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

(11) **EP 2 365 356 B1**

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
25.07.2018 Bulletin 2018/30

(21) Application number: **11150363.7**

(22) Date of filing: **07.01.2011**

(51) Int Cl.:
G01S 15/89 *(2006.01)*
G01S 7/52 *(2006.01)*
A61B 8/00 *(2006.01)*
A61B 8/08 *(2006.01)*
A61B 8/14 *(2006.01)*
G06T 7/60 *(2017.01)*
G06T 19/00 *(2011.01)*

(54) **Three-dimensional (3D) ultrasound system for scanning object inside human body and method for operating 3D ultrasound system**

Dreidimensionales Ultraschallsystem zum Abtasten eines Objekts in einem menschlichen Körper und Verfahren zum Betrieb des 3D-Ultraschallsystems

Système à ultrasons tridimensionnel (3D) pour analyser un objet à l'intérieur du corps humain et procédé de fonctionnement dudit système

(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 RS SE SI SK SM TR

(30) Priority: **10.03.2010 KR 20100021136**
26.05.2010 KR 20100049028

(43) Date of publication of application:
14.09.2011 Bulletin 2011/37

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Printed by Jouve, 75001 PARIS (FR)

Description

BACKGROUND

1. Field

[0001] The present invention relates to a three-dimensional (3D) ultrasound system of scanning an object inside a human body and a method of operating the 3D ultrasound system.

2. Description of the Related Art

[0002] An ultrasound system may transmit, from the surface of a human body, an ultrasound signal toward a predetermined portion inside the human body, for example, a fetus, an organ, and the like, to obtain an image associated with a section of soft tissue or the bloodstream by using information of the ultrasound signal having been reflected from tissue inside the body.

[0003] The ultrasound system has an advantage of being small, inexpensive, displayable in real time, and reliable since a subject is not exposed to an X-ray and the like and thus, the ultrasound system is widely used together with other image diagnostic devices, such as a computerized tomography (CT) scanner, a magnetic resonance image (MRI) device, a nuclear medicine device, and the like.

[0004] A fetus having Down's syndrome is generally identified based on a scheme of measuring a thickness of a nuchal translucency (NT) of the fetus. The scheme was designed by Nicolaides, in 1992. When the fetus has Down's syndrome, a thick NT is observed since body fluid is accumulated in a subcutaneous tissue of a neck.

[0005] Specifically, when the fetus has a chromosomal anomaly or a deformity of the heart, a thick NT is often observed. Therefore, a physician may measure a thickness of the NT of the fetus through the ultrasound system, and may observe the fetus using a Chorionic Villus sampling scheme or an amniocentesis scheme when the thickness is over 2.5 mm.

[0006] As another scheme of identifying Down's syndrome in a fetus, an angle between the palate and the dorsum nasi, namely, the frontmaxillary facial (FMF) angle, may be measured. The FMF angle of a normal fetus is 78.1 degrees, and a fetus having an FMF angle of 88.7 degrees has a high possibility of having Down's syndrome. There are various schemes for identifying Down's syndrome, such as measuring the biparietal diameter (BPD), Head Circumference (HC), Abdominal Circumference (AC), Femur Length (FL), and the like. A gestational age and a weight of the fetus may be estimated based on the schemes.

[0007] A process of obtaining an accurate sagittal view from ultrasound data needs to be performed in advance, to identify Down's syndrome in the fetus by measuring the thickness of the NT and the FMF angle between the palate and the dorsum nasi.

[0008] Conventionally, however, the sagittal view is determined based on experience of the physician and thus, the measured thickness of the NT of the fetus or the FMF angle between the palate and the dorsum nasi may be different from an actual thickness and an actual angle. Accordingly, there has been a difficulty in making an accurate diagnosis.

[0009] Reference is made to CHUNG B L et al: "The application of three-dimensional ultrasound to nuchal translucency measurement in early pregnancy (10-14 weeks): a preliminary study", ULTRASOUND IN OBSTETRICS AND GYNECOLOGY, vol. 15, no, 2, 1 February 2000 (2000-02-01), pages 122-125, XP002612511, ISSN: 0960-7692, DOI: 10.1046/J. 1469-0705.2000.00052.X.

[0010] The US 2008/188748 A1 discloses methods for prenatal screening for trisomy employ examination of the fronto-maxillary facial (FMF) angle of a fetus. In one embodiment, the methods comprise obtaining a two or three dimensional image of a fetal face, measuring the FMF-bone angle on the image, and comparing the measured FMFbone angle with an FMFbone angle characteristic of chromosomally normal fetuses, wherein a measured FMFbone angle greater than the FMFbone angle characteristic of chromosomally normal fetuses provides an indication of an increased likelihood of the occurrence of trisomy in the fetus. In another embodiment, the methods comprise obtaining a two or three dimensional image of a fetal face, measuring the FMFskin angle on the image, and comparing the measured FMFskin angle with an FMFskin angle characteristic of chromosomally normal fetuses, wherein a measured FMFskin angle greater than the FMFskin angle characteristic of chromosomally normal fetuses provides an indication of an increased likelihood of the occurrence of trisomy in the fetus. In additional embodiments, both FMFbone angle and FMFskin angle are measured and compared with values characteristic of chromosomally normal fetuses.

[0011] The US 2007/081705 A1 describes a method for segmenting and measuring anatomical structures in fetal ultrasound images including the steps of providing a digitized ultrasound image of a fetus comprising a plurality of intensities corresponding to a domain of points on a 3-dimensional grid, providing a plurality of classifiers trained to detect anatomical structures in said image of said fetus, and segmenting and measuring an anatomical structure using said image classifiers by applying said elliptical contour classifiers to said fetal ultrasound image, wherein a plurality of 2-dimensional contours characterizing said anatomical structure are detected. The anatomical structure measurement can be combined with measurement of another anatomical structure to estimate gestational age of the fetus.

SUMMARY

[0012] The invention is defined by claim 1. Regarding the method of operating a 3D ultrasound system the invention is defined by claim 7.

[0013] Additional aspects and/or advantages will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the embodiments.

Effect

[0014] According to embodiments, an accurate sagittal view may be automatically determined by three-dimensional (3D) ultrasound data with respect to an object inside a human body.

[0015] According to embodiments, whether a fetus has an abnormality may be accurately diagnosed by measuring, from ultrasound data determined as a sagittal view, a thickness of an NT of the fetus or an FMF angle between a dorsum nasi of the fetus and a palate of the fetus, when an object is the fetus.

[0016] According to embodiments, a sagittal view may be redetermined based on a fine movement of a fetus.

