

(19)



(11)

EP 2 394 581 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
28.03.2018 Bulletin 2018/13

(51) Int Cl.:
A61B 8/08 (2006.01)

(21) Application number: **11168935.2**

(22) Date of filing: **07.06.2011**

(54) Providing an elastic image in an ultrasound system

Bereitstellung eines elastischen Bildes in einem Ultraschallsystem

Fourniture d'une image élastique dans un système à ultrasons

(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: **09.06.2010 KR 20100054143**

(43) Date of publication of application:
14.12.2011 Bulletin 2011/50

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(56) References cited:
**EP-A1- 1 665 987 EP-A1- 1 815 796
WO-A2-2009/001077**

EP 2 394 581 B1

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Description

TECHNICAL FIELD

[0001] The present disclosure generally relates to ultrasound systems, and more particularly to providing an elastic image in an ultrasound system.

BACKGROUND

[0002] Recently, an ultrasound system has been extensively used in the medical field due to its non-invasive and non-destructive nature. Modern high-performance ultrasound imaging systems and techniques are commonly used to produce two and three-dimensional ultrasound images of internal features of patients.

[0003] Generally, the ultrasound image is displayed in a Brightness mode (B-mode) by using reflectivity caused by an acoustic impedance difference between the tissues of a target object. However, if the reflectivity of the target object is hardly different from those of the neighboring tissues such as tumor, cancer or the like, then it is not easy to recognize the target object in the B-mode image. Further, an ultrasound elastic imaging technology has been developed to display an image of the target object by using mechanical characteristics of the target object. Such technology is very helpful for diagnosing lesions such as cancers. The tumor or cancer is relatively stiffer than the neighboring tissues. Thus, when pressure is uniformly applied, a variation of the tumor or cancer is typically smaller than those of the neighboring tissues.

[0004] The elasticity of a tissue is measured by using ultrasound data obtained before and after applying the pressure to the tissue. A compression plate mounted on an ultrasound probe may be used to apply the pressure to the tissue. A user may press the compression plate on the target object, thereby applying the pressure to the tissues of the target object. In such a case, strain data in the tissues may vary according to the pressure applied by the user. Thus, the video quality of an elastic image may be changed according to the pressure applied to the tissue.

[0005] EP 1 665 987 A1 describes an ultrasonic diagnostic apparatus comprising a displacement measuring section for measuring the displacement of an organism tissue of a subject according to a reflection echo signal received correspondingly when an ultrasonic wave is transmitted from a probe to the subject, an elastic image creating section for creating an elastic image after determining the distortion amount or the elastic modulus from the displacement, and an image display for displaying the elastic image.

SUMMARY

[0006] Embodiments for forming an elastic image in an ultrasound system are disclosed herein.

[0007] In one embodiment, by way of non-limiting ex-

ample, an ultrasound system comprises the features stated in claim 1.

[0008] In another embodiment, there is provided a method of providing an elastic image, comprising the features stated in claim 5. The Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used in determining the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

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

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

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

FIG. 4 is a flow chart showing a process of forming an elastic image in accordance with a first embodiment.

FIG. 5 is a schematic diagram showing an example of calculating displacement.

FIG. 6 is a schematic diagram showing an example of calculating the displacement in accordance with the embodiment.

FIG. 7 is a schematic diagram showing an example of a strain threshold range.

FIG. 8 is a flow chart showing a process of forming the elastic image in accordance with the second embodiment (not forming part of the invention).

FIG. 9 is a flow chart showing a process of forming an elastic image in accordance with a third embodiment (not forming part of the invention).

FIG. 10 is a flow chart showing a process of forming an elastic image in accordance with a fourth embodiment (not forming part of the invention).

DETAILED DESCRIPTION

[0010] A detailed description may be provided with reference to the accompanying drawings. One of ordinary skill in the art may realize that the following description is illustrative only and is not in any way limiting.

[0011] Referring to FIG. 1, an ultrasound system 100 in accordance with an illustrative embodiment is shown. As depicted therein, the ultrasound system 100 includes an ultrasound data acquisition unit 110. The ultrasound data acquisition unit 110 is configured to transmit and receive ultrasound signals to and from a living body while applying compression to the target object, and output ultrasound data. The living body includes a plurality of target objects (e.g., blood vessels, a heart, a lesion etc.).

[0012] FIG. 2 is a block diagram showing an illustrative

embodiment of the ultrasound data acquisition unit 110. Referring to FIG. 2, the ultrasound data acquisition unit 110 includes an ultrasound probe 210, a transmit (Tx) signal generating section 220, a beam former 230 and an ultrasound data forming section 240.

[0013] The ultrasound probe 210 applies the compression provided from an external to the living body. The ultrasound probe 210 includes a plurality of elements (not shown) for reciprocally converting between ultrasound signals and electrical signals. The ultrasound probe 210 is configured to transmit ultrasound signals to the living body. The ultrasound probe 210 is further configured to receive ultrasound signals (i.e., ultrasound echo signals) from the living body and output electrical signals ("received signals"). The received signals are analog signals. The ultrasound probe 210 includes a convex probe, a linear probe and the like.

[0014] The Tx signal generating section 220 is configured to control the transmission of the ultrasound signals. The Tx signal generating section 220 is further configured to generate electrical signals ("Tx signals") in consideration of the elements and focal points. In one embodiment, the Tx signal generating section 220 generates Tx signals for obtaining a plurality of frames F_i ($1 \leq i \leq N$) while applying compression to the living body, as shown in FIG. 3. Thus, the ultrasound probe 210 converts the Tx signals provided from the Tx signal generating section 220 into the ultrasound signals, transmit the ultrasound signals to the living body and receive the ultrasound echo signals from the living body to thereby output the received signals. The frame includes a brightness mode image. However, it should be noted herein that the frame may not be limited thereto.

[0015] The beam former 230 is configured to convert the received signals provided from the ultrasound probe 210 into digital signals. The beam former 230 is further configured to apply delays to the digital signals in consideration of the elements and the focal points to output digital receive-focused signals.

[0016] The ultrasound data forming section 240 is configured to form ultrasound data based on the digital receive-focused signals provided from the beam former 230. The ultrasound data includes radio frequency data. However, it should be noted herein that the ultrasound data may not be limited thereto. The ultrasound data forming section 240 is further configured to perform various signal processing (e.g., gain adjustment) upon the digital receive-focused signals. In one embodiment, the ultrasound data forming section 240 forms the ultrasound data corresponding to each of the frames F_i ($1 \leq i \leq N$) based on the digital receive-focused signals provided from the beam former 230.

[0017] Referring back to FIG. 1, the ultrasound system 100 further includes a processing unit 120 in communication with the ultrasound data acquisition unit 110. The processing unit 120 includes a central processing unit, a microprocessor or a graphic processing unit. However, it should be noted herein that the processing unit 120

may not be limited thereto.

