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

(11) **EP 3 082 611 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
**14.08.2019 Bulletin 2019/33**

(21) Application number: **14820815.0**

(22) Date of filing: **15.12.2014**

(51) Int Cl.:
***A61B 8/00*** *(2006.01)* ***G06T 7/00*** *(2017.01)*
***A61B 8/08*** *(2006.01)*

(86) International application number:
**PCT/EP2014/077775**

(87) International publication number:
**WO 2015/091368 (25.06.2015 Gazette 2015/25)**

# (54) ULTRASOUND IMAGING ASSEMBLY AND METHOD FOR DISPLAYING ULTRASOUND IMAGES

ULTRASCHALLBILDGEBUNGSANORDNUNG UND VERFAHREN ZUM ANZEIGEN VON ULTRASCHALLBILDERN

ENSEMBLE D'IMAGERIE À ULTRASONS ET PROCÉDÉ POUR AFFICHER DES IMAGES ULTRASONORES

(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: **20.12.2013 EP 13306807**

(43) Date of publication of application:
**26.10.2016 Bulletin 2016/43**

(73) Proprietor: **Koninklijke Philips N.V.**
**5656 AE Eindhoven (NL)**

(72) Inventors:
- **AUVRAY, Vincent Maurice André**
  **NL-5656 AE Eindhoven (NL)**
- **CUINGNET, Remi Nicolas Thierry**
  **NL-5656 AE Eindhoven (NL)**
- **ARDON, Roberto José**
  **NL-5656 AE Eindhoven (NL)**

(74) Representative: **Steffen, Thomas**
**Philips Intellectual Property & Standards**
**High Tech Campus 5**
**5656 AE Eindhoven (NL)**

(56) References cited:
**WO-A1-2010/017508**
**JP-A- 2003 325 514**
**JP-A- 2010 207 492**
**US-A1- 2003 161 513**
**US-A1- 2005 113 695**
**US-A1- 2012 243 757**



EP 3 082 611 B1

## Description

### FIELD OF THE INVENTION

**[0001]** The present invention relates to an ultrasound imaging assembly for ultrasound imaging. The present invention further relates to a method for displaying ultrasound images. Finally, the present invention relates to an ultrasound transducer assembly including ultrasound transducer elements for transmitting and receiving ultrasound waves.

### BACKGROUND OF THE INVENTION

**[0002]** In the field of ultrasound imaging, it is generally known that the ultrasound images are subjected to different artifacts, which have to be distinguished from anatomic objects in the volume of interest in order to provide a reliable medical examination of a patient. One of the most important artifacts are the acoustic shadows. The ultrasound images are based on the propagation and interaction of ultrasound waves in tissues and anatomic objects of various acoustic impedances. At the boundaries of two materials having different impedances, the ultrasound waves are transmitted, reflected, dispersed or diffracted. If the acoustic energy is almost totally reflected or dispersed, an acoustic shadow appears in an area of the volume of interest beyond the respective boundary. These shadowed areas may cause major issues, since these shadowed areas are totally obscured in the respective ultrasound image and may hide an area of interest.

**[0003]** Due to the different anatomic properties, some organs or regions of the human body are difficult to analyze without introducing acoustic shadows because the ultrasound probe has to be positioned at the thorax so that the acoustic waves are reflected or dispersed at the ribs and the areas beyond are obscured by the resulting acoustic shadow.

**[0004]** In the field of ultrasound imaging, it is known to detect acoustic shadows within the ultrasound image automatically and to correct the shadowed areas within the ultrasound image for example by overlaying different ultrasound images. It is further known from US 2012/0243757 A1 to detect the shadowed areas and to display merely those ultrasound images which show a reduced amount of shadowed areas.

**[0005]** Hence, the known ultrasound imaging systems do not distinguish shadowed areas from anatomic objects, however the operator has to make sure that the shadowed areas do not obscure a region of interest, which is important for the medical examination.

**[0006]** JP 2010 207492 A, which forms the basis for the preamble of claim 1, discloses an ultrasonic diagnostic apparatus for detecting a shadow in an ultrasonic image. The apparatus includes a shadow detecting section for detecting the shadow included in the reception beams formed in a reception beam former. The shadow detecting section forms an echo change signal indicating the magnitude of a change in the echo signal for every reception beam, detects the position of a hard tissue such as a bone on the reception beam based on the echo change signal and detects the shadow formed on a region deeper than the detected position.

**[0007]** JP 2003 325514 A discloses an ultrasound diagnostic apparatus to which a cross-section in an optional direction can properly be set in a relation with a noticing tissue within a subject.

### SUMMARY OF THE INVENTION

**[0008]** It is an object of the present invention to provide an improved ultrasound imaging assembly, in particular for 3D ultrasound imaging, having improved imaging conditions so that a more reliable examination is possible. It is further an object of the present invention to provide a corresponding method for ultrasound imaging.

**[0009]** In a first aspect of the present invention, an ultrasound imaging assembly according to claim 1 is provided comprising:

- an image processing unit for real time receiving and for evaluating at least one set of ultrasound data resulting from an ultrasound scan of a volume of interest and for providing corresponding image data on the basis of the ultrasound data,
- a display unit for displaying an ultrasound image on the basis of the image data,
- an evaluation unit adapted to detect a shadowed area and its position within the volume of interest on the basis of the ultrasound data,

wherein the image processing unit is adapted to determine ultrasound image data of a plurality of different two-dimensional slices of the shadowed area, wherein the slices are disposed in a transverse direction to each other, and wherein the display unit is adapted to simultaneously display graphical representations of a corresponding sectional views of the detected shadowed area within each of the ultrasound image data corresponding to the respective two-dimensional slice.

**[0010]** In a further aspect of the present invention, a method for displaying ultrasound images is provided according to claim 8 comprising the steps of:

- receiving at least one set of ultrasound data resulting from an ultrasound scan of a volume of interest,
- evaluating the at least one set of ultrasound data,
- providing corresponding image data on the basis of the ultrasound data,
- displaying an ultrasound image on a display unit on the basis of the image data,
- detecting whether a shadowed area is present and its position within the volume of interest on the basis of the ultrasound data, and
- determining ultrasound image data of a two-dimen-

sional slice of the shadowed area, wherein the slices are disposed in a transverse direction to each other, and displaying graphical representations of corresponding sectional views of the detected shadowed area within the ultrasound image data corresponding to the respective two-dimensional slice on the display unit.

**[0011]** In a still further aspect of the present invention, an ultrasound transducer assembly is provided comprising an ultrasound transducer unit including the plurality of ultrasound transducer elements for transmitting and receiving ultrasound waves and an ultrasound imaging assembly of this kind for evaluating and displaying ultrasound data received from the ultrasound transducer unit.

**[0012]** Preferred embodiments of the invention are defined in the dependent claims. It should be understood that the claimed method has similar and/or identical preferred embodiments as the claimed device and as defined in the dependent claims.

**[0013]** The present invention is based on the idea to determine whether a shadowed area or a plurality of shadowed areas are present within the volume of interest by evaluating the ultrasound data and to indicate on the display unit whether a shadowed area has been detected within the volume of interest and to determine image data of a two-dimensional slice of the shadowed area and to display a corresponding sectional view of the shadowed area in order to indicate that certain regions of interest are obscured and where the obscured areas are located. The operator can consider the ultrasound data and can verify whether the region of interest is obscured or a high quality ultrasound image is provided. Hence, the operator is able to ensure that the region of interest is analyzed with an optimal quality and no acoustic shadows obscure the region of interest so that the overall reliability of the medical examination is increased.