[0017] According to embodiments, a sagittal view may be reliably determined by determining a direction of a head of a fetus, and selecting, as a reference axis, a location of a falx included in data where data obtained by scanning the falx in the determined direction of the head is outputted to be brightest

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] These and/or other aspects and advantages will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings of which:

FIG. 1 is a diagram illustrating an internal configuration of a 3D ultrasound system according to an embodiment of the present invention;

FIG. 2 is a diagram illustrating an object inside a human body and ultrasound data generated by scanning the object according to an embodiment of the present invention;

FIG. 3 is a flowchart illustrating a 3D ultrasound system operating method according to an embodiment of the present invention; and

FIG. 4 is a flowchart illustrating a process of setting a reference axis according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0019] Reference will now be made in detail to example embodiments, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout.

[0020] FIG. 1 illustrates an internal configuration of a three-dimensional (3D) ultrasound system 100 according to an embodiment of the present invention.

[0021] Referring to FIG. 1, the 3D ultrasound system 100 includes a scanner 110, a processing unit 120, and a controller 130.

[0022] The scanner 110 generates ultrasound data including image data generated by scanning an object inside a human body. The object inside the human body may be a fetus, an organ, and the like. The scanner 110 generates, as the ultrasound data, the image data generated by scanning the fetus, the organ, and the like.

[0023] As an example of generating the ultrasound data, the scanner 110 may set a region of interest (ROI) with respect to the object and may locate a seed in the set ROI. In this example, when the object is the fetus, the seed may be located adjacent to an NT of the fetus. The scanner 110 may generate the image data by scanning the object using a 3D ultrasound to generate the ultrasound data with respect to the object. An area occupied by the object in the generated ultrasound data may be the generated image data.

[0024] The processing unit 120 detects a center point of the object from the generated ultrasound data, and may generate a virtual plane on which the detected center point is placed. The processing unit 120 generates the virtual plane including the detected center point on the ultrasound data and thus, may form a B-Plane. For example, the B-Plane may be a plane displaying image data viewed from a head of the fetus.

[0025] For example, when the object inside the human body is the fetus, the processing unit 120 may determine, from the generated ultrasound data, a first feature point associated with a dorsum nasi of the fetus, may determine a second feature point associated with a palate of the fetus based on the determined first feature point, and may detect the center point of the object, namely, a head of the fetus, based on the second feature point.

[0026] Specifically, the processing unit 120 may determine the first feature point associated with the dorsum nasi of the fetus based on the seed located adjacent to the NT of the fetus from an A-Plane, the A-Plane illustrating a side of the fetus, and may determine the second feature point associated with the palate based on the first feature point. The processing unit 120 may detect the center point of the head of the fetus from the A-Plane based on the first feature point and the second feature point. A point in the ultrasound data may be determined as the center point of the head of the fetus, and the point may be experimentally determined, to be close to an actual center of the head, based on years of experiences and experimentations. For example, a point located several centimeters apart from the second feature point, from among points included in a virtual line generated between the first feature point and the second feature point.

[0027] The processing unit 120 may generate, on the ultrasound data, the B-plane, namely, a virtual plane that includes the detected center point of the head of the fetus and is vertical to the A-Plane.

[0028] For reference, the processing unit 120 may approximately determine the first feature point, the second feature point, and the center point by appropriately combining and utilizing a well-known algorithm and an image processing with respect to the ultrasound data, and by utilizing integrated data based on years of experiences and experimentations.

[0029] The controller 130 rotates the ultrasound data based on the image data included in the virtual plane to determine a sagittal view with respect to the object. When the B-Plane is rotated, the A-Plane being vertical to the B-Plane may be interoperably rotated. The controller 130 may enable the A-plane to be the sagittal view based on the rotation of the B-plane. When the object is the fetus, the image data included in the virtual plane may be an area corresponding to the object viewed from a direction of the head of the fetus.

[0030] The controller 130 matches a figure corresponding to the image data with the image data included in the virtual plane, and rotates the ultrasound data to enable an axis constituting the matched figure to be parallel with a predetermined reference axis.

[0031] The reference axis is a line used as a reference when the ultrasound data is rotated to correct the ultrasound data to generate the sagittal view. The 3D ultrasound system 100 may further include a direction identifier 160 to select the reference axis.

[0032] When the object is the fetus, the direction identifier 160 may identify a direction of the head of the fetus from the ultrasound data. Features of the scanned fetus may be identified from the ultrasound data including a vague shape of the fetus, by identifying the direction of the head of the fetus.

[0033] The direction identifier 160 may estimate the direction of the head by scoring with respect to an FMF angle. The direction identifier 160 may obtain a plurality of slice data with respect to a side direction of the ultrasound data, and may determine the direction of the head of the fetus based on an FMF angle of each slice data measured by the measuring unit 150.

[0034] A process where the direction identifier 160 identifies the direction of the head may be described.

[0035] The direction identifier 160 may detect a nasal bridge from each slice data of the A-Plane and may perform scoring with respect to the detected nasal bridge.

1) Top-hat Transform

[0036] The direction identifier 160 may apply a top-hat transform to the ultrasound data to detect the nasal bridge and the palate.

[0037] The top-hat transform is applied to the ultrasound data to compensate for weak points of other schemes utilized for restoring an original image, for example, an edge detection scheme or a scheme of applying a threshold to the original image. When the original image of the fetus is restored based on the edge detection scheme, the edge detection scheme may have a weak point in restoring a boundary of the fetus, a boundary of the ultrasound data, and other tissues of the mother, together with an original image of the fetus. The scheme of applying threshold to the original image may have a weak point of restoring an image of skin of the fetus, the placenta of the mother, and the like which are relatively bright compared with a background, together with the original image of the fetus.

[0038] The direction identifier 160 may restore the image of the fetus in the ultrasound data by applying top-hat transform to the ultrasound data, to remove the obstructive factors. The top-hat transform may be a well-known scheme and thus, a detailed example of using the top-hat transform is omitted.

2) Adaptive thresholding

[0039] The direction identifier 160 may apply a threshold with respect to an image generated by applying the top-hat transform to the ultrasound data, the threshold being generated by appropriately combining a mean and a standard deviation of an entire image. The direction identifier 160 may obtain, from the ultrasound data, a thresholded image from which bright details including the nasal bridge and the palate are extracted.

[0040] The direction identifier 160 distinguishes the nasal bridge and the palate from the ultrasound data by applying top-hat transform and an adaptive threshold to the ultrasound data.

3) Detection of Nasal Bridge Line (NBL)

[0041] The direction identifier 160 may detect a nasal bridge line (NBL) from the thresholded image, and may estimate the direction of the head of the fetus based on an angle of a slope of the NBL.

[0042] For example, when the NBL of the thresholded image may have a slope of '\', the direction identifier 160 may estimate the direction of the head of the fetus based on the slope and an FMF angle between the NBL and the palate, as being on the left on the A-Plane.

