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(54) **ULTRASOUND SYSTEM AND METHOD FOR PROVIDING PANORAMIC IMAGE**

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(57) **ABSTRACT**

Provided are an ultrasound system and method that can provide improved storage efficiency of a storage unit by storing only some of a plurality of ultrasound images needed to produce a panoramic image in the storage unit. The ultrasound system includes: an ultrasound data acquisition unit for sequentially acquiring ultrasound data corresponding to a living body; a processor for producing a plurality of ultrasound images by using the ultrasound data, setting a region of interest (ROI) on each of the ultrasound images, performing motion estimation between the plurality of ultrasound images to estimate motion of the ROI, and extracting ultrasound images needed for forming a panoramic image from the ultrasound images based on the estimated motion; and a storage unit for storing the extracted ultrasound images.

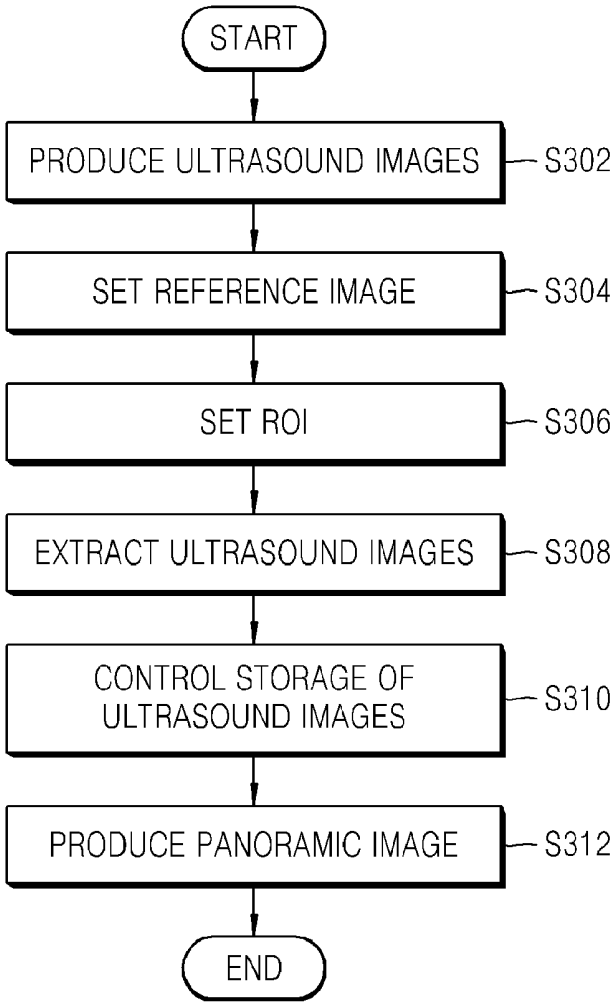


FIG. 1

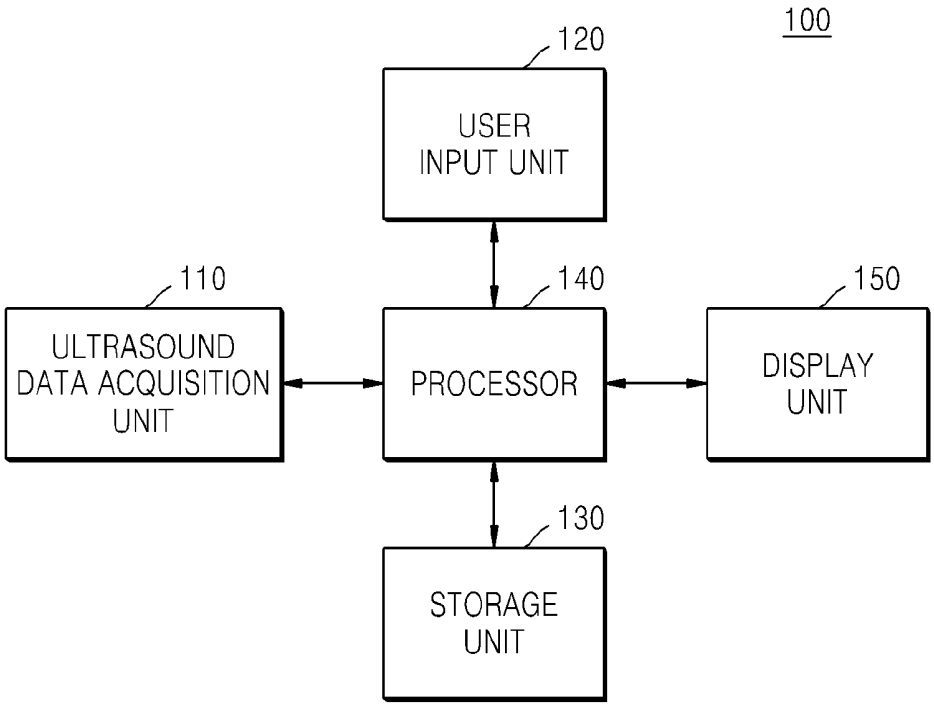

100
120
USER INPUT UNIT
110
ULTRASOUND DATA ACQUISITION UNIT
140
PROCESSOR
150
DISPLAY UNIT
130
STORAGE UNIT

FIG. 2

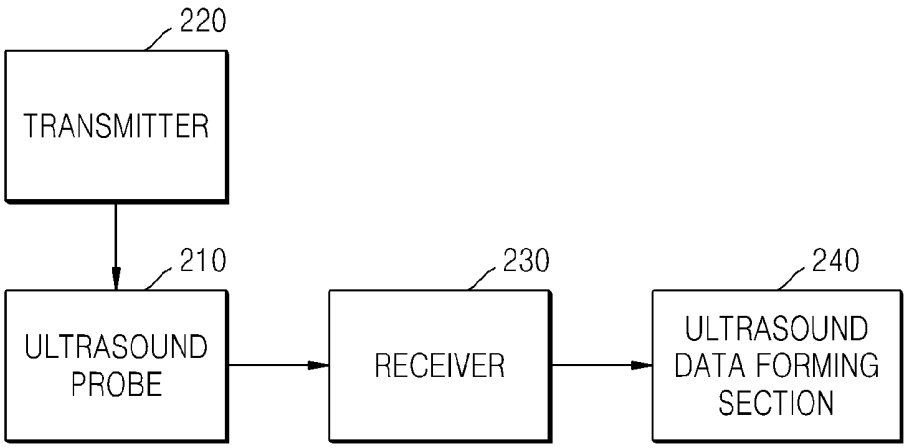

220
TRANSMITTER
210
ULTRASOUND PROBE
230
RECEIVER
240
ULTRASOUND DATA FORMING SECTION

FIG. 3

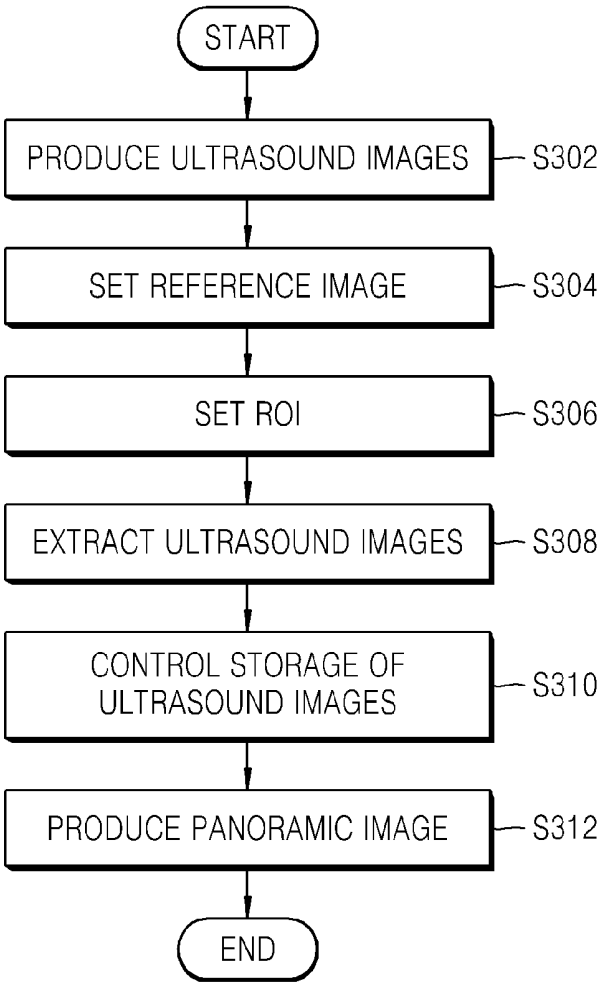

START
PRODUCE ULTRASOUND IMAGES
S302
SET REFERENCE IMAGE
S304
SET ROI
S306
EXTRACT ULTRASOUND IMAGES
S308
CONTROL STORAGE OF ULTRASOUND IMAGES
S310
PRODUCE PANORAMIC IMAGE
S312
END