**[0014]** In a preferred embodiment, the display unit is further adapted to indicate whether no shadowed area has been detected within the volume of interest. This is a possibility to indicate to the operator that high quality images are displayed and no area is obscured.

**[0015]** In a preferred embodiment, the display unit is adapted to indicate whether a shadowed area has been detected within the volume of interest.

**[0016]** In a preferred embodiment, a warning message is displayed on the display unit. This is a simple possibility to indicate that a shadowed area has been detected.

**[0017]** In a preferred embodiment, the evaluation unit is adapted to detect a position of the shadowed area within the volume of interest and the display unit is adapted to display a graphical representation of the shadowed area within an ultrasound image. This is a possibility to reduce the duration of the analysis, since the position of the shadowed area is displayed so that the operator can easily decide whether a detailed analysis is necessary.

**[0018]** In a preferred embodiment, the evaluation unit is adapted to determine a size of the detected shadowed area and the display unit is adapted to display a graphical representation corresponding to the size of the shadowed area within the ultrasound image. This is a possibility to indicate the quality of the ultrasound image, since the size of the shadowed area with respect to the size of the ultrasound image can be considered by the operator.

**[0019]** In a preferred embodiment, the evaluation unit is adapted to detect a plurality of shadowed areas within the volume of interest and the display unit is adapted to display at least one sectional view of one of at least one of the shadowed areas. This is a possibility to identify separately different shadowed areas within the volume of interest and to quickly assess the relevance of the shadows.

**[0020]** It is preferred if the sectional views of the shadowed areas are displayed simultaneously or successively for a predefined time or on demand by the operator so that all shadowed areas can be displayed in detail. This is a possibility to increase the reliability of the medical examination since each shadowed area can be assessed in detail.

**[0021]** In a preferred embodiment, the two-dimensional slice is a plane within the volume of interest parallel to a direction of propagation of ultrasound waves of the ultrasound scan. This is a simple possibility to display the ultrasound image corresponding to standard ultrasound views of the region of interest so that the operator can easily determine whether relevant areas are obscured.

**[0022]** In a preferred embodiment, the imaging processing unit is adapted to determine image data of a plurality of different two-dimensional slices of the shadowed area, wherein the slices are disposed in a transverse direction to each other. This is a possibility to determine the three-dimensional extent of the shadowed area so that the operator can easily determine whether a region of interest is obscured.

**[0023]** In a preferred embodiment, the display unit is adapted to display the different sectional views of the shadowed areas. This is a possibility to display simultaneously the sectional views corresponding to the different two-dimensional slices so that the operator can easily determine whether anatomic objects are obscured by the shadowed area.

**[0024]** In a preferred embodiment, the positions of the different two-dimensional slices of the shadowed area are determined by an operator. This is a possibility to individually determine the two-dimensional slices within the ultrsound image.

**[0025]** In a preferred embodiment, the display unit is adapted to highlight the graphical representation of the shadowed area within the displayed ultrasound image. This is a simple possibility to indicate the position of the shadowed area so that the operator can easily determine whether a region of interest is obscured by the shadowed area.

**[0026]** In a preferred embodiment, the evaluation unit is adapted to identify anatomical objects within the volume of interest and the display unit is adapted to indicate

the identified anatomical objects within the ultrasound image. This is a further possibility to increase the reliability of the ultrasound imaging, since a warning message can be displayed to inform the operator that a part of a given anatomical object is obscured. In a further preferred embodiment, the portion of the anatomical object that is obscured can also be quantified.

**[0027]** In a preferred embodiment, the image processing unit is adapted to determine image data of a plan view of the shadowed area corresponding to a direction of propagation of the ultrasound waves and the display unit is adapted to display the plan view image data. This is a further possibility to improve the reliability of the ultrasound imaging and the clinical examination, since the shadowed areas can be displayed in a plan view so that the operator can easily understand the geometrical location of the shadow.

**[0028]** In a preferred embodiment, the evaluation unit is adapted to determine a size of the shadowed area in a direction of propagation of the ultrasound waves, and wherein the display unit is adapted to display the size of the shadowed area in the plan view image data. This is a possibility to display the size of the shadowed area in the plan view image so that the operator can easily understand the spatial extend and the spatial position of the shadow. It is further preferred to display the size of the shadowed area in the plan view color-coded.

**[0029]** As mentioned above, since the display unit is adapted to indicate whether a shadowed area has been detected within the volume of interest or not, the operator can easily determine whether a region of interest is obscured by the shadowed area so that the reliability of the medical examination is improved. Due to the visualization of the shadowed area within the ultrasound image, the extent or the position of the shadows can help to locate the shadowed area and to distinguish whether anatomical objects or shadowed areas are visible within the ultrasound image. By means of the two-dimensional slices and the respective sectional views of the volume of interest, the operator can easily determine the position of the shadows on the basis of the standard views of the ultrasound image system. Consequently, the reliability of the ultrasound image examination is improved and the duration of the examination can be reduced.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0030]** These and other aspects of the invention will be apparent from and elucidated with reference to the embodiment(s) described hereinafter. In the following drawings

Fig. 1 shows a schematic representation of an ultrasound imaging system in use to scan a volume of a patient's body;

Figs. 2a, b show a schematic illustration of a three-dimensional raw ultrasound image and an ultrasound image including a displayed shadow;

Figs. 3a-c show schematic illustrations of two-dimensional slices of the shadow of the three-dimensional ultrasound image shown in Fig. 2a, b;

Fig. 4 shows a schematic view of a three-dimensional ultrasound image including a three-dimensional representation of a detected shadowed area; and

Figs. 5a-c show a graphical representation of the shadowed area and two sectional views corresponding to a selected position of the shadowed area.

## DETAILED DESCRIPTION OF THE INVENTION

**[0031]** Fig. 1 shows a schematic illustration of an ultrasound system 10 according to an embodiment, in particular a medical three-dimensional (3D) ultrasound imaging assembly. The ultrasound imaging assembly 10 is applied to inspect a volume of interest of an anatomical side, in particular an anatomical side of a patient 12. The ultrasound imaging assembly 10 comprises an ultrasound probe 14 having at least one transducer array having a multitude of transducer elements for transmitting and/or receiving ultrasound waves. In one example, the transducer elements each can transmit ultrasound waves in form of at least one transmit impulse of a specific pulse duration, in particular a plurality of subsequent transmit pulses. The transducer elements are preferably arranged in a one-dimensional string or a two-dimensional array, in particular for providing a multi-planar or a three-dimensional image.

**[0032]** A 3D ultrasound scan typically involves emitting ultrasound waves that illuminate a particular volume within a body, which may be designated as volume of interest. This can be achieved by emitting ultrasound waves at multiple different angles. A set of volume data is then obtained by receiving and processing reflected waves. The set of volume data are a representation of a target volume within the patient's body.

**[0033]** It shall be understood that the ultrasound probe 14 may either be used in a non-invasive manner (as shown in Fig. 1) or in an invasive manner as this is usually done in TEE (not explicitly shown). The ultrasound probe 14 may be hand-held by the user of the system, for example medical staff or a doctor. The ultrasound probe 14 is applied to the body of the patient 12 so that an image of an anatomical side, in particular an anatomical object of the patient is provided.