4) Scoring

[0043] Arms of the fetus, the placenta of the mother, and bright regions of other tissues exist around the head of the fetus. Therefore, when the direction of the head of the fetus is estimated by only detecting an NBL for a A-Plane of an initial plane, a great number of errors may occur. A nasal bridge or a zygomatic bone is symmetrical around a face of the fetus and thus, the direction identifier 160 may obtain plurality of slice data with respect to the side direction of the ultrasound data based on the initial plane, may determine an NBL for each of the plurality of obtained slice data, and may perform scoring with respect to a direction estimated from each slice data, to detect an accurate direction of the head.

[0044] For example, when ten slice data are obtained from the ultrasound data, the direction identifier 160 may perform scoring with respect to the direction of the head estimated from each slice data, as 'left : right = 7 : 3'.

Therefore, the left having a relatively higher score may be determined as the direction of the head of the fetus.

[0045] The controller 130 selects, as a reference axis, a location of a falx included in a reference image having a highest brightness intensity among reference images obtained by scanning the falx of the fetus in the determined direction of the head. The controller 130 determines, as the reference axis used for obtaining the sagittal view, the location where the reference image outputted to be brightest.

[0046] When the A-plane is used for a mid-sagittal view, a falx cerebri region is evenly bright, the A-plane showing a side of the fetus. However, when the A-Plane is not used for mid-sagittal view, the falx cerebri region may not evenly bright, and may have a dark region.

[0047] The controller 130 may move and rotate the ultrasound data based on a center of the head and may determine a case where the falx region is brightest and is evenly distributed, as the mid-sagittal view, namely, the reference axis for determining the sagittal view.

[0048] The rotation of the ultrasound data performed by the controller 130 will be described again. As another example, the controller 130 matches a figure with image data included in the virtual plane, and rotates the ultrasound data by an angle between an axis constituting the matched figure and the predetermined reference axis.

[0049] For example, the controller 130 may determine the figure matched with the image data as an oval. In this example, the controller 130 may focus on, using a predetermined color or a predetermined line, the figure matched with the image data to display the focused figure on a display screen. When the figure matched with the image data is determined as the oval, the controller 130 may display, on the display screen, information associated with at least one of a major axis, a minor axis, and a circumference of the oval.

[0050] The controller 130 may rotate the ultrasound data to enable the major axis of the oval to be parallel with a reference axis of the image data, the major axis passing a center point of the object and the reference axis being a vertical axis or a y axis. The controller 130 may rotate the ultrasound data by an angle between the major axis of the oval and the reference axis of the image data.

[0051] According to an embodiment, an accurate sagittal view may be automatically determined based on 3D ultrasound data with respect to the object inside the human body.

[0052] The controller 130 may finely rotate the ultrasound data based on a manipulation of an operator to redetermine the sagittal view. Accordingly, when the object is the fetus, the controller 130 may finely rotate the ultrasound data based on the manipulation of the operator, and the manipulation may be based on a fine movement of the fetus and thus, a more accurate sagittal view may be determined.

[0053] According to another embodiment, the 3D ultrasound system 100 may further include a seed setting unit 140 and a measuring unit 150.

[0054] When the object inside a human body is the fetus, the seed setting unit 140 may set a seed around the NT of the fetus in the ultrasound data, the ultrasound data being determined as the sagittal view by performing the rotation.

[0055] The measuring unit 150 may automatically measure, from the ultrasound data determined as the sagittal view, a thickness of the NT of the fetus based on the set seed to display the measured thickness on the display screen.

[0056] Therefore, the operator or a physician may more accurately diagnose whether the fetus has an abnormality, based on the measured thickness of the NT of the fetus. In this example, the measuring unit 150 may focus on the NT of the fetus in the ultrasound data, using a predetermined color or a predetermined line, and may display the focused around the seed.

[0057] According to another embodiment, the measuring unit 150 may automatically measure, from the ultrasound data determined as the sagittal view, an FMF angle between the first feature point associated with the dorsum nasi of the fetus and the second point associated with the palate of the fetus, and may display the measured FMF angle on the display screen. Therefore, the operator or the physician may more accurately diagnose whether the fetus has an abnormality, based on the measured FMF angle. In this example, the measuring unit 150 may focus the first feature point and the second feature point in the ultrasound data, using a predetermined color or a predetermined line to display on the display screen.

[0058] In this example, when the sagittal view is redetermined by finely rotating the ultrasound data based on the manipulation of the operator, the measuring unit 150 may edit the measured thickness of the NT of the fetus, the measured FMF angle, the circumference of the figure matched with the image data, for example the circumference of the oval, and the like.

[0059] Therefore, according to an embodiment, when the object is the fetus, the thickness of the NT of the fetus or the FMF angle between the dorsum nasi and the palate of the fetus are measured from the ultrasound data determined as the sagittal view and thus, whether the fetus has an abnormality may be accurately diagnosed.

[0060] FIG. 2 illustrates a fetus 210 inside a human body and ultrasound data 220 generated by scanning the fetus 210 according to an embodiment of the present invention.

[0061] Referring to FIG. 2, a 3D ultrasound system may scan the fetus 210 using a 3D ultrasound system, to generate the ultrasound data 220. In this example, an area corresponding to the fetus 210 in the generated ultrasound data 220 may be image data. A seed may be located around an NT 230 of the fetus 210.

[0062] The 3D ultrasound system may automatically measure, from the ultrasound data 220 determined as a sagittal view, a thickness of the NT 230 of the fetus 210 based on a set seed, and may display the measured NT on a display screen. Therefore, an operator or a physician may more accurately diagnose whether the fetus 210 has an abnormality, based on the measured thickness of the NT 230 of the fetus 210. In this example, the measuring unit 150 may focus on the NT 230 of the fetus 210 in the ultrasound data 220, using a predetermined color or a predetermined line, and may display the focused NT 230 around the seed.

[0063] FIG. 3 illustrates a 3D ultrasound system operating method according to an embodiment of the present invention.

[0064] According to an embodiment, the 3D ultrasound system operating method may be embodied by the 3D ultrasound system 100. The 3D ultrasound system operating method maybe described with reference to FIGS. 1 and 3.

[0065] In operation 310, the 3D ultrasound system 100 generates ultrasound data including image data generated by scanning an object inside a human body.

[0066] In this example, the object inside the human body may be a fetus and an organ.

[0067] For example, the scanner 110 may set an ROI with respect to the object, and may locate a seed in the set ROI. When the object is the fetus, the seed may be located around an NT of the fetus. The scanner 110 may scan the object using a 3D ultrasound to generate ultrasound data. An area corresponding to the object in the generated ultrasound data may be image data.

[0068] In operations 320 and 330, the 3D ultrasound system 100 detects a center point of the object from the generated ultrasound data, and the 3D ultrasound system 100 generates, on the ultrasound data, a virtual plane on which the detected center point is placed.