[0018] FIG. 4 is a flow chart showing a process of forming an elastic image in accordance with a first embodiment. The processing unit 120 is configured to calculate displacement ("first displacement") based on the ultrasound data corresponding to a current frame and the ultrasound data corresponding to a predetermined number of previous frames, at step S402 in FIG. 4. The first displacement is roughly calculated.

[0019] Generally, the displacement D_{i-1} , wherein i is a positive integer, corresponding to an elastic image E_{i-1} between a current frame F_i and a previous frame F_{i-1} was calculated based on the ultrasound data provided from the ultrasound data acquisition unit 110, as shown in FIG. 5.

[0020] In the embodiment, the processing unit 120 is configured to extract the predetermined number of the previous frames based on the current frame. The processing unit 120 is further configured to calculate the first displacement corresponding to the elastic images between the current frame and each of the previous frames based on the ultrasound data.

[0021] As one example, the processing unit 120 is configured to extract the predetermined number of the previous frames F_{i-1} to F_{i-6} based on the current frame F_i , as shown in FIG. 6. The processing unit 120 is further configured to calculate the first displacement D_{i-1} to D_{i-6} corresponding to the elastic images E_{i-1} to E_{i-6} between the current frame F_i and each of the previous frames F_{i-1} to F_{i-6} based on the ultrasound data, as shown in FIG. 6.

[0022] As another example, the processing unit 120 is configured to extract the predetermined number of the previous frames F_{i-1} to F_{i-6} based on the current frame F_i . The processing unit 120 is further configured to set a region of interest ("ROI") on the current frame F_i and the extracted previous frames F_{i-1} to F_{i-6} . The processing unit 120 is further configured to calculate the first displacements between the ROI of the current frame F_i and the ROI of each of the extracted previous frames F_{i-1} to F_{i-6} .

[0023] As yet another example, the processing unit 120 is configured to extract the predetermined number of the previous frames F_{i-1} to F_{i-6} based on the current frame F_i . The processing unit 120 is further configured to calculate axial motions corresponding to the elastic images E_{i-1} to E_{i-6} between the current frame F_i and each of the previous frames F_{i-1} to F_{i-6} . The methods of calculating the axial motion (e.g., blocking matching) are well known in the art. Thus, they have not been described in detail so as not to unnecessarily obscure the present invention. The processing unit 120 is further configured to calculate the first displacement D_{i-1} to D_{i-6} corresponding to the elastic images E_{i-1} to E_{i-6} based on the calculated axial motions.

[0024] As yet another example, the processing unit 120 is configured to extract the predetermined number of the previous frames F_{i-1} to F_{i-6} based on the current frame F_i . The processing unit 120 is further configured to set

the ROI on the current frame F_i and the previous frames F_{i-1} to F_{i-6} . The processing unit 120 is also configured to calculate the axial motions corresponding to the elastic images E_{i-1} to E_{i-6} between the current frame F_i and each of the previous frames F_{i-1} to F_{i-6} . The processing unit 120 is further configured to calculate the first displacement D_{i-1} to D_{i-6} corresponding to the elastic images E_{i-1} to E_{i-6} based on the calculated axial motions.

[0025] The processing unit 120 is configured to calculate strain corresponding to each of the elastic images based on the first displacement, at step S404 in FIG. 4. The methods of calculating the strain are well known in the art. For example, the processing unit 120 calculates a differential value of the first displacement as the strain.

[0026] The processing unit 120 is configured to calculate a strain mean value corresponding to each of the elastic images based on the calculated strain, at step S406 in FIG. 4.

[0027] The processing unit 120 is configured to compare the calculated strain mean values with a predetermined strain threshold range to detect at least one strain mean value corresponding to the strain threshold range, at step S408 in FIG. 4. For example, the processing unit 120 compares each of the strain mean values S_{i-1} to S_{i-6} with the strain threshold range $S_{\min}$ to $S_{\max}$ to detect strain mean values S_{i-2} , S_{i-3} and S_{i-6} , which are comprised in the strain threshold range $S_{\min}$ to $S_{\max}$, as shown in FIG. 7.

[0028] The processing unit 120 is configured to detect an optimal previous frame for forming an optimal elastic image from at least one previous frame corresponding to the at least one strain mean value, at step S410 in FIG. 4. For example, the processing unit 120 calculates standard deviation of the strain for the previous frames F_{i-2} , F_{i-3} and F_{i-6} corresponding to the detected strain mean values S_{i-2} , S_{i-3} and S_{i-6} . The processing unit 120 further extracts a previous frame (e.g., F_{i-3}) corresponding to minimum standard deviation as the optimal.

[0029] Although it is described above that the processing unit 120 detects the previous frame corresponding to the minimum standard deviation as the optimal previous frame for forming the elastic image, the processing unit 120 further detects the previous frame corresponding to a strain mean value, which is closest to a predetermined threshold in the strain threshold range, as the optimal previous frame. Alternatively, the processing unit 120 detects the previous frame corresponding to a strain mean value, which is smaller than or larger than the predetermined threshold in the strain threshold range, as the optimal previous frame.

[0030] The processing unit 120 is configured to calculate displacement ("second displacement") between the optimal previous frame and the current frame based on the ultrasound data provided from the ultrasound data acquisition unit 110, at step S412 in FIG. 4. For example, the processing unit 120 calculates the second displacement between the optimal previous frame F_{i-3} and the current frame F_i based on the ultrasound data provided

from the ultrasound data acquisition unit 110.

[0031] The processing unit 120 is configured to calculate the strain based on the second displacement, at step S414 in FIG. 4. The processing unit 120 is configured to form the optimal elastic image based on the strain, at step S416 in FIG. 4. The methods of forming the elastic image based on the strain are well known in the art. Thus, they have not been described in detail so as not to unnecessarily obscure the present invention.

[0032] FIG. 8 is a flow chart showing a process of forming an elastic image in accordance with a second embodiment (not forming part of the invention). The processing unit 120 is configured to extract a predetermined number of previous frames based on a current frame, at step S802 in FIG. 8.

[0033] The processing unit 120 is configured to perform motion tracking (e.g., block matching) between the current frame and each of the extracted previous frames to detect lateral motion between the current first frame and each of the previous first frames, at step S804 in FIG. 8.

[0034] The processing unit 120 is configured to detect an optimal previous frame for forming an optimal elastic image from the extracted previous frames, at step S806 in FIG. 8.

[0035] For example, the processing unit 120 compares the detected lateral motion to detect a previous frame corresponding to minimum lateral motion. The processing unit 120 further sets the detected previous frame as the optimal previous frame.

