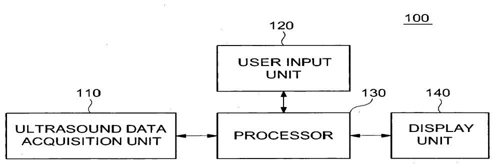

FIG. 2