[0069] For example, when the object inside the human body is the fetus, the processing unit 120 determines, from the generated ultrasound data, a first feature point associated with a dorsum nasi of the fetus, determines a second feature point associated with a palate of the fetus based on the determined first feature point, and detects the center point of the object based on the determined second feature point, namely, a center point of a head of the fetus.

[0070] Specifically, the processing unit 120 determines the first feature point associated with the dorsum nasi based on the seed located around the NT of the fetus from the A-Plane, the A-Plane illustrating a side of the fetus, and may determine the second feature point associated with the palate based on the first feature point. The processing unit 120 may determine the center point of the head of the fetus from the A-Plane, based on the first feature point and the second feature point. The processing unit 120 may generate the B-Plane that is a virtual plane including the determined center point of the head of the fetus and being vertical to the A-Plane.

[0071] For reference, the processing unit 120 may determine the first feature point, the second feature point, and the center point, using a predetermined algorithm and image processing with respect to the ultrasound data or using integrated data based on years of experimentations.

[0072] In operation 340, the 3D ultrasound system 100 rotates the ultrasound data using the image data included in the virtual plane, and determines the sagittal view with respect to the object.

[0073] The image data may be an area corresponding to the object, for example, the fetus, in the virtual plane.

[0074] For example, the controller 130 may determine a figure matched with the image data as an oval. In this example, the controller 130 may focus on the figure matched with the image data using a predetermined color or a predetermined line to display the focused figure on a display screen. When the figure matched with the image data is determined as the oval, the controller 130 may display, on the display screen, information associated with at least one of a major axis, a minor axis, a circumference of the oval.

[0075] The controller 130 may rotate the ultrasound data to enable the major axis of the oval to be parallel with a reference axis of the image data, the major axis of the oval passing the center point of the object and the reference axis of the image data being a vertical axis or a y axis.

[0076] A process of setting the reference axis may be described with reference to FIG. 4.

[0077] FIG. 4 illustrates a process of setting a reference axis according to an embodiment of the present invention.

[0078] When an object is a fetus, the 3D ultrasound system 100 obtains a plurality of slice data with respect to a side direction of ultrasound data in operation 410. The 3D ultrasound system 100 may obtain the plurality of slice data with respect to the side direction of the ultrasound data based on an initial plane of A-Plane.

[0079] In operation 420, the 3D ultrasound system 100 measures an FMF angle between a first feature associated with a dorsum nasi of the fetus and a second feature point associated with a palate of the fetus, with respect to each slice data. The 3D ultrasound system 100 measures the FMF angle between a nasal bridge and a palate, and particularly, measures a direction where the FMF angle is formed.

[0080] In operation 430, the 3D ultrasound system 100 determines a direction of a head of the fetus based on an FMF angle measured with respect to each slice data. The 3D ultrasound system 100 performs scoring with respect to the direction of the head determined in each slice data, and determines a direction having a relatively higher score as the direction of the head of the fetus.

[0081] For example, when ten slice data are obtained from the ultrasound data, the 3D ultrasound system 100 may perform scoring with respect to the direction of the head estimated from each slice data, as 'left : right = 7 : 3'. Therefore, the left having a relatively higher score may be determined as the direction of the head of the fetus.

[0082] In operation 440, the 3D ultrasound system 100 determines, as the reference axis, a location of a falx included in a reference image having a highest brightness intensity among reference images obtained by scanning the falx of the fetus in the determined direction of the head. The 3D ultrasound system 100 may determine, as the reference axis used for obtaining a sagittal view, the location where the reference image is outputted to be brightest.

[0083] Referring again to FIG. 3, the controller 130 of the 3D ultrasound system 100 may rotate the ultrasound data by an angle between a major axis of an oval and a reference axis of image data, the major axis passing a center point of the object and the reference axis being a vertical axis or a y axis.

[0084] According to an embodiment, the 3D ultrasound data with respect to an object inside a human body may automatically determine an accurate sagittal view.

[0085] In operation 350, the 3D ultrasound system 100 finely rotates the ultrasound data based on a manipulation of an operator to redetermine the sagittal view.

[0086] Therefore, when the object is the fetus, the controller 130 may finely rotate the ultrasound data based on the manipulation of the operator, and the manipulation may be based on a fine movement of the fetus and thus, a more accurate sagittal view may be determined.

[0087] In operation 360, when the object inside the human body is the fetus, the 3D ultrasound system 100 automatically measures, from the ultrasound data determined as the sagittal view, a thickness of an NT of the fetus, based on a set seed, or automatically measures, from the ultrasound data determined as the sagittal view, an FMF angle between a first feature point associated with a dorsum nasi of the fetus and a second feature point associated with a palate of the fetus.

[0088] The measuring unit 150 may display the measured thickness of the NT of the fetus or the measured FMF angle on the display screen and thus, the operator or a physician may more accurately diagnose whether the fetus has an abnormality, based on the measured data.

[0089] When the sagittal view is redetermined by finely rotating the ultrasound data based on a manipulation of the operator, the measuring unit 150 may edit the measured thickness of the NT of the fetus, the measured FMF angle, a circumference of a figure matched with the image data, for example, a circumference of an oval, and the like.

[0090] Therefore, according to an embodiment, when the object is the fetus, the thickness of the NT of the fetus or the FMF angle between the dorsum nasi and the palate of the fetus are measured from the ultrasound data determined as the sagittal view and thus, whether the fetus has an abnormality may be accurately diagnosed.

[0091] In this example, the measuring unit 150 may focus on the NT of the fetus or the first feature point and the second feature point in the ultrasound data, using a predetermined color or a predetermined line and may display the focused data around the seed.

[0092] The method according to the above-described embodiments of the present invention may be recorded in non-transitory computer readable media including program instructions to implement various operations embodied by a computer. The media may also include, alone or in combination with the program instructions, data files, data structures, and the like. Examples of non-transitory computer readable media include magnetic media such as hard disks, floppy disks, and magnetic tape; optical media such as CD ROM disks and DVDs; magneto-optical media such as optical disks; and hardware devices that are specially configured to store and perform program instructions, such as read-only memory (ROM), random access memory (RAM), flash memory, and the like. Examples of program instructions include both machine code, such as produced by a compiler, and files containing higher level code that may be executed by the computer using an interpreter.

Claims

1. A three-dimensional (3D) ultrasound system (100), the system (100) comprising:

   a scanner (110) configured to generate ultrasound data (220) including image data generated by scanning an object inside a human body;
   a processor (120) configured to detect a center point of the object from the generated ultrasound data (220), and to generate, on the ultrasound data (220), a virtual plane on which the detected center point is placed; and
   a controller (130) configured to match, with the image data included in the virtual plane, a figure corresponding to the image data, to rotate the ultrasound data (220) generated by the scanner by an angle between an axis constituting the matched figure and a predetermined reference axis so as to generate a sagittal view with respect to the object,
   wherein, when the object is a fetus (210), the controller (130) is configured to select, as the reference axis, a line defined by a falx being in a reference sagittal view image having a highest brightness intensity around a predetermined region around the center point among a plurality of reference sagittal view images.