**[0034]** Further, the ultrasound assembly may comprise a control unit 16 that controls the provision of an ultrasound image via the ultrasound assembly 10. The control unit 16 drives the ultrasound probe 14 and in particular the transducer elements for emitting the ultrasound waves and receives ultrasound data from the transducer elements of the ultrasound probe 14 in order to provide ultrasound images on the basis of the ultrasound data. The ultrasound assembly 10 may further comprise a display 18 for displaying the ultrasound image to the user. Still further, an input device may be provided that may comprise keys or a keyboard 22 and further inputting

devices, for example a trackball 24. The input device 20 might be connected to the display 18 or directly to the control unit 16.

**[0035]** The control unit 16 comprises an image processing unit 26 for receiving the ultrasound data from the ultrasound probe 14 and for evaluating the ultrasound data. The image processing unit 26 provides image data corresponding to the ultrasound data received from the ultrasound probe 14. The control unit 16 further comprises an evaluation unit 28, which receives the ultrasound data from the ultrasound probe 14 and detects a shadowed area within the volume of interest as described in the following.

**[0036]** The evaluation unit 28 receives the ultrasound data from the ultrasound probe 14 and detects shadowed areas within the volume of interest. The shadowed areas are usually identified on the basis of a linear scan of the transducer array or a planar scan, wherein the intensity of the received ultrasound waves dependent on the detection angle of the ultrasound probe 14 is evaluated.

**[0037]** In a first step, a discussion is performed line by line. Suspected shadow segments are identified where the intensity of the received ultrasound waves presents a signature typical for shadows: while a first part of the signals present real anatomical information resulting in varying displayed intensities, e.g. a succession of bright or dark regions, a sudden decay is observed, followed by a long uniform very dark region.

**[0038]** In a second step, a 3D consolidation is performed: a shadow is detected only if a group of shadow segments with similar lengths are suspected in the same neighborhood.

**[0039]** If a shadowed area is detected in the ultrasound data, the evaluation unit 28 provides the information to the display unit 18 or to the image processing unit 26 so that the presence of the shadowed area can be displayed on the screen of the display unit 18. If no shadowed area is detected, this information may be also be indicated on the display screen. Alternatively, the presence of a shadowed area my be indicated on the display screen by highlighting a graphical representation of the border of the shadowed area within a three-dimensional or two-dimensional ultrasound image or by a three-dimensional representation of the shadowed area in a three-dimensional ultrasound image as described in detail in the following.

**[0040]** In the following, the indication of the shadowed areas is described for three-dimensional ultrasound image systems, however, the indication of the shadowed areas may also be provided for two-dimensional ultrasound image systems.

**[0041]** In Fig. 2a a typical three-dimensional ultrasound image is schematically shown and generally denoted by 30. The data is represented using the maximum intensity projection method (MIP). At each pixel the highest value of the volume is shown crossed by the eye of an observer that looks in the particular direction. The ultrasound data is received from a volume of interest 31 of the patient 12. Due to the multi-planar or three-dimensional illustration of the ultrasound data, shadows are difficult to identify in the three-dimensional ultrasound image 30. In Fig. 2b, the three-dimensional ultrasound image 30 is shown and a shadowed area is indicated in the image and generally denoted by 32. The shadowed area is without any indication not visible in the three-dimensional ultrasound image 30, since the different planes of the ultrasound measurements or the three-dimensional illustration of the ultrasound data hide the shadowed area 32, which may be visible more easily in a two-dimensional standard ultrasound image. The evaluation unit 28 detects the shadowed area 32 by evaluating the ultrasound data received from the ultrasound probe 14 and displays the presence of the shadowed area 32 on the display screen of the display unit 18. The indication of the shadowed area 32 may be a simple warning message displayed on the display screen so that the user can browse into the volume of interest 31 to assess whether the shadowed area 32 obscures a certain region of interest within the volume of interest 31. Additionally, the warning message may include further information on the extent and/or the position of the detected shadowed area 32.

**[0042]** In Fig. 3a-c, a preferred embodiment of the illustration of the shadowed area 32 in different slices is schematically shown. The image processing unit 26 provides two-dimensional slices of the volume of interest 31 including the detected shadowed area 32 so that the position and the size of the shadowed area 32 can be easily identified and distinguished from anatomical objects within the volume of interest 31. The shadowed area is in this certain embodiment indicated or highlighted by illustrating the border of the shadowed area 32. The two-dimensional slices shown in Fig. 3a and 3b are planes directed in parallel to the propagation direction of the ultrasound waves within the volume of interest 31. These two-dimensional slices show a sectional view of the volume of interest 31 corresponding to a standard two-dimensional view of an ultrasound image. The slices may be disposed in the shadowed area vertically to each other or in a different angle to each other. The slices are preferably determined automatically, however the operator may also determine the position of the slices individually e.g. by a cursor. Fig. 3a, b show that the so highlighted shadowed area 32 can be easily identified by the operator and easily distinguished from anatomical objects within the volume of interest 31. By this indication of the shadowed area 32, the operator can easily determine whether the region of interest is obscured by the shadowed area 32 and whether a different analysis or a different position of the ultrasound probe 14 may be necessary to achieve a reliable image from the region of interest. In Fig. 3c a two-dimensional plan view of the volume of interest 31 is schematically shown. The plan view is a viewing direction parallel to the propagation direction of the ultrasound waves, wherein the shadowed area 32 is highlighted by indicating the borders of the shadowed area 32.

**[0043]** In the case that more than one shadowed area 32 is detected, the ultrasound imaging assembly 10 may

display the most relevant shadowed area 32, e.g. on the basis of the size or the position of the shadowed area 32. In that case, the user does not have to interact with the ultrasound imaging assembly by means of the input device 20 and can leave the ultrasound probe 14 in place. Alternatively, all detected shadowed areas 32 can be displayed in the two-dimensional sectional or plan views either simultaneously or successively. The shadowed areas 32 may be displayed for a couple of seconds or on demand of the operator to switch between the different shadowed areas 32. In that case also different two-dimensional slices and sectional views or plan views of the shadowed areas 32 may be displayed on the display screen of the display unit 18.

**[0044]** In Fig. 4 a three-dimensional representation of the ultrasound data is schematically shown. The volume of interest 31 is displayed as a cone, wherein the shadowed area 32 is displayed as a three-dimensional representation within the volume of interest 31. The three-dimensional representation shown in Fig. 4 is a virtual three-dimensional image displayed on a two-dimensional display screen, wherein a three-dimensional illustration can be achieved by rotating the respective image. In the three-dimensional representation shown in Fig. 4, further reference objects or anatomic objects may be highlighted in order to help the understanding of the three-dimensional volume of interest 31 and to understand which part of the volume of interest is obstructed by the shadowed area 32. It provides also a clear representation for the clinician to immediately understand where the suspected region lies geographically. He can then navigate efficiently to the interesting slices. Alternatively, a tool can be provided that displays automatically the corresponding slices when he clicks over the representation shown in Fig.4. The anatomic objects may be organs or bones within the patient's body 12. A warning message can be provided if one anatomical object is obscured or partially obscured. The portion of the anatomical object that is obscured can be quantified and the amount of the obscured portion can be displayed on the display screen e.g. 30% of the kidney is obscured by a shadow. The warning message may be provided if a certain amount of an anatomic object is obscured such as a threshold level, e.g. if more than 20% of the kidney is obscured by a shadow.