FIG. 4

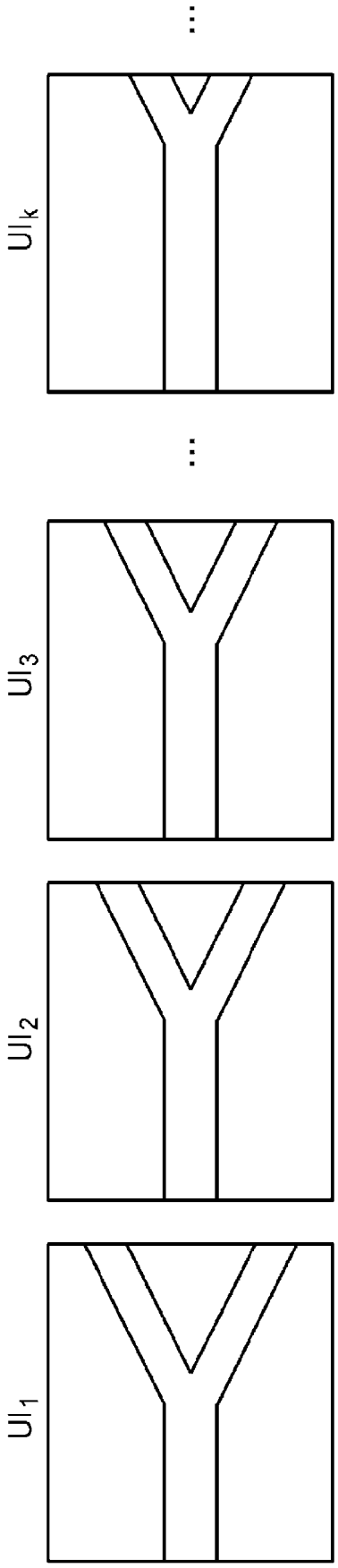


FIG. 5

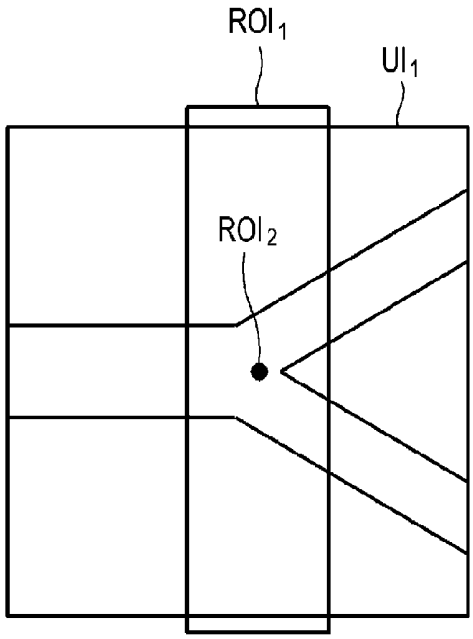


FIG. 6

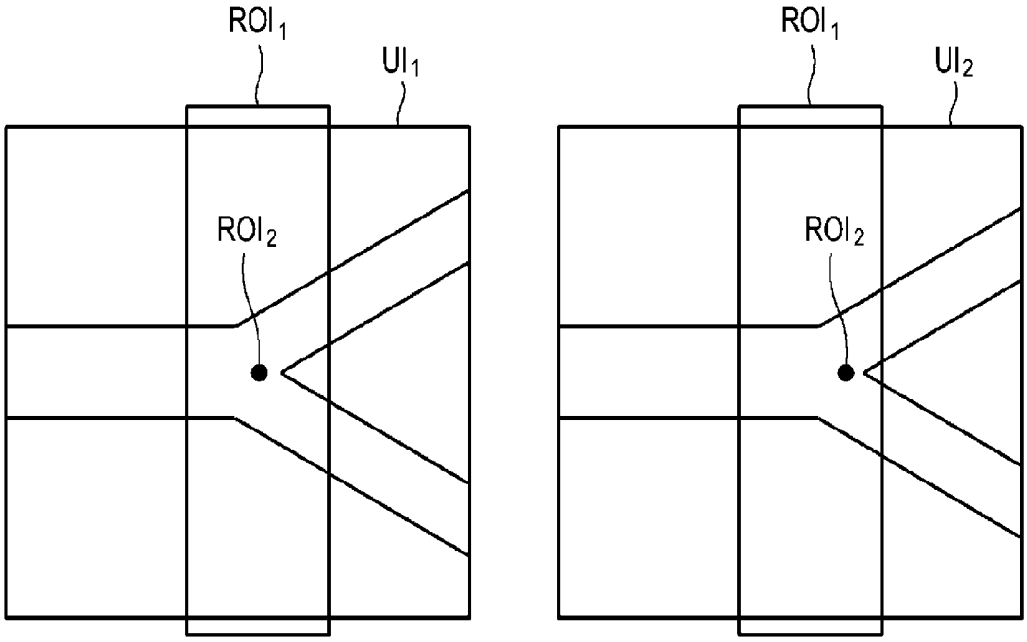


FIG. 7

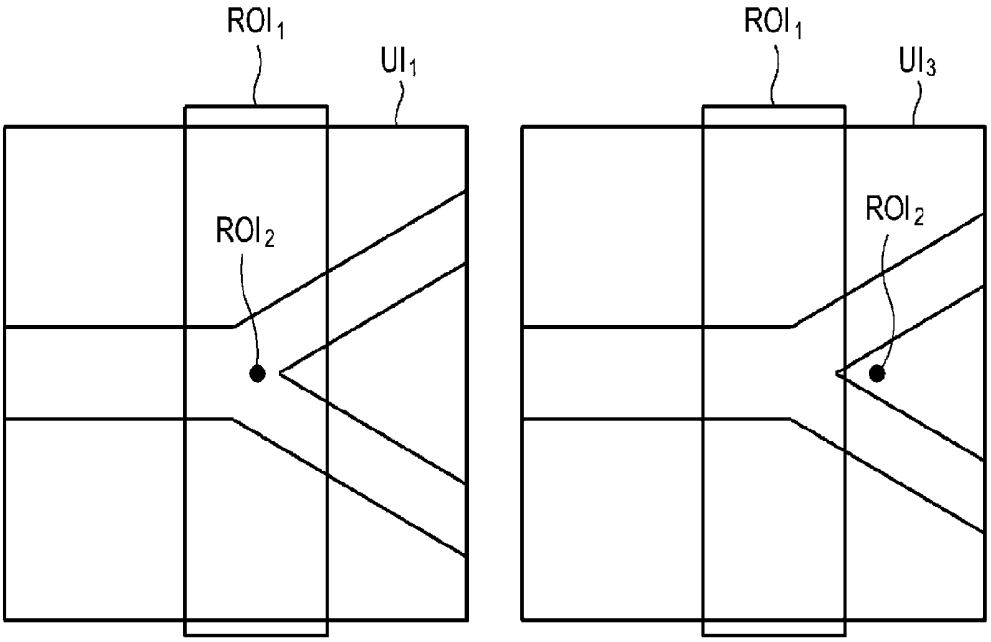


FIG. 8

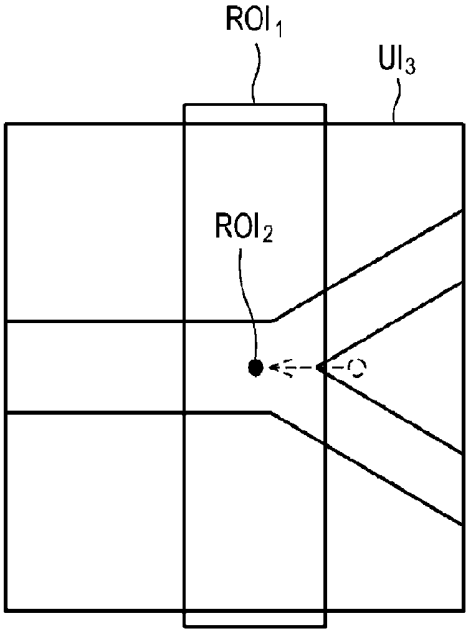


FIG. 9

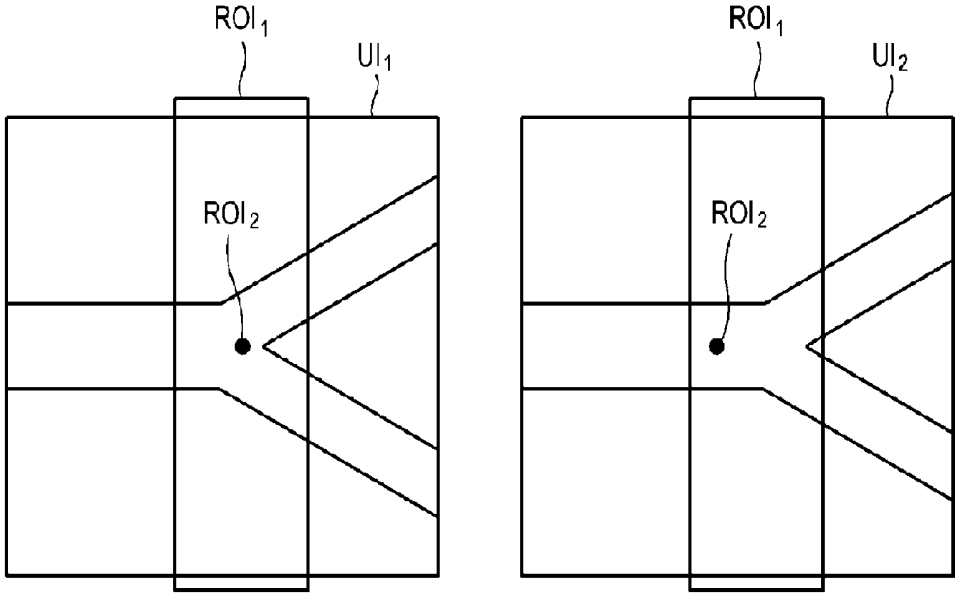


FIG. 10

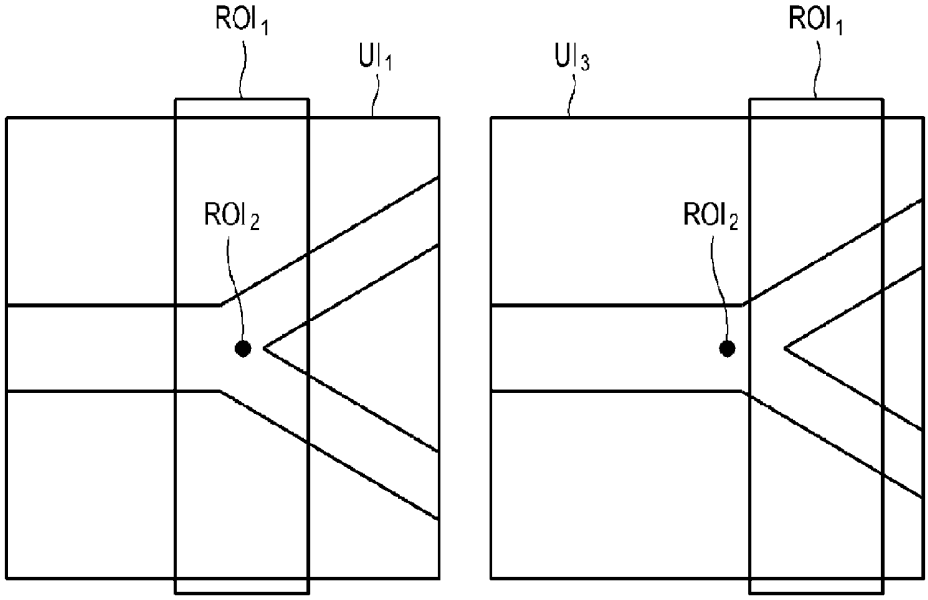
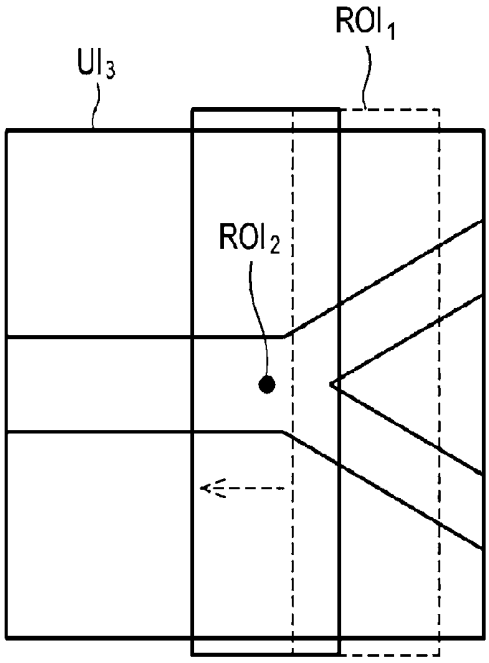


FIG. 11



ULTRASOUND SYSTEM AND METHOD FOR PROVIDING PANORAMIC IMAGE

RELATED APPLICATIONS

[0001] This application claims the benefit of Korean Patent Application No. 10-2012-0096316, filed on Aug. 31, 2012, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND

[0002] 1. Field

[0003] One or more embodiments of the present invention relate to an ultrasound system, and more particularly, to an ultrasound system and method adapted to store only ultrasound images needed to produce a panoramic image in a storage unit.