2. The system (100) of claim 1, wherein, when the matched figure is an oval, the controller (130) rotates the ultrasound data to enable a major axis of the oval to be parallel with the predetermined reference axis.

3. The system (100) of claim 1, wherein, when the object is a fetus (210), the processor (120) performs:

   determining, from the generated ultrasound da-

ta (220), a first feature point associated with a dorsum nasi of the fetus (210);
determining, based on the first feature point, a second feature point associated with a palate of the fetus; and
detecting the center point of the object based on the determined second feature point.

4. The system (100) of claim 1, wherein, when the object is the fetus (210), the system (100) further comprises:
a measuring unit (150) to measure a thickness of a nuchal translucency (NT) (230) based on the determined sagittal view.

5. The system (100) of claim 1, wherein, when the object is the fetus (210), the system (100) further comprises:
a measuring unit (150) to measure, from the ultrasound data determined as the sagittal view, an angle between a first feature point associated with a dorsum nasi of the fetus (210) and a second feature point associated with a palate of the fetus (210).

6. The system (100) of claim 1, wherein the controller (130) finely rotates the ultrasound data based on a manipulation of an operator to redetermine the sagittal view.

7. A method of operating a 3D ultrasound system (100), the method comprising:

generating ultrasound data (220) including image data generated by scanning an object inside a human body;
detecting a center point of the object from the generated ultrasound data (220);
generating, on the ultrasound data (220), a virtual plane on which the detected center point is placed; and
matching, with the image data included in the virtual plane, a figure corresponding to the image data;
rotating the generated ultrasound data (220) by an angle between an axis constituting the matched figure and a predetermined reference axis so as to generate a sagittal view with respect to the object;
when the object is a fetus (210), selecting, as the reference axis, a line defined by a falx being in a reference sagittal view image having a highest brightness intensity around a predetermined region around the center point among a plurality of reference sagittal view images.

8. The method of claim 7, wherein, when the matched figure is an oval, the rotating comprises:
rotating the ultrasound data (210) to enable a major axis of the oval to be parallel with the predetermined reference axis.

Patentansprüche

1. Dreidimensionales (3D) Ultraschallsystem (100), wobei das System (100) Folgendes aufweist:

einen Scanner (110), der dafür vorgesehen ist, Ultraschalldaten (220) einschließlich durch Scannen eines Objekts innerhalb eines menschlichen Körpers erzeugten Bilddaten zu erzeugen;
einen Prozessor (120), der dafür vorgesehen ist, einen Mittelpunkt des Objekts aus den erzeugten Ultraschalldaten (220) zu detektieren und auf den Ultraschalldaten (220) eine virtuelle Ebene zu erzeugen, auf der der detektierte Mittelpunkt angeordnet ist; und
ein Steuergerät (130), das dafür vorgesehen ist, mit den in der virtuellen Ebene enthaltenen Bilddaten eine den Bilddaten entsprechende Figur abzugleichen bzw. diese aufeinander abzustimmen, um die von dem Scanner erzeugten Ultraschalldaten (220) um einen Winkel zwischen einer die abgeglichene Figur bildende Achse und einer vorbestimmten Referenzachse zu rotieren, um eine sagittale Ansicht in Bezug auf das Objekt zu erzeugen;
wobei, wenn es sich bei dem Objekt um einen Fötus (210) handelt, das Steuergerät (130) dafür vorgesehen ist, als die Referenzachse eine Linie auszuwählen, die durch eine Sichel definiert ist, die in einem Referenzsagittalansichtsbild vorhanden ist und eine höchste Helligkeitsintensität um einen vorbestimmten Bereich um den Mittelpunkt unter einer Vielzahl von Referenzsagittalansichtsbildern aufweist.

2. System (100) nach Anspruch 1, wobei, wenn die abgeglichene Figur ein Oval ist, das Steuergerät (130) die Ultraschalldaten rotiert, um es zu ermöglichen, dass eine Hauptachse des Ovals parallel mit der vorbestimmten Referenzachse ist.

3. System (100) nach Anspruch 1, wobei, wenn das Objekt ein Fötus (210) ist, das Steuergerät (120) Folgendes ausführt:

Ermitteln eines ersten Merkmalspunkts, der mit einem knöchernen Nasenrücken des Fötus (210) in Verbindung steht, aus den erzeugten Ultraschalldaten (220);
Ermitteln eines zweiten Merkmalspunkts, der mit einem Gaumen des Fötus in Verbindung steht, basierend auf dem ersten Merkmalspunkt; und

Detektieren des Mittelpunkts des Objekts basierend auf dem ermittelten zweiten Merkmalspunkt.

4. System (100) nach Anspruch 1, wobei, wenn das Objekt der Fötus (210) ist, das System (100) des Weiteren Folgendes aufweist:
eine Messeinheit (150), um eine Dicke einer Nackenfalte (NT) (230) basierend auf der ermittelten sagittalen Ansicht zu messen.

5. System (100) nach Anspruch 1, wobei, wenn das Objekt der Fötus (210) ist, das System (100) des Weiteren Folgendes aufweist:
eine Messeinheit (150) zum Messen, aus den als die Sagittalansicht ermittelten Ultraschalldaten, eines Winkels zwischen einem ersten Merkmalspunkt, der mit einem knöchernen Nasenrücken des Fötus (210) in Verbindung ist, und einem zweiten Merkmalspunkt, der mit einem Gaumen des Fötus (210) in Verbindung ist.

6. System (100) nach Anspruch 1, wobei das Steuergerät (130) die Ultraschalldaten basierend auf einer Handhabung einer Bedienperson fein rotiert, um die sagittale Ansicht wieder zu ermitteln.

7. Verfahren zum Betreiben eines 3D-Ultraschallsystems (100), wobei das Verfahren Folgendes aufweist:

Erzeugen von Ultraschalldaten (220) einschließlich durch Scannen eines Objekts innerhalb eines menschlichen Körpers erzeugten Bilddaten;
Detektieren eines Mittelpunkts des Objekts aus den erzeugten Ultraschalldaten (220);
Erzeugen einer virtuellen Ebene, auf welcher der detektierte Mittelpunkt angeordnet ist, auf den Ultraschalldaten (220); und
aufeinander Abstimmen bzw. Abgleichen einer den Bilddaten entsprechenden Figur mit den in der virtuellen Ebene enthaltenen Bilddaten;
Rotieren der erzeugten Ultraschalldaten (220) um einen Winkel zwischen einer Achse, welche die abgeglichene Figur bildet, und einer vorbestimmten Referenzachse, um eine sagittale Ansicht in Bezug auf das Objekt zu erzeugen;
wenn das Objekt ein Fötus (210) ist, Auswählen einer Linie als die Referenzachse, die durch eine Sichel definiert ist, die in einem Referenzsagittalansichtsbild vorhanden ist und eine höchste Helligkeitsintensität um einen vorbestimmten Bereich um den Mittelpunkt unter einer Vielzahl von Referenzsagittalansichtsbildern aufweist.