**[0045]** In Fig. 5 a further embodiment of displaying the shadowed area 32 is schematically shown. The shadowed area is displayed in a plan view corresponding to a viewing direction parallel to the propagation direction of the ultrasound waves. The plan view is shown in Fig. 5a, wherein the shadowed area 32 may be displayed or highlighted color-coded so that the shadowed area 32 can be easily identified. The color code of the plan view image shown in Fig 5a represents the depth or the length of the shadowed area. The depth or the length of the shadowed area in the direction of the propagation of the ultrasound waves is measured or detected and indicated in the color-coded image. The non-shadowed area is not-colored e.g. black or white.

**[0046]** In order to analyze the depth of the shadowed area 32, two-dimensional slices through the shadowed area 32 can be provided additionally as a sectional view corresponding to a standard view of ultrasound images which are schematically shown in Fig. 5b and 5c. The position of the slices may be determined automatically by means of the ultrasound imaging assembly or may be selected by the operator by means of the cursor 34.

**[0047]** The two-dimensional slices shown in Fig. 5b and c are planes within the volume of interest 31 which are disposed orthogonal to each other or in different angles e.g. 30°. The two-dimensional slice shown in Fig. 5b corresponds to the x direction and the slice shown in Fig. 5c corresponds to the y direction of the plan view shown in Fig. 5a. By means of these different two-dimensional slices and the corresponding sectional views, the depth of the shadowed area 32 can be easily visualized, wherein the size and the depth do not need to be certainly displayed in the sectional views shown in Fig. 5b and c.

**[0048]** The synthetic representation shown in Figs. 4 and 5 may be combined with the visualization of the slices shown in Figs. 3a, b. The displaying of the shadowed areas 32 may be provided in real time during the ultrasound examination process so that the operator may move the ultrasound probe 14 to a different position so that the shadowed area 32 is moved to a different position, so that the respective area of interest is not obscured. Further, other artifacts which obscure certain areas within the ultrasound image may be detected and displayed, e.g. dirty shadowing, comet tails or the like.

**[0049]** While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims.

**[0050]** In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. A single element or other unit may fulfill the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

**[0051]** Any reference signs in the claims should not be construed as limiting the scope.

## Claims

**1.** An ultrasound imaging assembly (10), comprising:

- an image processing unit (26) for real time receiving and for evaluating at least one set of ul-

trasound data resulting from an ultrasound scan of a volume of interest (31) and for providing corresponding image data on the basis of the ultrasound data,
- a display unit (18) for displaying an ultrasound image (30) on the basis of the image data,
- an evaluation unit (28) adapted to detect a shadowed area (32) and its position within the volume of interest (31) on the basis of the ultrasound data,

**characterized in that** the image processing unit is adapted to determine ultrasound image data of a plurality of different two-dimensional slices of the shadowed area, wherein the slices are disposed in a transverse direction to each other, and wherein the display unit is adapted to simultaneously display graphical representations of corresponding sectional views of the detected shadowed area within each of the ultrasound image data corresponding to the respective two-dimensional slice.

**2.** The ultrasound imaging assembly as claimed in claim 1, wherein the evaluation unit is adapted to determine a size of the detected shadowed area and wherein the display unit is adapted to display a graphical representation corresponding to the size of the shadowed area within the ultrasound image.

**3.** The ultrasound imaging assembly as claimed in claim 1, wherein the evaluation unit is adapted to detect a plurality of shadowed areas within the volume of interest and wherein the display unit is further adapted to display sectional views of the plurality of the shadowed areas.

**4.** The ultrasound imaging assembly as claimed in claim 1, wherein positions of the different two-dimensional slices of the shadowed area are determined by an operator.

**5.** The ultrasound imaging assembly as claimed in claim 1, wherein the display is adapted to highlight the graphical representation of the shadowed area within the displayed ultrasound image.

**6.** The ultrasound imaging assembly as claimed in claim 1, wherein the image processing unit is further adapted to determine image data of a plan view of the shadowed area corresponding to a direction of propagation of the ultrasound waves and wherein the display unit is adapted to display the plan view image data.

**7.** The ultrasound imaging assembly as claimed in claim 6, wherein the evaluation unit is adapted to determine a size of the shadowed area in a direction of propagation of the ultrasound waves, and wherein the display unit is adapted to display the size of the shadowed area in the plan view image data.

**8.** Method for displaying ultrasound images (30) comprising the steps of:

- receiving in real-time at least one set of ultrasound data resulting from an ultrasound scan of a volume of interest (31),
- evaluating the at least one set of ultrasound data,
- providing corresponding image data on the basis of the ultrasound data,
- displaying an ultrasound image on a display unit (18) on the basis of the image data, and
- detecting whether a shadowed area (32) is present and its position within the volume of interest on the basis of the ultrasound data,

**characterized in that** the method further comprises the steps of:

- determining ultrasound image data of a plurality of different two-dimensional slices of the shadowed area, wherein the slices are disposed in a transverse direction to each other, and simultaneously displaying graphical representations of corresponding sectional views of the detected shadowed area within the ultrasound image data of each of the plurality of two-dimensional slices on the display unit.

**9.** An ultrasound transducer assembly, comprising an ultrasound transducer unit (14) including a plurality of ultrasound transducer elements for transmitting and receiving ultrasound waves and an ultrasound imaging assembly (10) as claimed in claim 1 for evaluating and displaying ultrasound data received from the ultrasound transducer unit.

**Patentansprüche**

**1.** Ultraschall-Bildgebungsanordnung (10), umfassend:
eine Bildverarbeitungseinheit (26) zum Echtzeitempfangen und Auswerten mindestens eines Satzes von Ultraschalldaten, die aus einer Ultraschallabtastung eines Volumens von Interesse (31) resultieren und zum Bereitstellen entsprechender Bilddaten auf der Basis der Ultraschalldaten,

- eine Anzeigeeinheit (18) zum Anzeigen eines Ultraschallbildes (30) auf der Basis der Bilddaten,
- eine Auswertungseinheit (28), die dazu ausgelegt ist, um einen schattierten Bereich (32) und seine Position innerhalb des Volumens von

Interesse (31) auf der Basis der Ultraschalldaten zu erfassen,
- **dadurch gekennzeichnet, dass** die Bildverarbeitungseinheit dazu ausgelegt ist, um Ultraschallbilddaten einer Vielzahl von unterschiedlichen zweidimensionalen Scheiben des schattierten Bereichs zu bestimmen, wobei die Scheiben in einer Querrichtung zueinander angeordnet sind und wobei die Anzeigeeinheit dazu ausgelegt ist, um gleichzeitig grafische Darstellungen entsprechender Schnittansichten des erfassten schattierten Bereichs in jedem der Ultraschallbilddaten anzuzeigen, die der jeweiligen zweidimensionalen Scheibe entsprechen.

**2.** Ultraschall-Bildgebungsanordnung nach Anspruch 1, wobei die Auswertungseinheit dazu ausgelegt ist, um eine Größe des erfassten schattierten Bereichs zu bestimmen, und wobei die Anzeigeeinheit dazu ausgelegt ist, um eine grafische Darstellung anzuzeigen, die der Größe des schattierten Bereichs in dem Ultraschallbild entspricht, anzuzeigen.