[0004] 2. Description of the Related Art

[0005] Due to its non-invasive and non-destructive nature, an ultrasound system has been widely used in the medical field that requires information about the inside of living bodies. The ultrasound system also plays a critical role in the medical profession since it can provide real-time, high-resolution images of tissue of a living body to a doctor without the need for a surgical procedure that directly incises the living body for observation.

[0006] The ultrasound system provides a panoramic image based on ultrasound images continuously acquired as an ultrasound probe moves along a surface of a living body. That is, the ultrasound system acquires continuous ultrasound images as the ultrasound probe moves along the surface of the living body and synthesizes the acquired continuous ultrasound images to generate a panoramic image.

SUMMARY

[0007] One or more embodiments of the present invention include an ultrasound imaging system and method that are capable of improving a storage efficiency of a storage unit by storing only some of a plurality of ultrasound images needed to produce a panoramic image in the storage unit.

[0008] Additional aspects 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 presented embodiments.

[0009] According to one or more embodiments of the present invention, an ultrasound system includes: an ultrasound data acquisition unit that sequentially acquires ultrasound data corresponding to a living body; a processor that produces a plurality of ultrasound images by using the ultrasound data, sets a region of interest (ROI) on each of the ultrasound images, performs motion estimation between the plurality of ultrasound images to estimate motion of the ROI, and extract ultrasound images needed for forming a panoramic image from the ultrasound images based on the estimated motion; and a storage unit that stores the extracted ultrasound images.

[0010] According to one or more embodiments of the present invention, a method of providing a panoramic image includes: sequentially acquiring ultrasound data corresponding to a living body; producing a plurality of ultrasound images by using the ultrasound data; setting a region of interest (ROI) on each of the ultrasound images, performing motion estimation between the plurality of ultrasound images to estimate motion of the ROI, and extracting ultrasound images needed for forming a panoramic image from the ultrasound images based on the estimated motion; and storing the extracted ultrasound images in a storage unit.

[0011] The ultrasound system and method for providing a panoramic image according to the embodiments of the present invention allow only some of a plurality of ultrasound images needed to produce a panoramic image to be stored in a storage unit, thereby improving storage efficiency of the storage unit. Furthermore, the panoramic image may be provided without limitations on the time taken to create the panoramic image, which are caused by limited storage capacity of the storage unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] These and/or other aspects will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings of which:

[0013] FIG. **1** is a block diagram showing a configuration of an ultrasound system according to an exemplary embodiment of the present invention;

[0014] FIG. **2** is a block diagram showing a configuration of an ultrasound data acquisition unit in an ultrasound system, according to an exemplary embodiment of the present invention;

[0015] FIG. **3** is a flowchart of a method of producing a panoramic image, according to an exemplary embodiment of the present invention;

[0016] FIG. **4** illustrates a plurality of ultrasound images generated by an ultrasound system according to an exemplary embodiment of the present invention;

[0017] FIG. **5** is an exemplary diagram showing setting of a first region of interest (ROI) and a second ROI on a reference image, according to an exemplary embodiment of the present invention;

[0018] FIGS. **6** and **7** are exemplary diagrams showing setting of first and second ROIs on an ultrasound image, according to an exemplary embodiment of the present invention;

[0019] FIG. **8** is an exemplary diagram of movement of a second ROI to its original position, according to an exemplary embodiment of the present invention;

[0020] FIGS. **9** and **10** are exemplary diagrams showing setting of first and second ROIs on an ultrasound image, according to another exemplary embodiment of the present invention; and

[0021] FIG. **11** is an exemplary diagram of movement of a first ROI to its original position, according to another exemplary embodiment of the present invention.

DETAILED DESCRIPTION

[0022] Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. In this regard, the present embodiments may have different forms and should not be construed as being limited to the descriptions set forth herein. Accordingly, the embodiments are merely described below, by referring to the figures, to explain aspects of the present description.

[0023] FIG. **1** is a block diagram illustrating a configuration of an ultrasound system **100** according to an exemplary embodiment of the present invention. Referring to FIG. **1**, the

ultrasound system **100** according to the present embodiment includes an ultrasound data acquisition unit **110**.

[0024] The ultrasound data acquisition unit **110** transmits an ultrasound signal to a living body, including an object, such as blood vessels, the heart, and the bloodstream, and receives an ultrasound signal (i.e., ultrasound echo signal) reflected from the living body to acquire ultrasound data.

[0025] FIG. **2** is a block diagram showing a configuration of the ultrasound data acquisition unit **110** in the ultrasound system **100** of FIG. **1**. Referring to FIG. **2**, the ultrasound data acquisition unit **110** includes an ultrasound probe **210**.

[0026] The ultrasound probe **210** includes a plurality of transducer elements (not shown) that convert electrical signals into ultrasound signals, and vice versa. The ultrasound probe **210** is configured to transmit an ultrasound signal to a living body and receive an ultrasound echo signal reflected from the living body to generate an electrical signal (hereinafter referred to as a "reception signal"). The reception signal is an analog signal. The ultrasound probe **210** includes a linear probe, but is not limited thereto.