[0036] Although it is described above that the processing unit 120 detects the lateral motion between the current frame and the previous frame, the processing unit 120 further detects elevation motion between a current three-dimensional frame and a previous three-dimensional frame. The three-dimensional frame includes a three-dimensional image. However, it should be noted herein that the three-dimensional frame may not be limited thereto.

[0037] The processing unit 120 is configured to calculate strain between the current frame and the optimal previous frame based on the ultrasound data provided from the ultrasound data acquisition unit 110, at step S808 in FIG. 8.

[0038] The processing unit 120 is configured to form the optimal elastic image based on the calculated strain, at step S810 in FIG. 8.

[0039] FIG. 9 is a flow chart showing a process of forming an elastic image in accordance with a third embodiment (not forming part of the invention). The processing unit 120 is configured to calculate the first displacement based on the ultrasound data corresponding to the current frame and the ultrasound data corresponding to the predetermined number of previous frames, at step S902 in FIG. 9. The step S902 in FIG. 9 is similar to the step S402 in FIG. 4. Thus, it has not been described in detail.

[0040] The processing unit 120 is configured to calculate the strain corresponding to each of the elastic images

based on the first displacement, at step S904 in FIG. 9.

[0041] The processing unit 120 is configured to calculate the strain mean value corresponding to each of the elastic images based on the calculated strain, at step S906 in FIG. 9.

[0042] The step S906 in FIG. 9 is similar to the step S406 in FIG. 4. Thus, it has not been described in detail.

[0043] The processing unit 120 is configured to compare the calculated strain mean values with the strain threshold range to detect at least one strain mean value corresponding to the strain threshold range, at step S908 in FIG. 9.

[0044] The processing unit 120 is configured to perform the motion tracking (e.g., block matching) between the current frame and at least one previous frame corresponding to the at least one strain mean value to detect the lateral motion between the current frame and the at least one previous frame, at step S910 in FIG. 9.

[0045] Although it is described above that the processing unit 120 detects the lateral motion between the current frame and the previous frame, the processing unit 120 further detects the elevation motion between a current three-dimensional frame and a previous three-dimensional frame. The three-dimensional frame includes a three-dimensional image. However, it should be noted herein that the three-dimensional frame may not be limited thereto.

[0046] The processing unit 120 is configured to detect the optimal previous frame for forming an optimal elastic image, at step S912 in FIG. 9. For example, the processing unit 120 compares the detected lateral motion to detect a previous frame corresponding to minimum lateral motion. The processing unit 120 further sets the detected previous frame as the optimal previous frame.

[0047] The processing unit 120 is configured to calculate second displacement between the optimal previous frame and the current frame based on the ultrasound data provided from the ultrasound data acquisition unit 110, at step S914 in FIG. 9.

[0048] The processing unit 120 is configured to calculate the strain based on the second displacement, at step S914 in FIG. 9. The processing unit 120 is configured to form the optimal elastic image based on the strain, at step S916 in FIG. 9.

[0049] FIG. 10 is a flow chart showing a process of forming an elastic image in accordance with a fourth embodiment (not forming part of the invention). The processing unit 120 is configured to calculate the first displacement based on the ultrasound data corresponding to the current frame and the ultrasound data corresponding to the predetermined number of previous frames, at step S1002 in FIG. 10. The step S1002 in FIG. 10 is similar to the step S402 in FIG. 4. Thus, it has not been described in detail.

[0050] The processing unit 120 is configured to calculate a displacement mean value corresponding to each of the elastic images based on the displacement, at step S1004 in FIG. 10.

[0051] The processing unit 120 is configured to compare the displacement mean values with a predetermined displacement threshold range to detect at least one displacement mean value corresponding to the displacement threshold range, at step S1006 in FIG. 10. The step S1006 in FIG. 10 is similar to the step S408 in FIG. 4. Thus, it has not been described in detail.

[0052] The processing unit 120 is configured to detect the optimal previous frame for forming an optimal elastic image, at step S1008 in FIG. 10. For example, the processing unit 120 calculates standard deviation of the strain for at least one previous frames corresponding to the at least one displacement mean value. The processing unit 120 further compares the calculated standard deviation to extract a previous frame corresponding to a minimum standard deviation. The processing unit 120 further sets the extracted previous frame as the optimal previous frame.

[0053] Although it is described above that the processing unit 120 detects the previous frame corresponding to the minimum standard deviation as the optimal previous frame for forming the elastic image, the processing unit 120 further detects the previous frame corresponding to a displacement mean value, which is closest to a predetermined threshold in the displacement threshold range, as the optimal previous frame, or detect the previous frame corresponding to a displacement mean value, which is smaller than or larger than the threshold in the displacement threshold range, as the optimal previous frame.

[0054] The processing unit 120 is configured to calculate second displacement between the optimal previous frame and the current frame based on the ultrasound data provided from the ultrasound data acquisition unit 110, at step S1010 in FIG. 10.

[0055] The processing unit 120 is configured to calculate the strain based on the second displacement, at step S1012 in FIG. 10. The processing unit 120 is configured to form the optimal elastic image based on the strain, at step S1014 in FIG. 10.

[0056] Referring back to FIG. 1, the ultrasound system 100 further includes a storage unit 130. The storage unit 130 stores the ultrasound data acquired by the ultrasound data acquisition unit 110. The storage unit 130 further stores the displacement and the strain calculated by the processing unit 120.

[0057] The ultrasound system 100 further includes a display unit 140. The display unit 140 displays the elastic image formed by the processing unit 120. The display unit 140 further displays the frames formed by the processing unit 120.