**3.** Ultraschall-Bildgebungsanordnung nach Anspruch 1, wobei die Auswertungseinheit dazu ausgelegt ist, um eine Vielzahl von schattierten Bereichen innerhalb des Volumens von Interesse zu erfassen und wobei die Anzeigeeinheit weiter dazu ausgelegt ist, um Schnittansichten der Vielzahl von schattierten Bereichen anzuzeigen.

**4.** Ultraschall-Bildgebungsanordnung nach Anspruch 1, wobei Positionen der unterschiedlichen zweidimensionalen Scheiben des schattierten Bereichs durch einen Bediener bestimmt werden.

**5.** Ultraschall-Bildgebungsanordnung nach Anspruch 1, wobei die Anzeige dazu ausgelegt ist, um die grafische Darstellung des schattierten Bereichs in dem angezeigten Ultraschallbild hervorzuheben.

**6.** Ultraschall-Bildgebungsanordnung nach Anspruch 1, wobei die Bildverarbeitungseinheit weiter dazu ausgelegt ist, um Bilddaten einer Draufsicht des schattierten Bereichs entsprechend einer Ausbreitungsrichtung der Ultraschallwellen zu bestimmen, und wobei die Anzeigeeinheit dazu ausgelegt ist, die Draufsicht-Bilddaten anzuzeigen.

**7.** Ultraschall-Bildgebungsanordnung nach Anspruch 6, wobei die Auswertungseinheit dazu ausgelegt ist, um eine Größe des schattierten Bereichs in einer Ausbreitungsrichtung der Ultraschallwellen zu bestimmen und wobei die Anzeigeeinheit dazu ausgelegt ist, um die Größe des schattierten Bereichs in den Draufsicht-Bilddaten anzuzeigen.

**8.** Verfahren zum Anzeigen von Ultraschallbildern (30), umfassend die folgenden Schritte:

- Empfangen mindestens eines Satzes von Ultraschalldaten in Echtzeit, die aus einer Ultraschallabtastung eines Volumens von Interesse (31) resultieren,
- Auswerten des mindestens einen Satzes von Ultraschalldaten,
- Bereitstellen entsprechender Bilddaten auf Basis der Ultraschalldaten,
- Anzeigen eines Ultraschallbildes auf einer Anzeigeeinheit (18) auf der Basis der Bilddaten und
- Erfassen, ob ein schattierter Bereich (32) vorhanden ist und seiner Position innerhalb des Volumens von Interesse auf der Basis der Ultraschalldaten,

**dadurch gekennzeichnet, dass** das Verfahren weiter die folgenden Schritte umfasst:

- Bestimmen der Ultraschallbilddaten einer Vielzahl von unterschiedlichen zweidimensionalen Scheiben des schattierten Bereichs, wobei die Scheiben in einer Querrichtung zueinander angeordnet sind, und gleichzeitig Anzeigen von grafischen Darstellungen entsprechender Schnittansichten des erfassten schattierten Bereichs in den Ultraschallbilddaten jeder der Vielzahl von zweidimensionalen Scheiben auf der Anzeigeeinheit.

**9.** Ultraschall-Wandleranordnung, umfassend eine Ultraschall-Wandlereinheit (14), aufweisend eine Vielzahl von Ultraschall-Wandlerelementen zum Senden und Empfangen von Ultraschallwellen und eine Ultraschall-Bildgebungsanordnung (10) nach Anspruch 1 zum Auswerten und Anzeigen von Ultraschalldaten, die von der Ultraschall-Wandlereinheit empfangen werden.

**Revendications**

**1.** Ensemble d'imagerie ultrasonore (10), comprenant :

- une unité de traitement d'image (26) pour recevoir en temps réel et pour évaluer au moins un ensemble de données d'ultrasons résultant d'un balayage ultrasonore d'un volume d'intérêt (31) et pour fournir des données d'image correspondantes sur la base des données d'ultrasons,
- une unité d'affichage (18) pour afficher une image ultrasonore (30) sur la base des données d'image,
- une unité d'évaluation (28) adaptée pour détecter une zone ombrée (32) et sa position dans le volume d'intérêt (31) sur la base des données

d'ultrasons,

**caractérisé en ce que** l'unité de traitement d'image est adaptée pour déterminer des données d'image ultrasonore d'une pluralité de tranches bidimensionnelles différentes de la zone ombrée, dans lequel les tranches sont disposées dans une direction transversale les unes par rapport aux autres, et dans lequel l'unité d'affichage est adaptée pour afficher simultanément des représentations graphiques de vues en coupe correspondantes de la zone ombrée détectée dans chacune des données d'image ultrasonore correspondant à la tranche bidimensionnelle respective.

**2.** Ensemble d'imagerie ultrasonore selon la revendication 1, dans lequel l'unité d'évaluation est adaptée pour déterminer une taille de la zone ombrée détectée et dans lequel l'unité d'affichage est adaptée pour afficher une représentation graphique correspondant à la taille de la zone ombrée dans l'image ultrasonore.

**3.** Ensemble d'imagerie ultrasonore selon la revendication 1, dans lequel l'unité d'évaluation est adaptée pour détecter une pluralité de zones ombrées dans le volume d'intérêt et dans lequel l'unité d'affichage est en outre adaptée pour afficher des vues en coupe de la pluralité des zones ombrées.

**4.** Ensemble d'imagerie ultrasonore selon la revendication 1, dans lequel des positions des tranches bidimensionnelles différentes de la zone ombrée sont déterminées par un opérateur.

**5.** Ensemble d'imagerie ultrasonore selon la revendication 1, dans lequel l'affichage est adapté pour mettre en évidence la représentation graphique de la zone ombrée dans l'image ultrasonore affichée.

**6.** Ensemble d'imagerie ultrasonore selon la revendication 1, dans lequel l'unité de traitement d'image est en outre adaptée pour déterminer des données d'image d'une vue en plan de la zone ombrée correspondant à une direction de propagation des ondes ultrasonores et dans lequel l'unité d'affichage est adaptée pour afficher les données d'image de vue en plan.

**7.** Ensemble d'imagerie ultrasonore selon la revendication 6, dans lequel l'unité d'évaluation est adaptée pour déterminer une taille de la zone ombrée dans une direction de propagation des ondes ultrasonores, et dans lequel l'unité d'affichage est adaptée pour afficher la taille de la zone ombrée dans les données d'image de vue en plan.

**8.** Procédé d'affichage d'images ultrasonores (30) comprenant les étapes consistant à :

- recevoir en temps réel au moins un ensemble de données d'ultrasons résultant d'un balayage ultrasonore d'un volume d'intérêt (31),
- évaluer le au moins un ensemble de données d'ultrasons,
- fournir des données d'image correspondantes sur la base des données d'ultrasons,
- afficher une image ultrasonore sur une unité d'affichage (18) sur la base des données d'image, et
- détecter si une zone ombrée (32) est présente et sa position dans le volume d'intérêt sur la base des données d'ultrasons,

**caractérisé en ce que** le procédé comprend en outre les étapes consistant à :

- déterminer des données d'image ultrasonores d'une pluralité de tranches bidimensionnelles différentes de la zone ombrée, dans lequel les tranches sont disposées dans une direction transversale les unes par rapport aux autres, et afficher simultanément des représentations graphiques de vues en coupe correspondantes de la zone ombrée détectée dans les données d'image ultrasonore de chacune de la pluralité de tranches bidimensionnelles sur l'unité d'affichage.