8. Verfahren nach Anspruch 7, wobei, wenn die abgeglichene Figur ein Oval ist, das Rotieren Folgendes aufweist:
Rotieren der Ultraschalldaten (210), um es zu ermöglichen, dass eine Hauptachse des Ovals parallel zu der vorbestimmten Referenzachse ist.

Revendications

1. Système ultrasonique (100) tridimensionnel (3D), le système (100) comprenant : un scanner (110) configuré pour générer des données ultrasoniques (220) comprenant des données d'image générées en scannant un objet à l'intérieur d'un corps humain ;
un processeur (120) configuré pour détecter un point central de l'objet à partir des données ultrasoniques générées (220), et pour générer, sur les données ultrasoniques (220), un plan virtuel sur lequel le point central détecté est placé ; et
un contrôleur (130) configuré pour faire correspondre, avec les données d'image incluses dans le plan virtuel, une figure correspondant aux données d'image, pour faire tourner les données ultrasoniques (220) générées par le scanner d'un angle entre un axe constituant la figure correspondante et un axe de référence prédéterminé de façon à générer une vue sagittale par rapport à l'objet,
dans lequel, lorsque l'objet est un foetus (210), le contrôleur (130) est configuré pour sélectionner, comme axe de référence, une ligne définie par une structure en forme de faucille se trouvant dans une image de vue sagittale de référence ayant une intensité de luminosité la plus élevée autour d'une région prédéterminée autour du point central parmi une pluralité des images de vue sagittale de référence.

2. Système (100) selon la revendication 1, dans lequel, lorsque la figure correspondante est un ovale, le contrôleur (130) fait tourner les données ultrasoniques pour permettre à un grand axe de l'ovale d'être parallèle à l'axe de référence prédéterminé.

3. Système (100) selon la revendication 1, dans lequel, lorsque l'objet est un foetus (210), le processeur (120) effectue :

la détermination, à partir des données ultrasoniques générées (220), d'un premier point caractéristique associé à un dorsum nasal du foetus (210) ;
la détermination, sur la base du premier point caractéristique, d'un deuxième point caractéristique associé à un palais du foetus ; et
la détection du point central de l'objet sur la base du second point caractéristique déterminé.

4. Système (100) selon la revendication 1, dans lequel, lorsque l'objet est le foetus (210), le système (100)

comprend en outre :
une unité de mesure (150) pour mesurer l'épaisseur d'une translucidité nucale (NT) (230) basée sur la vue sagittale déterminée.

5. Système (100) selon la revendication 1, dans lequel, lorsque l'objet est le foetus (210), le système (100) comprend en outre :
une unité de mesure (150) pour mesurer, à partir des données ultrasoniques déterminées en tant que vue sagittale, un angle entre un premier point caractéristique associé à un dorsum nasal du foetus (210) et un second point caractéristique associé à un palais du foetus (210).

6. Système (100) selon la revendication 1, dans lequel le contrôleur (130) tourne finement les données ultrasoniques sur la base d'une manipulation d'un opérateur pour redéfinir la vue sagittale.

7. Procédé de fonctionnement d'un système ultrasonique 3D (100), le procédé comprenant :

la génération de données ultrasoniques (220) comprenant des données d'image générées en scannant un objet à l'intérieur d'un corps humain;
la détection d'un point central de l'objet à partir des données ultrasoniques générées (220) :

la génération, sur les données ultrasoniques (220), d'un plan virtuel sur lequel le point central détecté est placé ; et
la mise en correspondance, avec les données d'image incluses dans le plan virtuel, d'une figure correspondant aux données d'image ;
la rotation des données ultrasoniques générées (220) d'un angle entre un axe constituant la figure correspondante et un axe de référence prédéterminé de manière à générer une vue sagittale par rapport à l'objet ;
lorsque l'objet est un foetus (210), la sélection, comme axe de référence, d'une ligne définie par une structure en forme de faucille se trouvant dans une image de vue sagittale de référence ayant une intensité de luminosité la plus élevée autour d'une région prédéterminée autour du point central parmi une pluralité d'images de vue sagittale de référence.

8. Procédé selon la revendication 7, dans lequel, lorsque la figure correspondante est un ovale, la rotation comprend :
la rotation des données ultrasoniques (210) pour permettre à un grand axe de l'ovale d'être parallèle à l'axe de référence prédéterminé.

FIG. 1

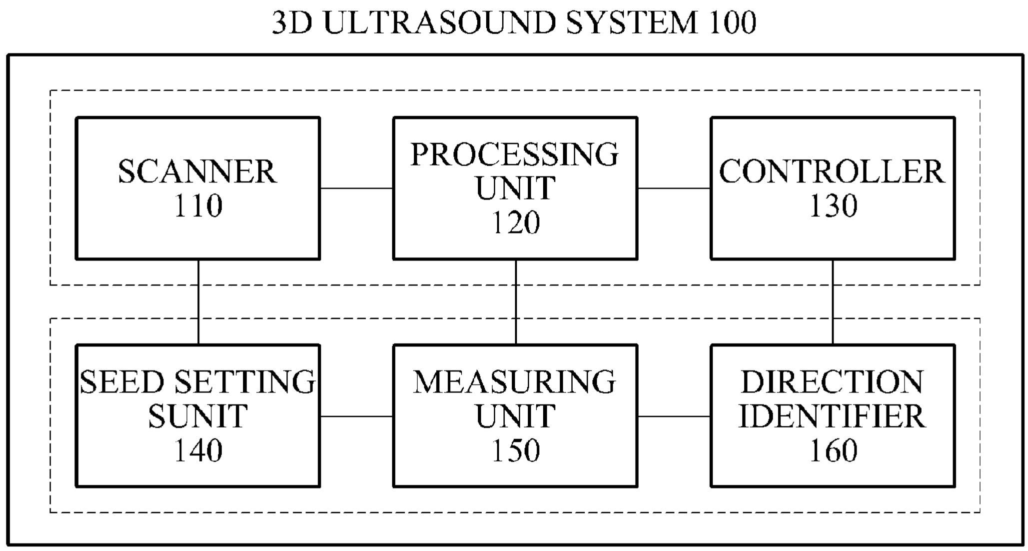
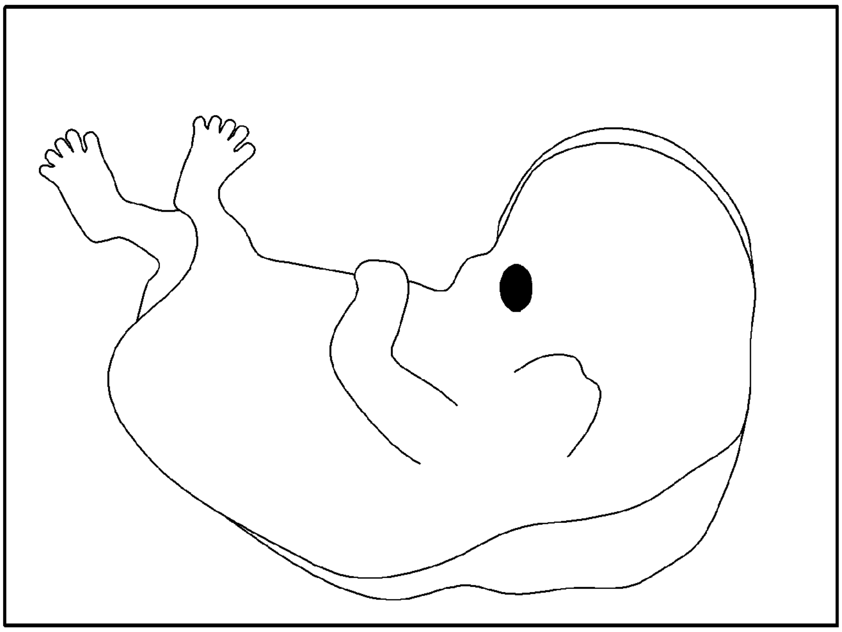