Claims

1. An ultrasound system (100), comprising:

an ultrasound data acquisition unit (110) config-

- ured to transmit and receive ultrasound signals to and from a living body to output ultrasound data corresponding to a plurality of frames while applying compression to the living body; and a processing unit (120) in communication with the ultrasound data acquisition unit (110), the processing unit (120) being configured to extract frames from a $(n-1)^{\text{th}}$ frame to a $(n-i)^{\text{th}}$ frame on a basis of a n^{th} frame, wherein n indicates an integer larger than one and i indicates a positive integer; calculate a first displacement between the n^{th} frame and each of the extracted frames based on the ultrasound data; calculate a first strain based on each of the first displacements; calculate strain mean values based on each of first strains; compare the strain mean values with a predetermined strain threshold range to detect at least one strain mean value corresponding to the predetermined strain threshold range; calculate standard deviation of the first strain for at least one frame corresponding to the at least one strain mean value; detect a frame corresponding to a minimum standard deviation as an optimal frame for forming an elastic image among the extracted frames calculate a second displacement between the optimal frame and the n^{th} frame based on the ultrasound data; and form an elastic image based on the second displacement.
2. The ultrasound system (100) of Claim 1, wherein the processing unit (120) is further configured to:
- set a region of interest on each of the frames from the n^{th} frame to the $(n-i)^{\text{th}}$ frame; and calculate the first displacement corresponding to the region of interest.
3. The ultrasound system (100) of Claim 1, wherein the processing unit (120) is further configured to:
- perform motion tracking between the n^{th} frame and each of the extracted frames to calculate axial motion; and calculate the first displacement based on the axial motion.
4. The ultrasound system (100) of Claim 1, wherein the processing unit (120) is further configured to:
- set a region of interest on each of the frames from the n^{th} frame to the $(n-i)^{\text{th}}$ frame; perform motion tracking between the region of interest corresponding to the n^{th} frame and the region of interest corresponding to each of the extracted frames to calculate axial motion; and calculate the first displacement based on the axial motion.
5. A method of forming an elastic image, comprising:
- a) transmitting and receiving ultrasound signals to and from a living body to output ultrasound data corresponding to a plurality of frames while applying compression to the living body;
- b) extracting frames from a $(n-1)^{\text{th}}$ frame to a $(n-i)^{\text{th}}$ frame on a basis of a n^{th} frame, wherein n indicates an integer larger than one and i indicates a positive integer;
- c) detecting an optimal frame for forming an elastic image among the extracted frames by using a first displacement between the n^{th} frame and each of the extracted frames based on the ultrasound data;
- d) calculating a second displacement between the optimal frame and the n^{th} frame based on the ultrasound data; and
- e) forming the elastic image based on the second displacement.
- wherein the step c) comprises:
- c1) calculating the first displacement between the n^{th} frame and each of the extracted frames based on the ultrasound data;
- c2) calculating a first strain based on each of the first displacements;
- c3) calculate strain mean values based on each of the first strains;
- c4) comparing the strain mean values with a predetermined strain threshold range to detect at least one strain mean value corresponding to the predetermined strain threshold range;
- c5) calculating standard deviation of the first strain for at least one frame corresponding to the at least one strain mean value; and
- c6) detecting a frame corresponding to a minimum standard deviation as the optimal frame for forming the elastic image.

Patentansprüche

1. Ultraschallsystem (100), welches folgendes aufweist:
- eine Ultraschalldatenerlangungseinheit (110), die dafür vorgesehen ist, Ultraschallsignale zu und von einem lebenden Körper zu übertragen und zu empfangen, um Ultraschalldaten auszugeben, die einer Vielzahl von Rahmen entsprechen, während ein Druck auf den lebenden Körper aufgebracht wird, und
- eine Verarbeitungseinheit (120), die in Verbindung mit der Ultraschalldatenerlangungseinheit (110) ist, wobei die Verarbeitungseinheit (120) dafür vorgesehen ist, Rahmen von einem $(n-1)^{\text{th}}$ Rahmen zu einem $(n-i)^{\text{th}}$ Rahmen auf Basis eines n^{th} Rahmens zu extrahieren, wobei n eine größere als eins ganze Zahl und i eine positive ganze Zahl ist; berechnen eine erste Verschiebung zwischen dem n^{th} Rahmen und jedem der extrahierten Rahmen auf Basis der Ultraschalldaten; berechnen eine erste Dehnung auf Basis von jeder der ersten Verschiebungen; berechnen Dehnungsmittelwerte auf Basis von jeder der ersten Dehnungen; vergleichen die Dehnungsmittelwerte mit einem vorbestimmten Dehnungsschwellenwertbereich, um mindestens einen Dehnungsmittelwert zu detektieren, der dem vorbestimmten Dehnungsschwellenwertbereich entspricht; berechnen die Standardabweichung der ersten Dehnung für mindestens einen Rahmen, der dem mindestens einen Dehnungsmittelwert entspricht; berechnen die Standardabweichung der ersten Dehnung für mindestens einen Rahmen, der dem mindestens einen Dehnungsmittelwert entspricht; und
- detektieren einen Rahmen, der einer minimalen Standardabweichung entspricht, als optimalen Rahmen für die Bildung des elastischen Bildes.

- 1)-ten-Rahmen zu einem (n-i)-ten-Rahmen auf einer Basis eines n-ten-Rahmen zu extrahieren, wobei n eine ganze Zahl größer als Eins ist und i eine positive ganze Zahl ist; Berechnen einer ersten Verschiebung zwischen dem n-ten-Rahmen und jedem der extrahierten Rahmen basierend auf den Ultraschalldaten; Berechnen einer ersten Spannung basierend auf jeder der ersten Verschiebungen; Berechnen von Spannungsmittelwerten basierend auf jeder der ersten Spannungen; Vergleichen der Spannungsmittelwerte mit einem vorbestimmten Spannungsgrenzbereich, um wenigstens einen Spannungsmittelwert zu detektieren, der dem vorbestimmten Spannungsgrenzbereich entspricht; Berechnen einer Standardabweichung der ersten Spannung für wenigstens einen Rahmen, die dem wenigstens einen Spannungsmittelwert entspricht; Detektieren eines Rahmens, der einer minimalen Standardabweichung entspricht, als einen optimalen Rahmen zum Erzeugen eines elastischen Bilds unter den extrahierten Rahmen; Berechnen einer zweiten Verschiebung zwischen dem optimalen Rahmen und dem n-ten-Rahmen basierend auf den Ultraschalldaten; und Erzeugen eines elastischen Bilds basierend auf der zweiten Verschiebung.
2. Ultraschallsystem (100) nach Anspruch 1, wobei die Verarbeitungseinheit (120) des Weiteren für folgendes vorgesehen ist:
- Festlegen eines interessierenden Bereichs von jedem der Rahmen von dem n-ten-Rahmen zu dem (n-i)-ten-Rahmen; und Berechnen der ersten Verschiebung, die dem interessierenden Bereich entspricht.
3. Ultraschallsystem (100) nach Anspruch 1, wobei die Verarbeitungseinheit (120) des Weiteren für folgendes vorgesehen ist:
- Durchführen einer Bewegungsverfolgung zwischen dem n-ten-Rahmen und jedem der extrahierten Rahmen, um eine axiale Bewegung zu berechnen; und Berechnen der ersten Verschiebung basierend auf der axialen Bewegung.
4. Ultraschallsystem (100) nach Anspruch 1, wobei die Verarbeitungseinheit (120) des Weiteren für folgendes vorgesehen ist:
- Festlegen eines interessierenden Bereichs von jedem der Rahmen von dem n-ten-Rahmen zu dem (n-i)-ten-Rahmen; Durchführen einer Bewegungsverfolgung zwischen dem interessierenden Bereich, der dem n-ten-Rahmen entspricht, und dem interessierenden Bereich, der jedem der extrahierten Rahmen entspricht, um eine axiale Bewegung zu berechnen; und Berechnen der ersten Verschiebung basierend auf der axialen Bewegung.
5. Verfahren zur Erzeugung eines elastischen Bilds, welches folgendes aufweist:
- a) Übertragen und Empfangen von Ultraschallsignalen zu und von einem lebenden Körper, um Ultraschalldaten auszugeben, die einer Vielzahl von Rahmen entsprechen, während ein Druck auf den lebenden Körper aufgebracht wird;
- b) Extrahieren von Rahmen von einem (n-1)-ten-Rahmen zu einem (n-i)-ten-Rahmen auf einer Basis eines n-ten-Rahmens, wobei n eine ganze Zahl größer als Eins ist und i eine positive ganze Zahl ist;
- c) Detektieren eines optimalen Rahmens zum Erzeugen eines elastischen Bilds unter den extrahierten Rahmen durch Verwenden einer ersten Verschiebung zwischen dem n-ten-Rahmen und jedem der extrahierten Rahmen basierend auf den Ultraschalldaten;
- d) Berechnen einer zweiten Verschiebung zwischen dem optimalen Rahmen und dem n-ten-Rahmen basierend auf den Ultraschalldaten; und
- e) Erzeugen des elastischen Bilds basierend auf der zweiten Verschiebung, wobei der Schritt c) folgendes aufweist:
- c1) Berechnen der ersten Verschiebung zwischen dem n-ten-Rahmen und jedem der extrahierten Rahmen basierend auf den Ultraschalldaten;
- c2) Berechnen einer ersten Spannung basierend auf jeder der ersten Verschiebungen;
- c3) Berechnen von Spannungsmittelwerten basierend auf jeder der ersten Spannungen;
- c4) Vergleichen der Spannungsmittelwerte mit einem vorbestimmten Spannungsgrenzbereich, um wenigstens einen Spannungsmittelwert zu detektieren, der dem vorbestimmten Spannungsgrenzbereich entspricht;
- c5) Berechnen einer Standardabweichung der ersten Spannung für wenigstens einen Rahmen, die dem wenigstens einen Spannungsmittelwert entspricht; und
- c6) Detektieren eines Rahmens, der einer minimalen Standardabweichung ent-