**9.** Ensemble transducteur ultrasonore, comprenant une unité de transducteur ultrasonore (14) incluant une pluralité d'éléments de transducteur ultrasonore pour émettre et recevoir des ondes ultrasonores et un ensemble d'imagerie ultrasonore (10) selon la revendication 1 pour évaluer et afficher des données d'ultrasons reçues de l'unité de transducteur ultrasonore.

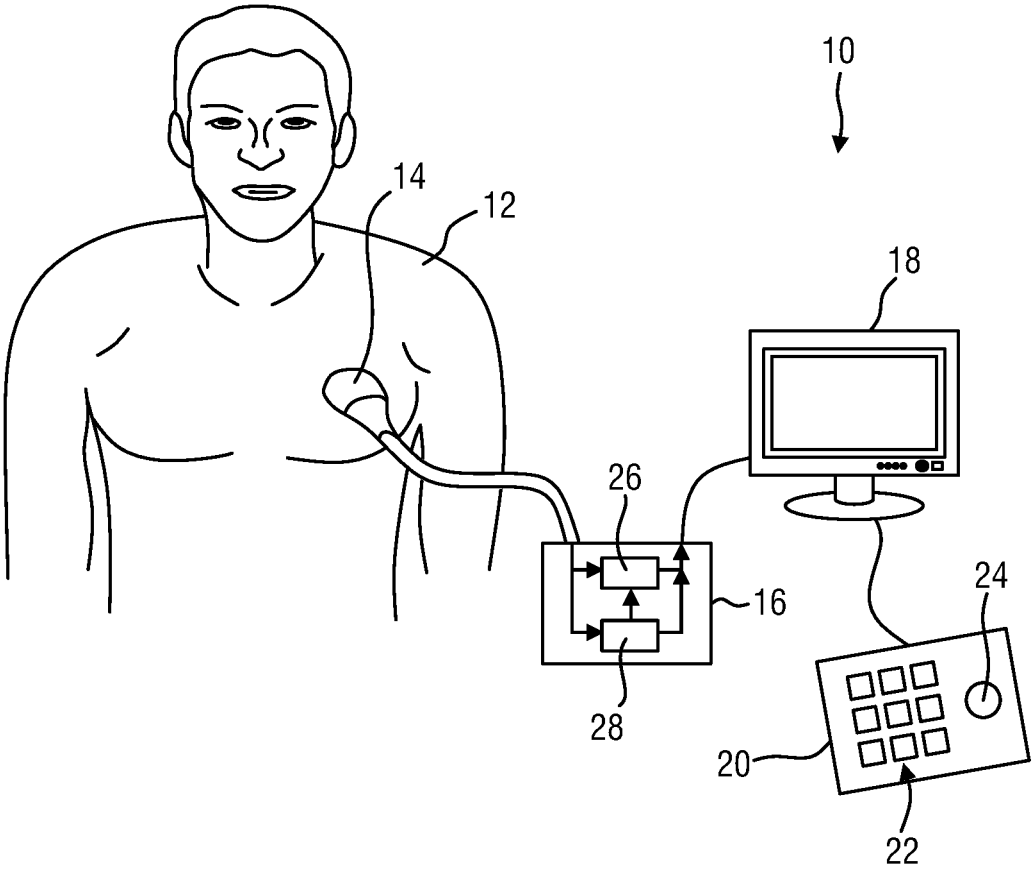
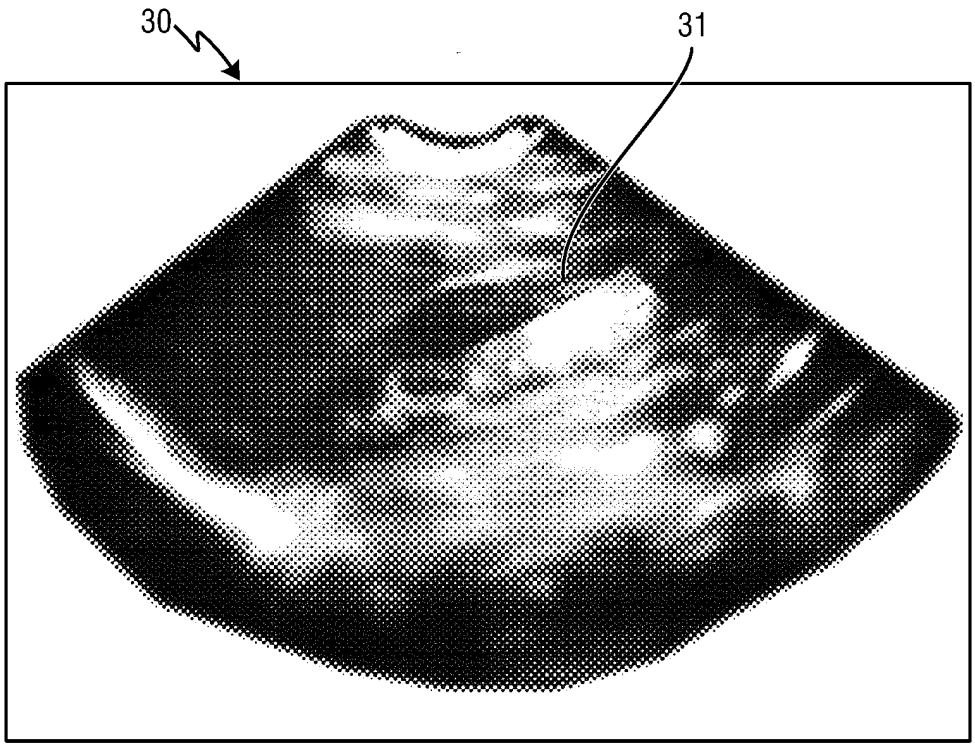
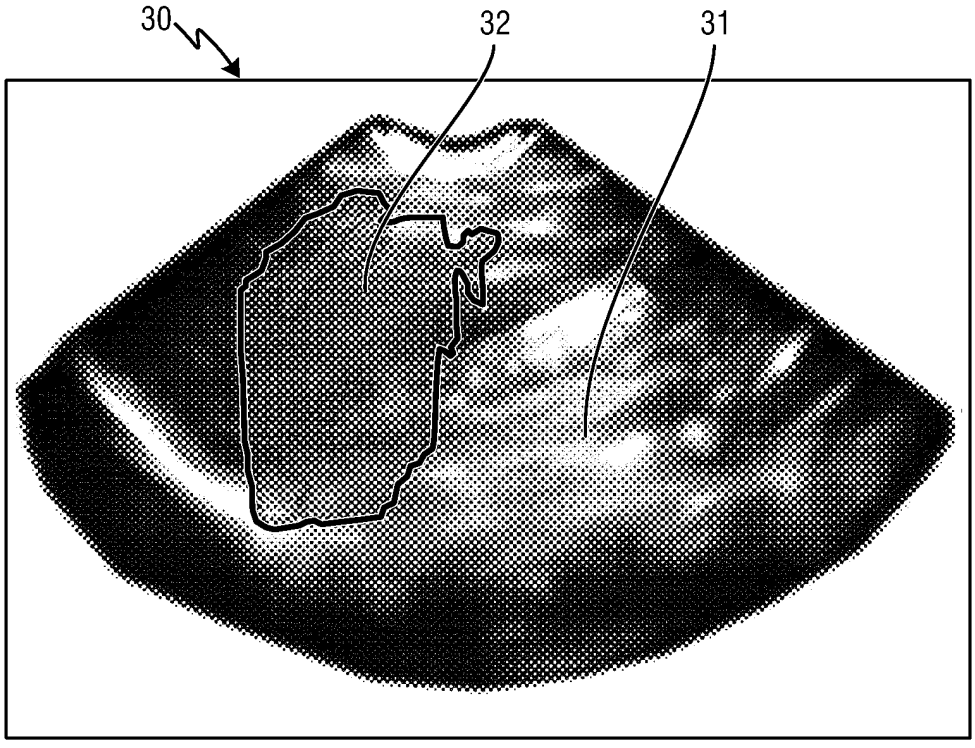