[0027] The ultrasound data acquisition unit **110** further includes a transmitter **220** for controlling the transmission of an ultrasound signal. The transmitter **220** produces an electrical signal (hereinafter referred to as a "transmission signal") that is used to obtain an ultrasound image in consideration of transducer elements and a focal point. In the present embodiment, the transmitter **220** creates a transmission signal that is used to obtain each of a plurality of ultrasound images corresponding to a panoramic image. Thus, upon receipt of the transmission signal from the transmitter **220**, the ultrasound probe **210** converts the transmission signal into an ultrasound signal, transmits the ultrasound signal to a living body, and creates a reception signal based on an ultrasound echo signal reflected from the living body.

[0028] The ultrasound data acquisition unit **110** further includes a receiver **230**. The receiver **230** performs analog-to-digital conversion on the reception signal provided by the ultrasound probe **210** to produce a digital signal. The receiver **230** also performs reception beamforming on the digital signal in consideration of the transducer elements and a focal point to create a focused reception signal.

[0029] The ultrasound data acquisition unit **110** further includes an ultrasound data forming section **240**. The ultrasound data forming section **240** creates ultrasound data corresponding to an ultrasound image by using the receive focused signal. According to the present embodiment, the ultrasound data forming section **240** forms ultrasound data corresponding to each of the ultrasound images by using the receive focused signal from the receiver **230**. The ultrasound data includes radio frequency (RF) data, but is not limited thereto. the ultrasound data forming section **240** may also perform various signal processings, such as gain control needed to form ultrasound data, on the receive focused signal

[0030] Referring back to FIG. **1**, the ultrasound system **100** further includes a user input unit **120** for receiving user input information. The input information includes first input information needed for setting a region of interest (ROI) on an ultrasound image. The first input information contains information about the size and location (e.g., coordinates) of the ROI. The ROI will be described below in more detail. The input information also contains second input information. The user input unit **120** includes a control panel, a trackball, a mouse, and a keyboard.

[0031] Referring back to FIG. **1**, the ultrasound system **100** further includes a storage unit **130**. The storage unit **130** stores ultrasound data acquired by the ultrasound data acquisition unit **110** as well as ultrasound images needed to produce a panoramic image. In the present embodiment, the storage unit **120** includes a first storage section (not shown) for temporarily storing the ultrasound data acquired by the ultrasound data acquisition unit **110** and a second storage section (not shown) for storing the ultrasound images needed to produce a panoramic image.

[0032] The ultrasound system **100** further includes a processor **140**. The processor **140** is connected to the ultrasound data acquisition unit **110**, the user input unit **120**, and the storage unit **130**. The processor **140** includes a central processing unit (CPU), a microprocessor, and a graphic processing unit (GPU).

[0033] FIG. **3** is a flowchart of a method of producing a panoramic image, according to an exemplary embodiment of the present invention. Referring to FIGS. **1** and **3**, the processor **140** produces ultrasound images by using ultrasound data provided by the ultrasound data acquisition unit **110** (S**302**). In the present embodiment, the processor **140** sequentially creates a plurality of ultrasound images UIi, as shown in FIG. **4**, by using ultrasound data sequentially provided by the ultrasound data acquisition unit **110**. In FIG. **4**, i in UIi is an integer representing the order in which the ultrasound images are formed.

[0034] The processor **140** sets a reference image among the ultrasound images UIi (S**304**). In the present embodiment, the processor **140** sets a first ultrasound image UI**1** as the reference image among the ultrasound images UIi. However, the present invention is not limited thereto. The reference image UI**1** may be stored in the storage unit **130**. The first ultrasound image UI**1** may be displayed on a display unit **150**. Thus, the user may set an ROI on the first ultrasound image UI**1** displayed on the display unit **150** by using the user input unit **120**.

[0035] The processor **140** sets an ROI on the reference image UI**1** based on input information (i.e., first input information) received from the user input unit **120** (S**306**). Referring to FIG. **5**, the processor **140** sets a first ROI ROI**1** and a second ROI ROI**2** on the reference image UI**1** based on the first input information needed for setting the first and second ROIs ROI**1** and ROI**2** as the ROI. The second ROI ROI**2** may be set within the first ROI ROI**1**.

[0036] The processor **140** extracts ultrasound images needed to form a panoramic image from the ultrasound images UIi based on the input information, the reference image UI**1**, and the ROI (S**308**). The processor **140** controls the storage unit **130** to store the extracted ultrasound images therein (S**310**).

[0037] More specifically, referring to FIG. **6**, in one embodiment, the processor **140** sets the first ROI ROI**1** on the second ultrasound image UI**2** based on input information (i.e., the first input information). In this case, the first ROI ROI**1** in the reference image UI**1** is at the same location as the first ROI ROI**1** in the second ultrasound image UI**2**. The processor **140** performs motion estimation between the reference image UI**1** and the second ultrasound image UI**2** to estimate motion of the second ROI ROI**2** in the reference image UI**1**. Since the motion estimation may be performed by using various known methods, a detailed description thereof is omitted here.

[0038] As shown in FIG. **6**, the processor **140** sets the second ROI ROI**2** on the second ultrasound image UI**2** based on the estimated motion. The processor **140** compares the first ROI ROI**1** in the second ultrasound image UI**2** with the second ROI ROI**2** therein and determines whether the second ROI ROI**2** is inside the first ROI ROI**1**.

[0039] When the second ROI ROI**2** in the second ultrasound image UI**2** is inside the first ROI ROI**1** therein, as shown in FIG. **6**, the processor **140** determines that the second ultrasound image UI**2** is not among the ultrasound images needed to form a panoramic image and controls the storage unit **130** not to store the second ultrasound image UI**2** therein.