spricht, als den optimalen Rahmen zum Erzeugen des elastischen Bilds.

ler le déplacement axial ; et
calculer le premier déplacement basé sur le déplacement axial.

Revendications

1. Système ultrasonique (100) comportant :

une unité d'acquisition de données ultrasoniques (110) configurées pour transmettre et recevoir des signaux ultrasoniques vers et en provenance d'un corps vivant pour extraire des données ultrasoniques correspondant à une pluralité de cadres pendant que l'on applique une compression sur le corps vivant ; et
une unité de traitement (120) en contact avec l'unité d'acquisition de données ultrasoniques (110), l'unité de traitement (120) étant configurée pour extraire des cadres d'un (n-1)^{ème} cadre au (n-i)^{ème} cadre sur une base d'un n^{ème} cadre, dans lequel n indique un entier plus grand que 1 et i indique un entier positif ; calculer un premier déplacement entre le n^{ème} cadre et chacun des cadres extraits basé sur les données ultrasoniques ; calculer un premier effort basé sur chacun desdits premiers déplacements ; calculer la valeur minimale de l'effort basé sur chacun des premiers efforts ; comparer les valeurs d'effort minimales avec un niveau de seuil prédéterminé d'effort pour détecter au moins une valeur minimale d'effort correspondant au niveau de seuil prédéterminé d'effort ; calculer la déviation standard du premier effort pour au moins un cadre correspondant à ladite au moins une valeur d'effort minimale ; détecter un cadre correspondant à une déviation minimale standard ainsi qu'un cadre optimal pour former une image élastique parmi les cadres extraits ; calculer un second déplacement entre le cadre optimal et le n^{ème} cadre basé sur les données ultrasoniques et former une image élastique basée sur le second déplacement.

2. Système ultrasonique (100) de la revendication 1, dans lequel l'unité de traitement (120) est en outre configurée pour :

déterminer une zone d'intérêt sur chacun des cadres depuis le n^{ème} jusqu'au (n-i)^{ème}, et
calculer le premier déplacement correspondant à la zone d'intérêt.

3. Système ultrasonique (100) de la revendication 1, dans lequel l'unité de traitement (120) est en outre configurée pour :

effectuer la saisie du déplacement entre le n^{ème} cadre et chacun des cadres extraits pour calcu-

4. Système ultrasonique (100) de la revendication 1, dans lequel l'unité de traitement (120) est en outre configurée pour :

déterminer une zone d'intérêt sur chacun des cadres du n^{ème} cadre au (ni)^{ème} cadre ;
effectuer la saisie du déplacement entre la zone d'intérêt correspondant au n^{ème} cadre et la zone d'intérêt correspondant à chacun des cadres extraits pour calculer le déplacement axial ; et
calculer le premier déplacement basé sur le déplacement axial.

5. Procédé pour former une image élastique, comportant :

a) la transmission et la réception de signaux ultrasoniques vers et en provenance d'un corps vivant pour extraire des données ultrasoniques correspondant à une pluralité de cadres pendant que l'on applique une compression sur le corps vivant ;
b) l'extraction de cadres d'un (n-1)^{ème} cadre à un (n-i)^{ème} cadre sur une base d'un n^{ème} cadre, dans lequel n indique un entier plus grand que 1 et i indique un entier positif ;
c) la détection d'un cadre optimal pour former une image élastique parmi les cadres extraits en utilisant un premier déplacement entre le n^{ème} cadre et chacun des cadres extraits basé sur les données ultrasoniques ;
d) le calcul d'un second déplacement entre le cadre optimal et le n^{ème} cadre basé sur les données ultrasoniques ; et
e) la formation de l'image élastique basée sur le second déplacement, dans lequel la phase c) comprend :

c1) le calcul du premier déplacement entre le n^{ème} cadre et chacun des cadres extraits basé sur les données ultrasoniques ;
c2) le calcul d'un premier effort basé sur chacun des premiers déplacements ;
c3) le calcul de la valeur minimale de l'effort basé sur chacun des premiers efforts ;
c4) la comparaison des valeurs d'effort minimale avec un niveau de seuil prédéterminé d'effort pour détecter au moins une valeur minimale d'effort correspondant au niveau de seuil prédéterminé d'effort ;
c5) le calcul de la déviation standard du premier effort pour au moins un cadre correspondant à ladite au moins une valeur d'effort minimale ; et

c6) la détection d'un cadre correspondant à une déviation minimale standard du cadre optimal, pour former une image élastique.