3D ULTRASOUND SYSTEM 100
SCANNER 110
PROCESSING UNIT 120
CONTROLLER 130
SEED SETTING SUNIT 140
MEASURING UNIT 150
DIRECTION IDENTIFIER 160

FIG. 2

210



220

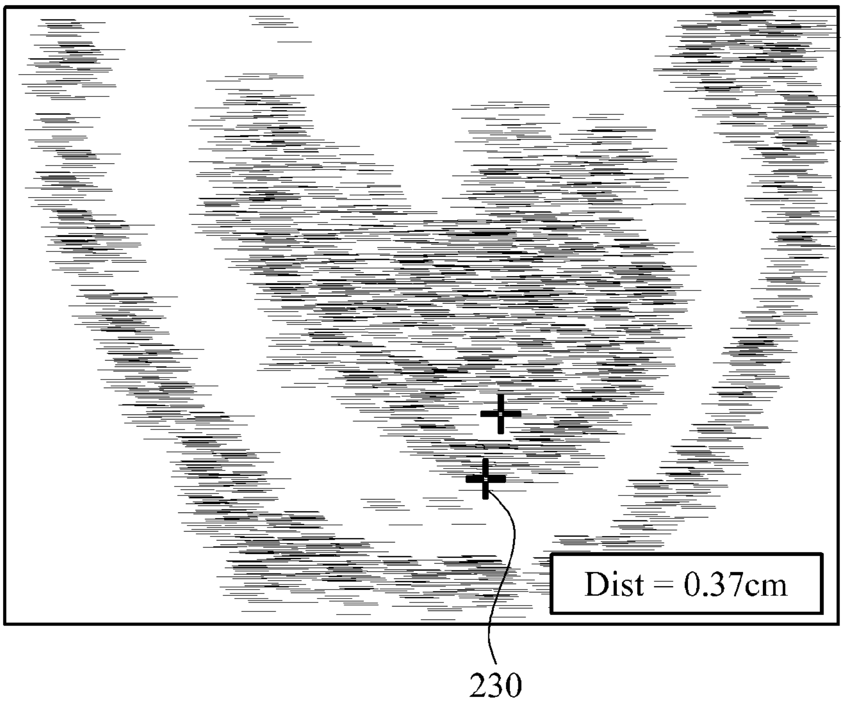


FIG. 3

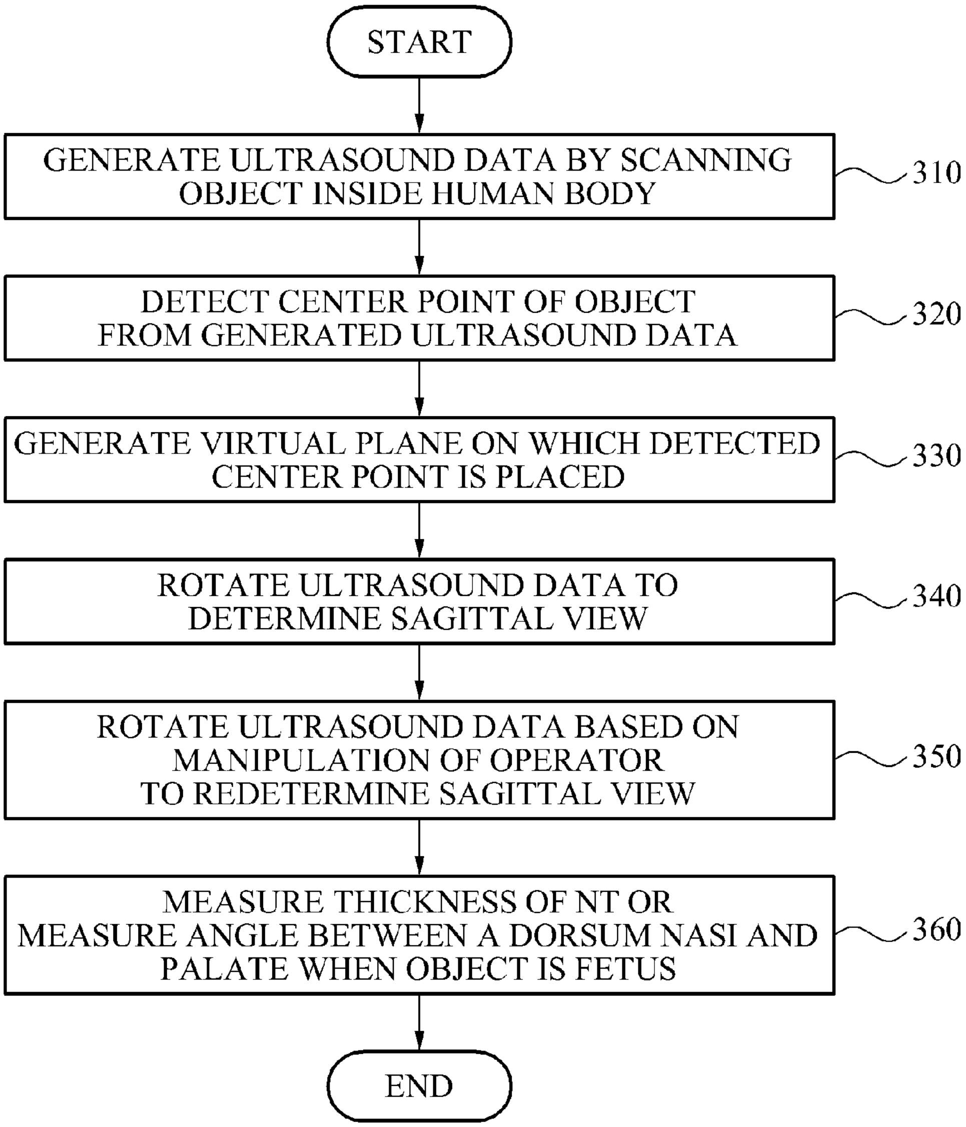
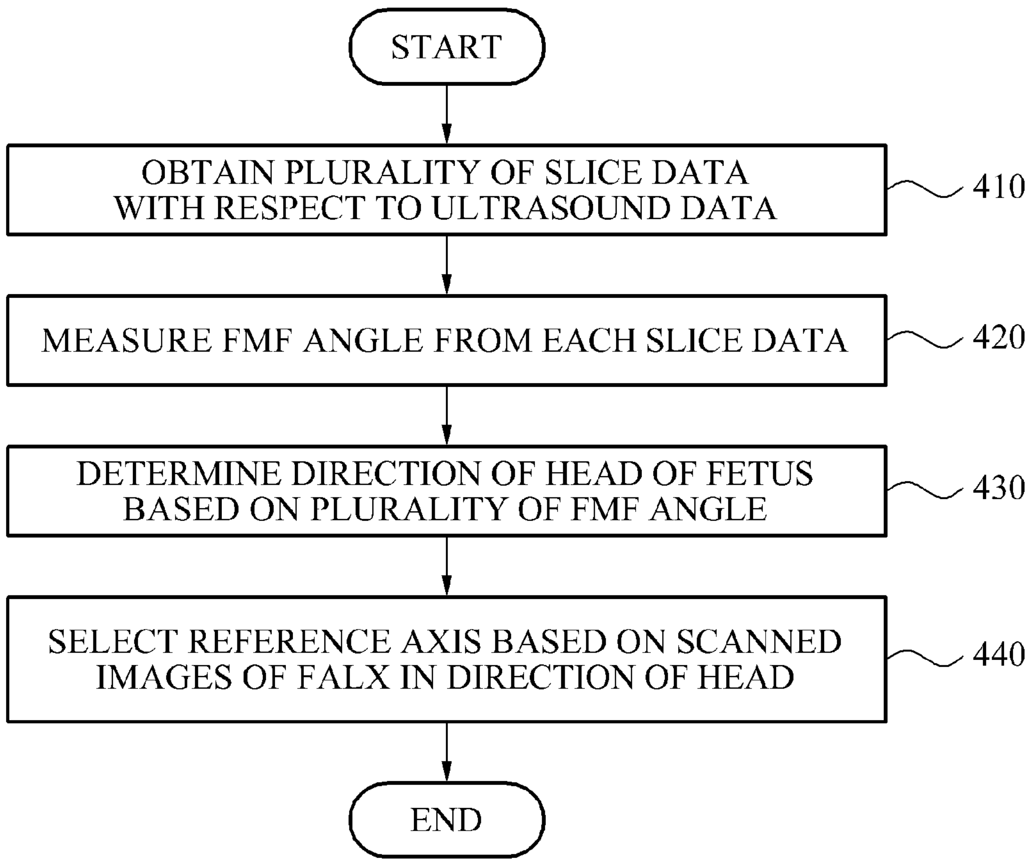

START
GENERATE ULTRASOUND DATA BY SCANNING OBJECT INSIDE HUMAN BODY
310
DETECT CENTER POINT OF OBJECT FROM GENERATED ULTRASOUND DATA
320
GENERATE VIRTUAL PLANE ON WHICH DETECTED CENTER POINT IS PLACED
330
ROTATE ULTRASOUND DATA TO DETERMINE SAGITTAL VIEW
340
ROTATE ULTRASOUND DATA BASED ON MANIPULATION OF OPERATOR TO REDETERMINE SAGITTAL VIEW
350
MEASURE THICKNESS OF NT OR MEASURE ANGLE BETWEEN A DORSUM NASI AND PALATE WHEN OBJECT IS FETUS
360
END

FIG. 4


START
OBTAIN PLURALITY OF SLICE DATA WITH RESPECT TO ULTRASOUND DATA
410
MEASURE FMF ANGLE FROM EACH SLICE DATA
420
DETERMINE DIRECTION OF HEAD OF FETUS BASED ON PLURALITY OF FMF ANGLE
430
SELECT REFERENCE AXIS BASED ON SCANNED IMAGES OF FALX IN DIRECTION OF HEAD
440
END

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2008188748 A1 **[0010]**
- US 2007081705 A1 **[0011]**