[0040] Referring to FIG. **7**, the processor **140** then sets the first ROI ROI**1** on a third ultrasound image UI**3** based on input information (i.e., first input information). In this case, as described above, the first ROI ROI**1** in the reference image UI**1** is at the same location as the first ROI ROI**1** in the third ultrasound image UI**3**.

[0041] The processor **140** performs motion estimation between the reference image UI**1** and the third ultrasound image UI**3** to estimate motion of the second ROI ROI**2** in the reference image UI**1**. As shown in FIG. **7**, the processor **140** sets the second ROI ROI**2** on the third ultrasound image UI**3** based on the estimated motion. The processor **140** compares the first ROI ROI**1** in the third ultrasound image UI**3** with the second ROI ROI**2** therein and determines whether the second ROI ROI**2** is inside the first ROI ROI**1**.

[0042] When the second ROI ROI**2** in the third ultrasound image UI**3** is not included in the first ROI ROI**1** therein, as shown in FIG. **7**, i.e., the second ROI ROI**2** is outside of the first ROI ROI**1**, the processor **140** determines that the third ultrasound image UI**3** is among the ultrasound images needed to form a panoramic image and controls the storage unit **130** to store third ultrasound image UI**3** therein. Thus, the storage unit **130** stores the third ultrasound image UI**3** according to a control of the processor **140**.

[0043] The processor **140** then sets the third ultrasound image UI**3** as a new reference image and moves the second ROI ROI**2** in the third ultrasound image UI**3** to its original position, as shown in FIG. **8**. More specifically, the processor **140** moves the second ROI ROI**2** in the third ultrasound image UI**3** to a location corresponding to the input information (i.e., information about the location of the second ROI ROI**2**). Thus, the second ROI ROI**2** in the previous reference image UI**1** is at the same location as the second ROI ROI**2** in the third ultrasound image UI**3** that is the new reference image.

[0044] The processor **140** performs the above-described processes on the remaining ultrasound images to extract ultrasound images needed to form a panoramic image.

[0045] Referring to FIG. **9**, in another embodiment, the processor **140** sets the second ROI ROI**2** on the second ultrasound image UI**2** based on input information (i.e., the first input information). In this case, the second ROI ROI**2** in the reference image UI**1** is at the same location as the second ROI ROI**2** in the second ultrasound image UI**2**. The processor **140** performs motion estimation between the reference image UI**1** and the second ultrasound image UI**2** to estimate motion of the first ROI ROI**1** in the reference image UI**1**.

[0046] As shown in FIG. **9**, the processor **140** sets the first ROI ROI**1** on the second ultrasound image UI**2** based on the estimated motion. The processor **140** compares the first ROI ROI**1** in the second ultrasound image UI**2** with the second ROI ROI**2** therein and determines whether the second ROI ROI**2** is inside the first ROI ROI**1**. When the second ROI ROI**2** in the second ultrasound image UI**2** is inside the first ROI ROI**1** therein, as shown in FIG. **9**, the processor **140** determines that the second ultrasound image UI**2** is not among the ultrasound images needed to form a panoramic image and controls the storage unit **130** not to store the second ultrasound image UI**2** therein.

[0047] Referring to FIG. **10**, subsequently, the processor **140** sets the second ROI ROI**2** on the third ultrasound image UI**3** based on input information (i.e., first input information). In this case, as described above, the second ROI ROI**2** in the reference image UI**1** is at the same location as the second ROI ROI**2** in the third ultrasound image UI**3**.

[0048] The processor **140** performs motion estimation between the reference image UI**1** and the third ultrasound image UI**3** to estimate motion of the first ROI ROI**1** in the reference image UI**1**. As shown in FIG. **10**, the processor **140** sets the first ROI ROI**1** on the third ultrasound image UI**3** based on the estimated motion. The processor **140** compares the first ROI ROI**1** in the third ultrasound image UI**3** with the second ROI ROI**2** therein and determines whether the second ROI ROI**2** is inside the first ROI ROI**1**.

[0049] When the second ROI ROI**2** in the third ultrasound image UI**3** is not included in the first ROI ROI**1** therein, as shown in FIG. **10**, i.e., the first ROI ROI**2** is outside of the second ROI ROI**1**, the processor **140** determines that the third ultrasound image UI**3** is among the ultrasound images needed to form a panoramic image and controls the storage unit **130** to store the third ultrasound image UI**3** therein.

[0050] Then, the processor **140** sets the third ultrasound image UI**3** as a new reference image and moves the first ROI ROI**1** in the third ultrasound image UI**3** to its original position, as shown in FIG. **11**. More specifically, the processor **140** moves the first ROI ROI**1** in the third ultrasound image UI**3** to a location corresponding to the input information (i.e., information about the location of the first ROI ROI**1**). Thus, the first ROI ROI**1** in the previous reference image UI**1** is at the same location as the first ROI ROI**1** in the third ultrasound image UI**3** that is the new reference image.

[0051] The processor **140** performs the above-described processes on the remaining ultrasound images to extract ultrasound images needed to form a panoramic image.

[0052] Referring back to FIG. **3**, the processor **140** extracts ultrasound images stored in the storage unit **130** and produces a panoramic image by using the extracted ultrasound images based on input information provided by the user input unit **120** (S**312**). Since the panoramic image may be created by using various known methods, a detailed description thereof is omitted here.

[0053] Referring back to FIG. **1**, the ultrasound system **100** further includes the display unit **150**. The display unit **150** displays ultrasound images generated by the processor **140**. The display unit **150** also displays a panoramic image created by the processor **140**.