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FIG. 1

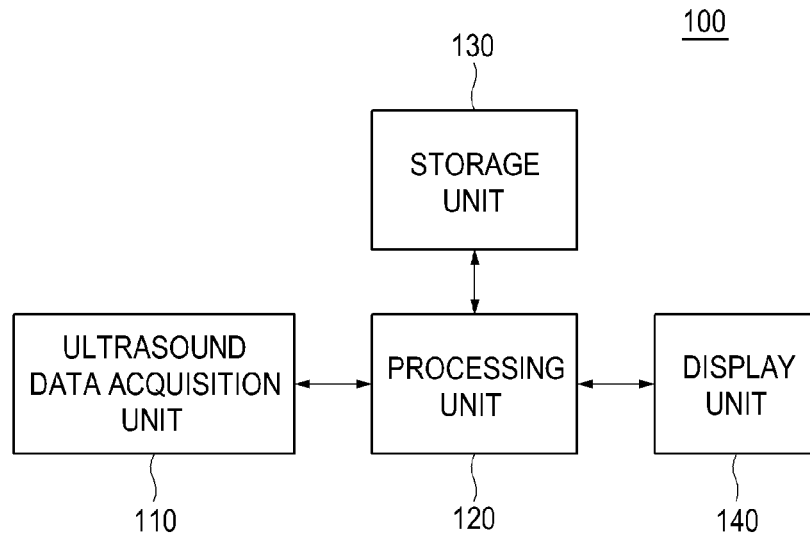


FIG. 2

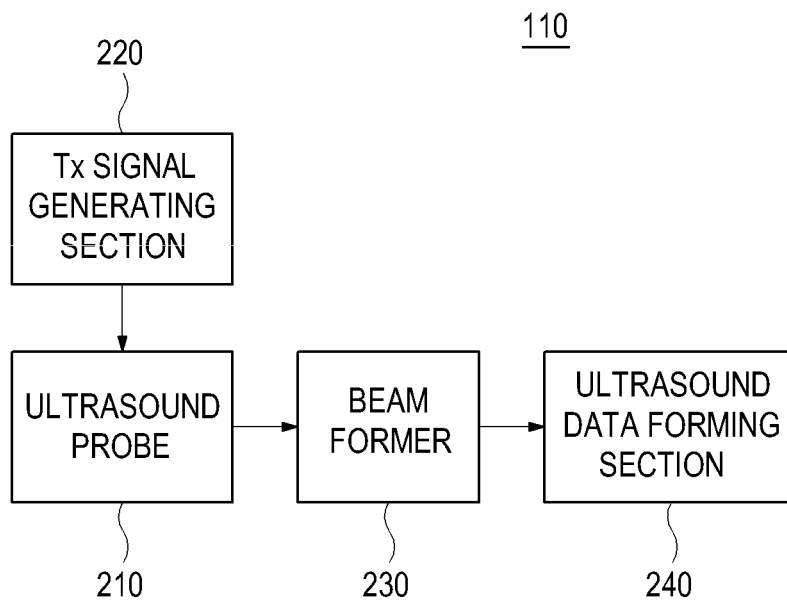


FIG. 3