FIG.1

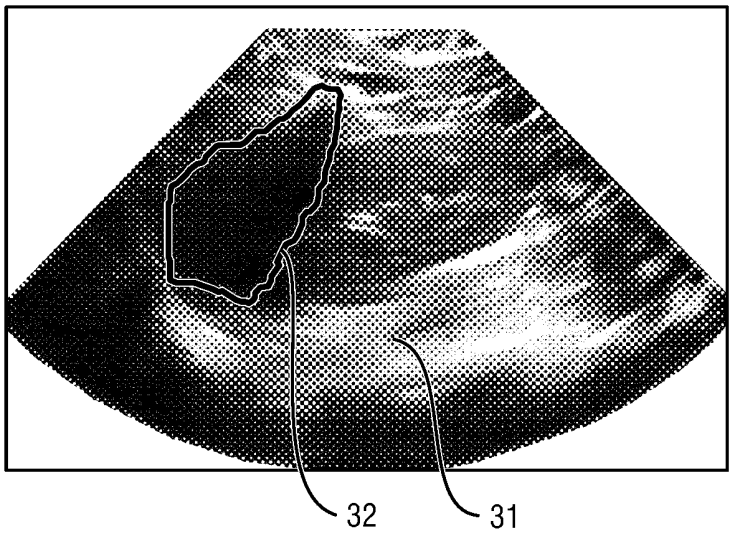



a)

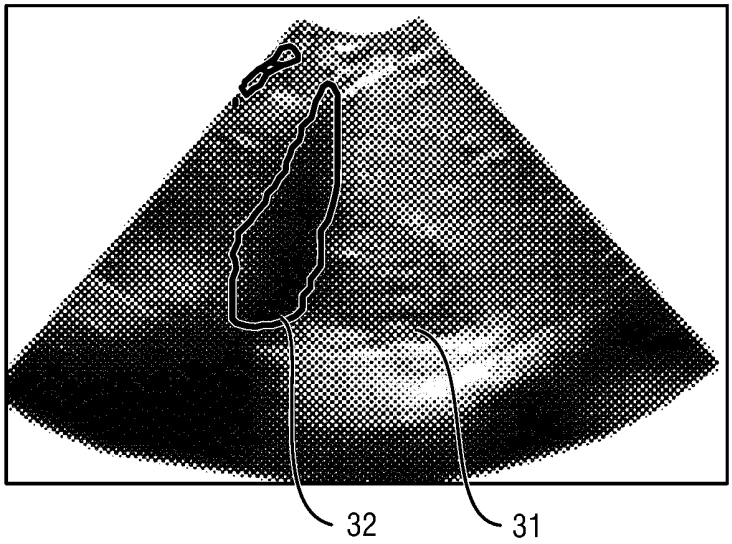



b)

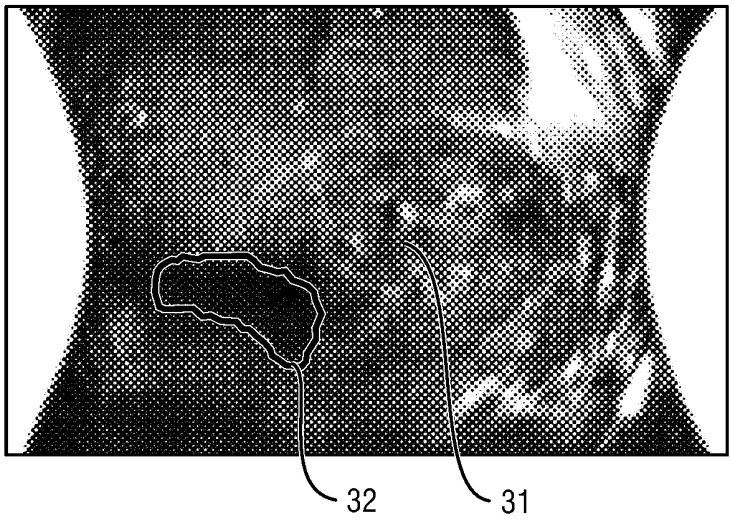
FIG.2




a)




b)




c)