Non-patent literature cited in the description

- **CHUNG B L et al.** The application of three-dimensional ultrasound to nuchal translucency measurement in early pregnancy (10-14 weeks): a preliminary study. *ULTRASOUND IN OBSTETRICS AND GYNECOLOGY,* 01 February 2000, vol. 15 (2), ISSN 0960-7692, 122-125 **[0009]**

patsnap

专利名称(译)	用于扫描人体内物体的三维（3D）超声系统和操作三维超声系统的方法		
公开(公告)号	EP2365356B1	公开(公告)日	2018-07-25
申请号	EP2011150363	申请日	2011-01-07
[标]申请(专利权)人(译)	三星麦迪森株式会社		
申请(专利权)人(译)	三星MEDISON CO.，LTD.		
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IPC分类号	G01S15/89 G01S7/52 A61B8/00 A61B8/08 A61B8/14 G06T7/60 G06T19/00		
CPC分类号	A61B8/0866 A61B8/145 A61B8/483 A61B8/54 G01S7/52063 G01S15/8993 G06T7/60 G06T19/00 G06T2207/10136 G06T2207/30044 G06T2210/41 G06T2219/008 G06T2219/2016		
代理机构(译)	SCHMID，WOLFGANG		
优先权	1020100021136 2010-03-10 KR 1020100049028 2010-05-26 KR		
其他公开文献	EP2365356A2 EP2365356A3		
外部链接	Espacenet		

摘要(译)

提供了一种三维（3D）超声系统和3D超声系统操作方法，其可以获得关于人体内的对象的3D超声数据，以确定准确的矢状视图。 3D超声系统可以包括：扫描仪，用于生成超声数据，包括通过扫描人体内的对象生成的图像数据;处理单元，用于从生成的超声数据中检测对象的中心点，以及生成超声数据，其上放置检测到的中心点的虚拟平面，以及基于虚拟平面中包括的图像数据旋转超声数据的控制器，并确定相对于对象的矢状视图。

FIG. 1