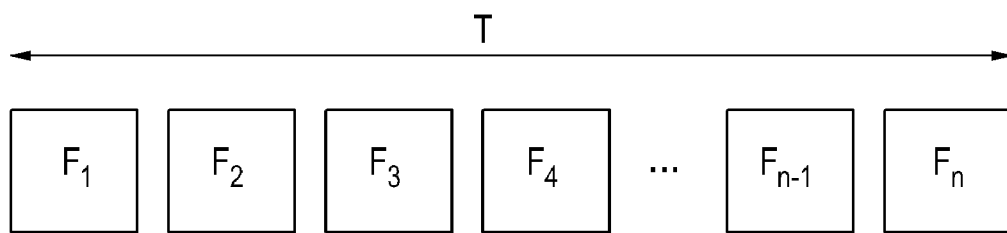


FIG. 4

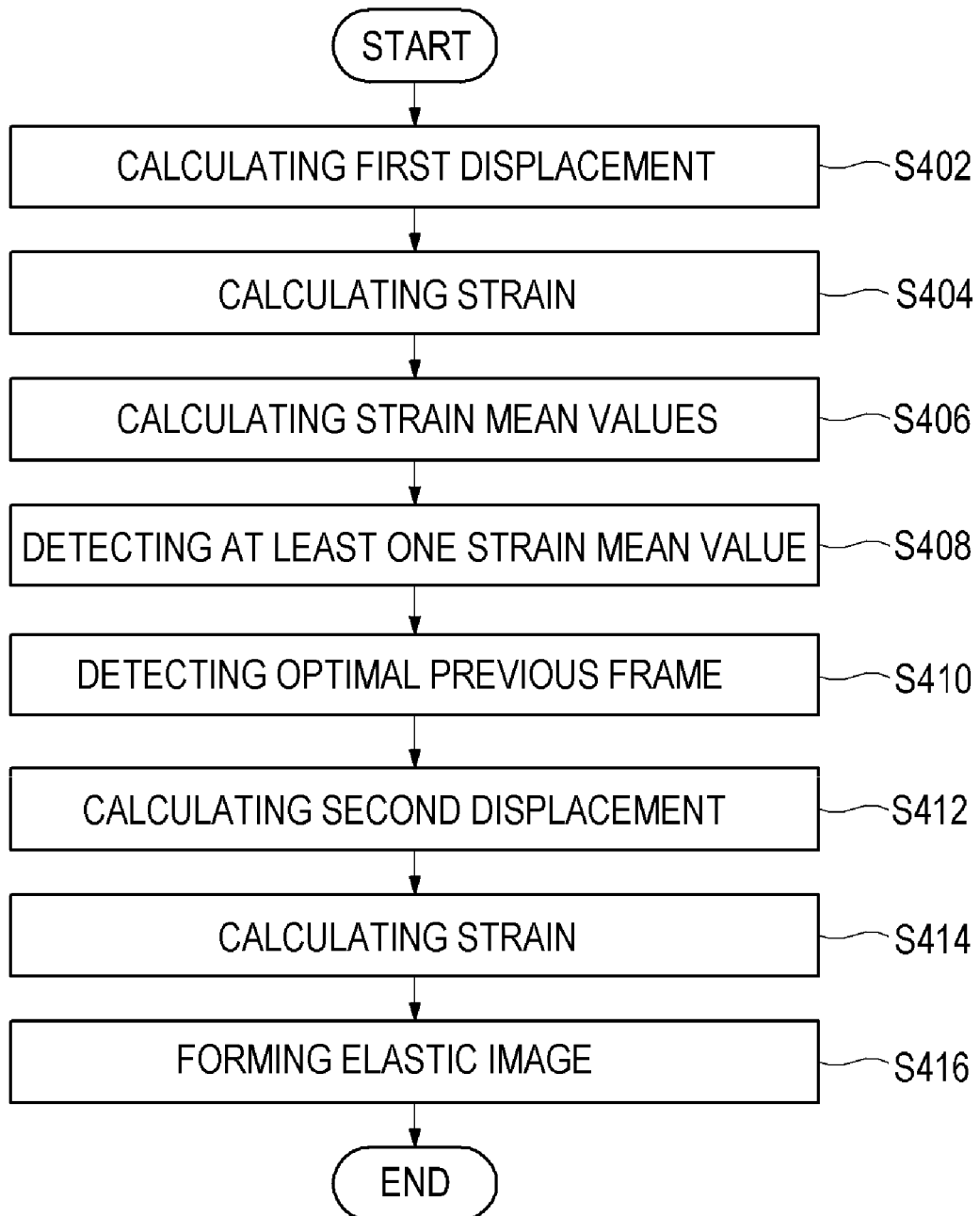


FIG. 5

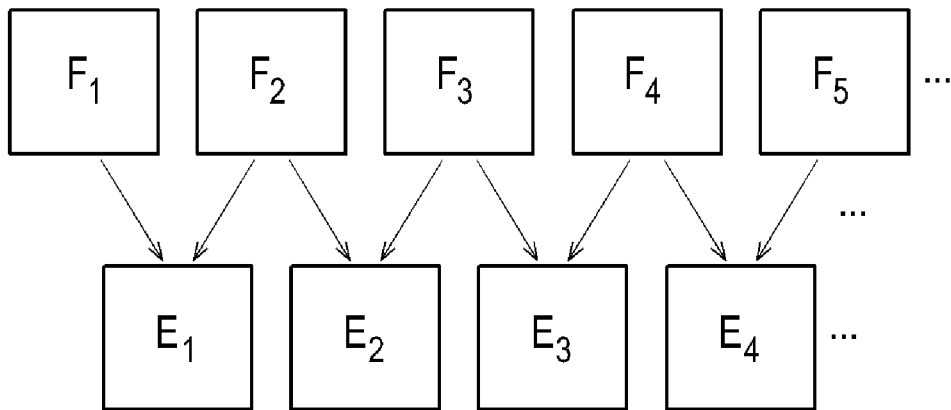


FIG. 6

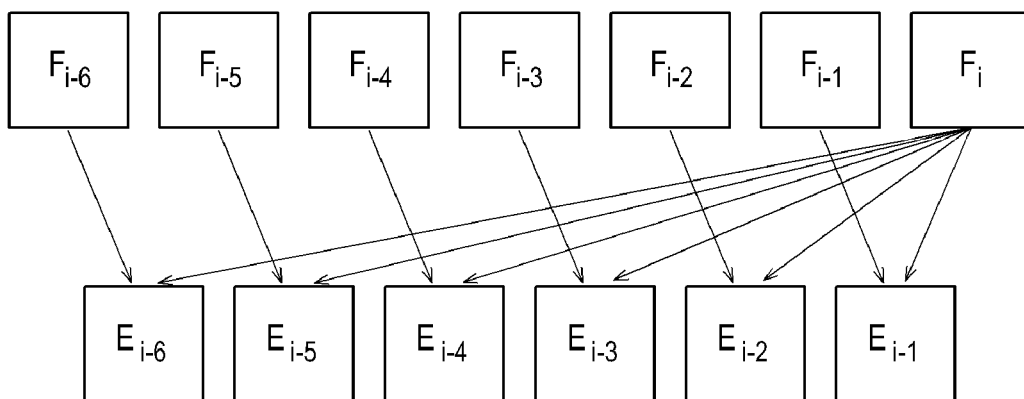