FIG.3

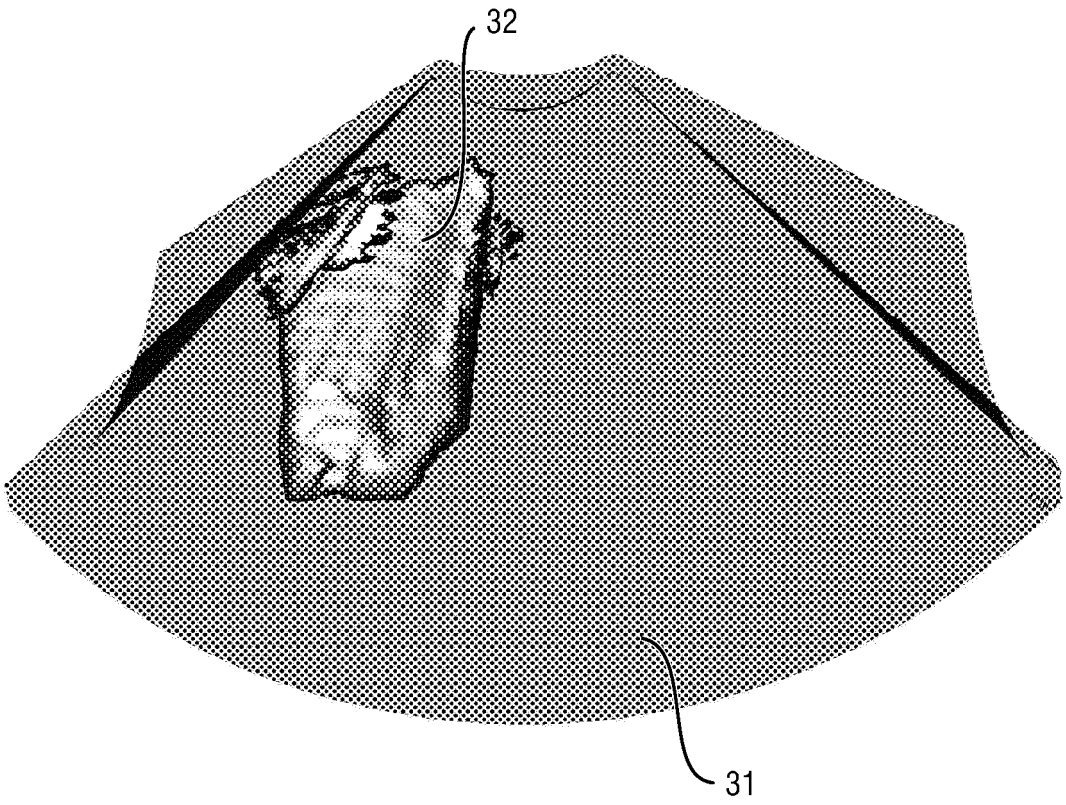



FIG.4

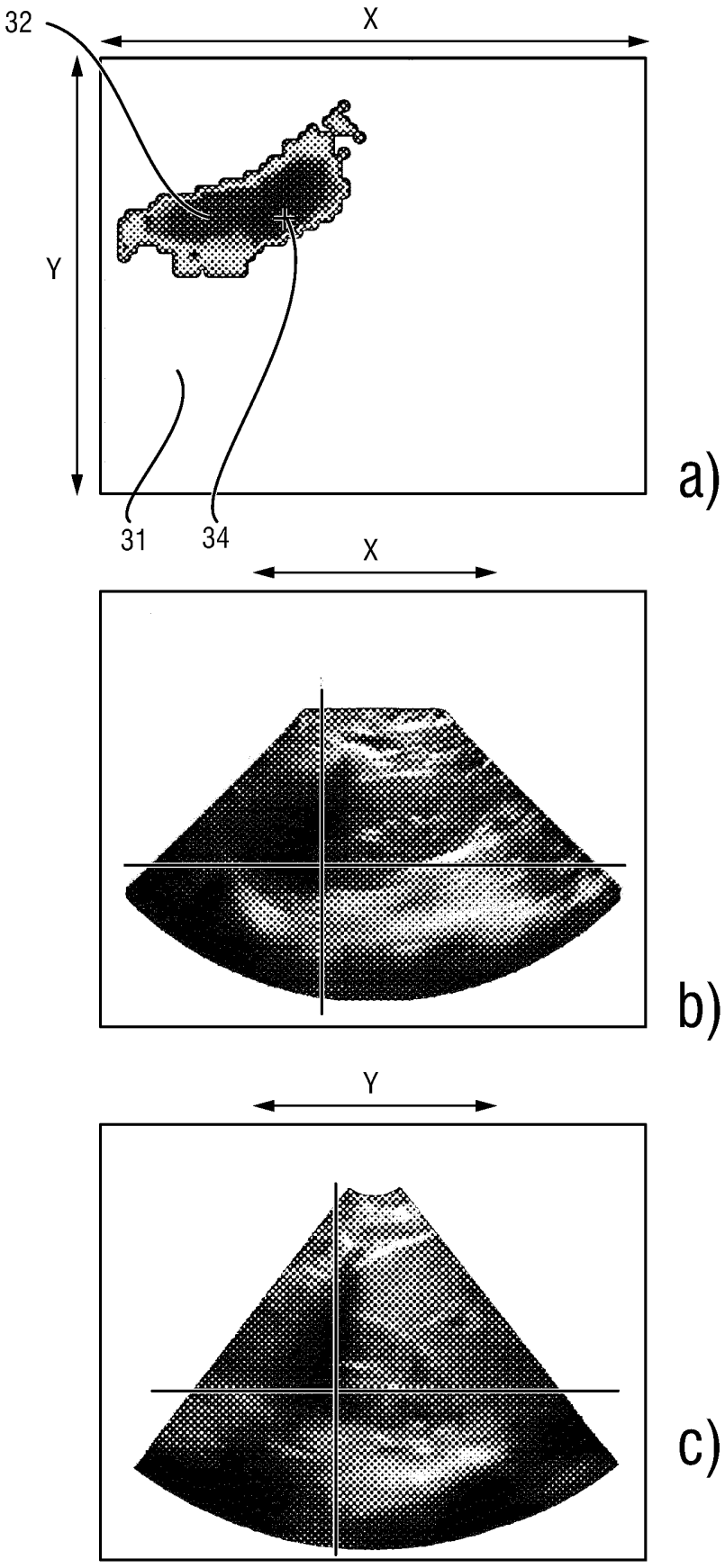



FIG.5

## REFERENCES CITED IN THE DESCRIPTION

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

### Patent documents cited in the description


- US 20120243757 A1 **[0004]**
- JP 2010207492 A **[0006]**
- JP 2003325514 A **[0007]**

| | | | |
|---|---|---|---|
| 专利名称(译) | 超声成像组件和用于显示超声图像的方法 | | |
| 公开(公告)号 | EP3082611B1 | 公开(公告)日 | 2019-08-14 |
| 申请号 | EP2014820815 | 申请日 | 2014-12-15 |
| [标]申请(专利权)人(译) | 皇家飞利浦电子股份有限公司 | | |
| 申请(专利权)人(译) | 皇家飞利浦N.V. | | |
| 当前申请(专利权)人(译) | 皇家飞利浦N.V. | | |
| [标]发明人 | AUVRAY VINCENT MAURICE ANE<br>CUINGNET REMI NICOLAS THIERRY<br>ARDON ROBERTO JOSE | | |
| 发明人 | AUVRAY, VINCENT MAURICE ANDRÉ<br>CUINGNET, REMI NICOLAS THIERRY<br>ARDON, ROBERTO JOSÉ | | |
| IPC分类号 | A61B8/00 G06T7/00 A61B8/08 | | |
| CPC分类号 | A61B8/085 A61B8/466 A61B8/483 A61B8/5215 A61B8/5269 G06T7/0012 G06T2207/10132 G06T7/11 G06T7/62 A61B8/4483 A61B8/461 A61B8/467 A61B8/54 | | |
| 代理机构(译) | STEFFEN，THOMAS | | |
| 优先权 | 2013306807 2013-12-20 EP | | |
| 其他公开文献 | EP3082611A1 | | |
| 外部链接 | Espacenet | | |


摘要(译)

公开了一种超声成像组件，包括图像处理单元（26），用于接收和评估由感兴趣体积（31）的超声扫描产生的至少一组超声数据，并用于基于以下方式提供相应的图像数据。超声数据。该组件包括：显示单元（18），用于基于图像数据显示超声图像（30）;以及评估单元（28），适于检测感兴趣体积内是否存在阴影区域（32）（ 31）基于超声数据，其中图像处理单元适于确定阴影区域的二维切片的超声图像数据，并且其中显示单元适于显示相应截面图的图形表示。超声图像中的阴影区域。

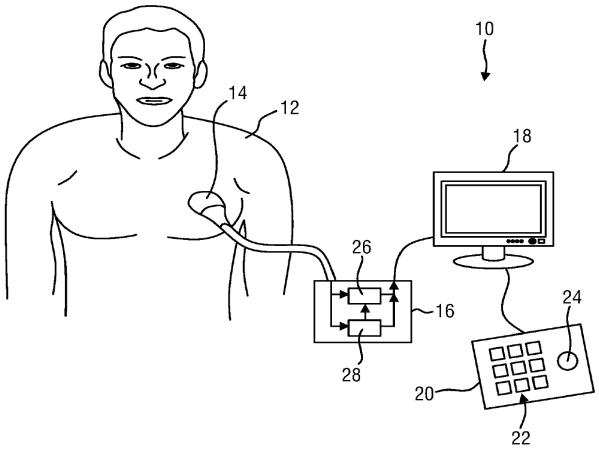




FIG.1