[0054] While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

What is claimed is:

1. An ultrasound system comprising:

an ultrasound data acquisition unit that sequentially acquires ultrasound data corresponding to a living body;

a processor that produces a plurality of ultrasound images by using the ultrasound data, sets a region of interest (ROI) on each of the ultrasound images, performs motion estimation between the plurality of ultrasound images to estimate motion of the ROI, and extract ultrasound images needed for forming a panoramic image from the ultrasound images based on the estimated motion; and

a storage unit that stores the extracted ultrasound images.

2. The system of claim **1**, wherein the ROI includes a first ROI and a second ROI that is set within the first ROI.

3. The system of claim **2**, wherein the processor is configured to set a first ultrasound image as a reference image among the ultrasound images, set the first and second ROIs on the reference image, perform motion estimation between the reference image and a second ultrasound image to estimate motion of the first or second ROI, and extract ultrasound images needed for forming a panoramic image from the ultrasound images based on the estimated motion of the first or second ROI.

4. The system of claim **3**, wherein the processor is configured to set the first ROI on a second ultrasound image based on the first ROI in the reference image, perform motion estimation between the reference image and the second ultrasound image to estimate motion of the second ROI, set the second ROI on the second ultrasound image based on the estimated motion, and extract the second ultrasound image as an ultrasound image needed for forming the panoramic image when the second ROI in the second ultrasound image is outside of the first ROI therein.

5. The system of claim **4**, wherein when the second ROI in the second ultrasound image is outside of the first ROI therein, the processor further moves the second ROI in the second ultrasound image to a position corresponding to the second ROI in the reference image and sets the second ultrasound image as the reference image.

6. The system of claim **3**, wherein the processor sets the second ROI on a second ultrasound image based on the second ROI in the reference image, performs motion estimation between the reference image and the second ultrasound image to estimate motion of the first ROI, sets the first ROI on the second ultrasound image based on the estimated motion, and extracts the second ultrasound image as an ultrasound image needed for forming the panoramic image when the second ROI in the second ultrasound image is outside of the first ROI therein.

7. The system of claim **6**, wherein when the second ROI in the second ultrasound image is outside of the first ROI therein, the processor further moves the first ROI in the second ultrasound image to a position corresponding to the first ROI in the reference image and sets the second ultrasound image as the reference image.

8. The system of claim **1**, further comprising a user input unit configured to receive input information needed for setting the ROI from a user.

9. A method of providing a panoramic image, the method comprising:

sequentially acquiring ultrasound data corresponding to a living body;

producing a plurality of ultrasound images by using the ultrasound data;

setting a region of interest (ROI) on each of the ultrasound images, performing motion estimation between the plurality of ultrasound images to estimate motion of the ROI, and extracting ultrasound images needed for forming a panoramic image from the ultrasound images based on the estimated motion; and

storing the extracted ultrasound images in a storage unit.

10. The method of claim **9**, wherein the ROI includes a first ROI and a second ROI that is set within the first ROI.

11. The method of claim **10**, wherein the setting of an ROI, the performing of motion estimation, and the extracting of ultrasound images comprise:

setting a first ultrasound image as a reference image among the ultrasound images;

setting the first and second ROIs on the reference image; and

performing the motion estimation between the reference image and each of the ultrasound images to estimate motion of the first or second ROI, and extracting ultrasound images needed for forming a panoramic image from the ultrasound images based on the estimated motion of the first or second ROI.

12. The method of claim **11**, wherein the performing of motion estimation and the extracting of ultrasound images comprise:

setting the first ROI on a second ultrasound image based on the first ROI in the reference image;

performing motion estimation between the reference image and the second ultrasound image to estimate motion of the second ROI;

setting the second ROI on the second ultrasound image based on the estimated motion; and

extracting the second ultrasound image as an ultrasound image needed for forming the panoramic image when the second ROI in the second ultrasound image is outside of the first ROI therein.

13. The method of claim **12**, wherein the extracting of the second ultrasound image further comprises moving the second ROI in the second ultrasound image to a position corresponding to the second ROI in the reference image and setting the second ultrasound image as the reference image.

14. The method of claim **11**, wherein the performing of motion estimation and the extracting of ultrasound images comprise:

setting the second ROI on a second ultrasound image based on the second ROI in the reference image;

performing the motion estimation between the reference image and the second ultrasound image to estimate motion of the first ROI;

setting the first ROI on the second ultrasound image based on the estimated motion; and

extracting the second ultrasound image as an ultrasound image needed for forming the panoramic image when the second ROI in the second ultrasound image is outside of the first ROI therein.

15. The method of claim **14**, wherein the extracting of the second ultrasound image further comprises moving the first ROI in the second ultrasound image to a position corresponding to the first ROI in the reference image and setting the second ultrasound image as the reference image.

16. The method of claim **9**, wherein the setting of an ROI, the performing of motion estimation, and the extracting of ultrasound images further comprise receiving input information needed for setting the ROI from a user.

* * * * *

专利名称(译)	超声系统和提供全景图像的方法		
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摘要(译)

提供了一种超声系统和方法，其能够通过仅存储在存储单元中产生全景图像所需的多个超声图像中的一些来提供存储单元的改进的存储效率。超声系统包括：超声数据获取单元，用于顺序获取与活体对应的超声数据;处理器，用于通过使用超声数据产生多个超声图像，在每个超声图像上设置感兴趣区域（ROI），在多个超声图像之间执行运动估计以估计ROI的运动，以及提取超声图像需要基于估计的运动从超声图像形成全景图像;以及存储单元，用于存储所提取的超声图像。