FIG. 7

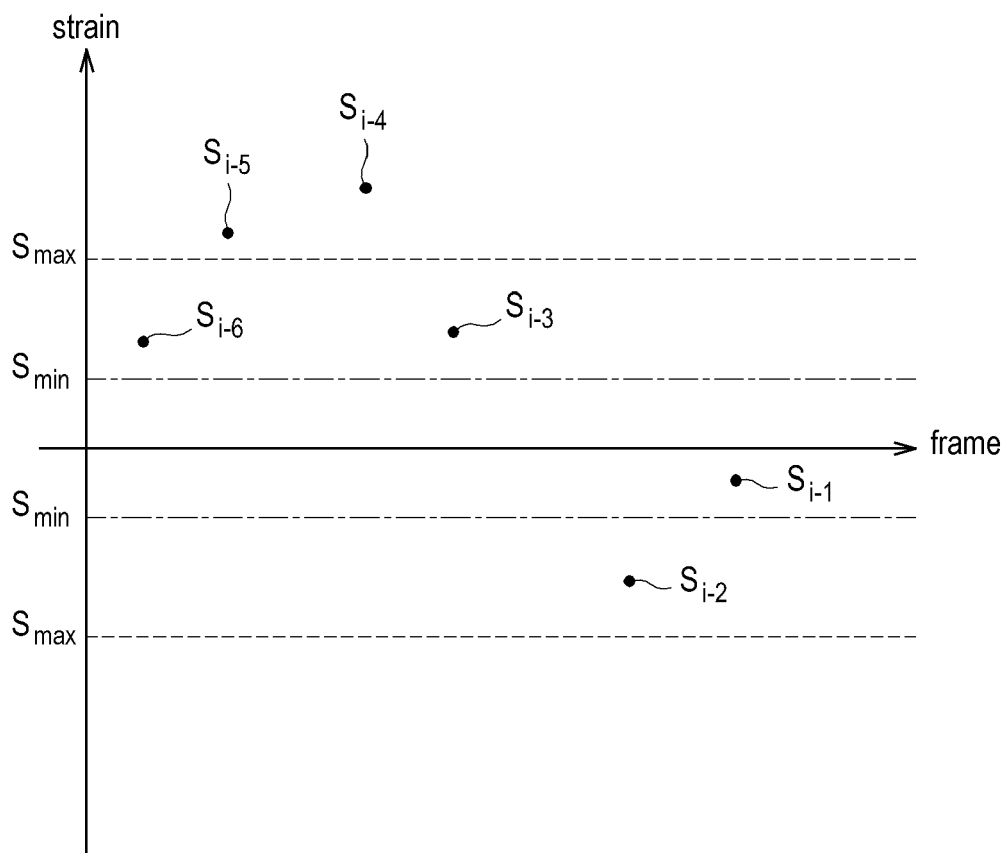


FIG. 8

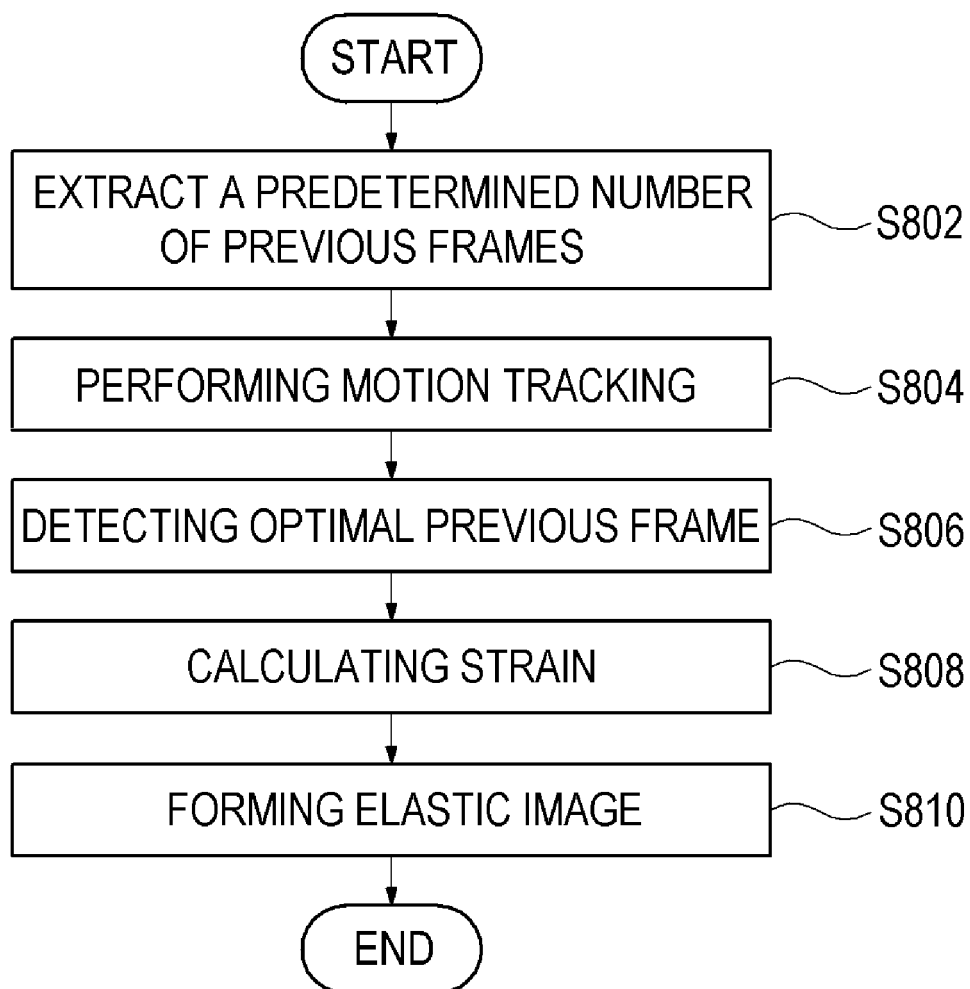


FIG. 9

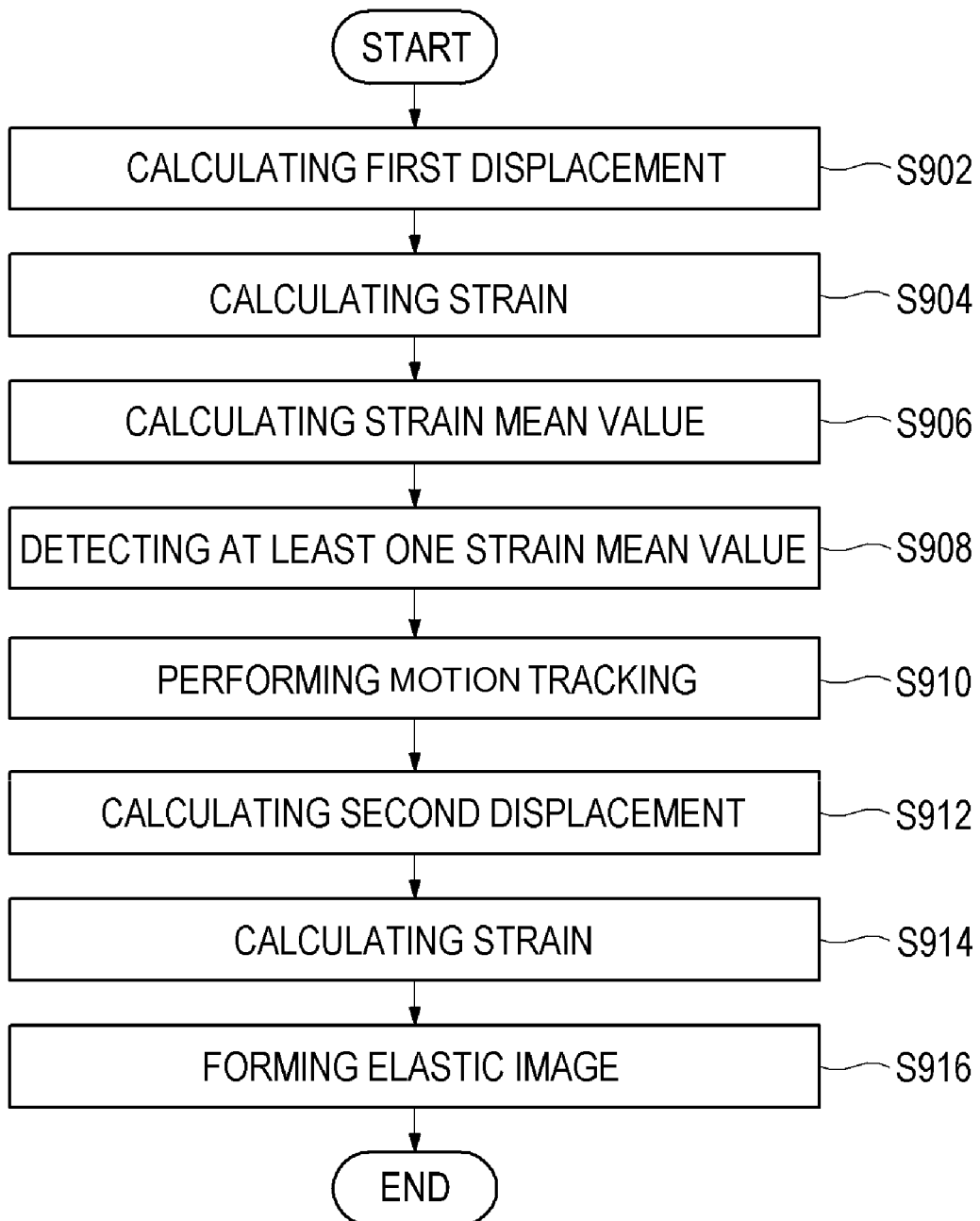
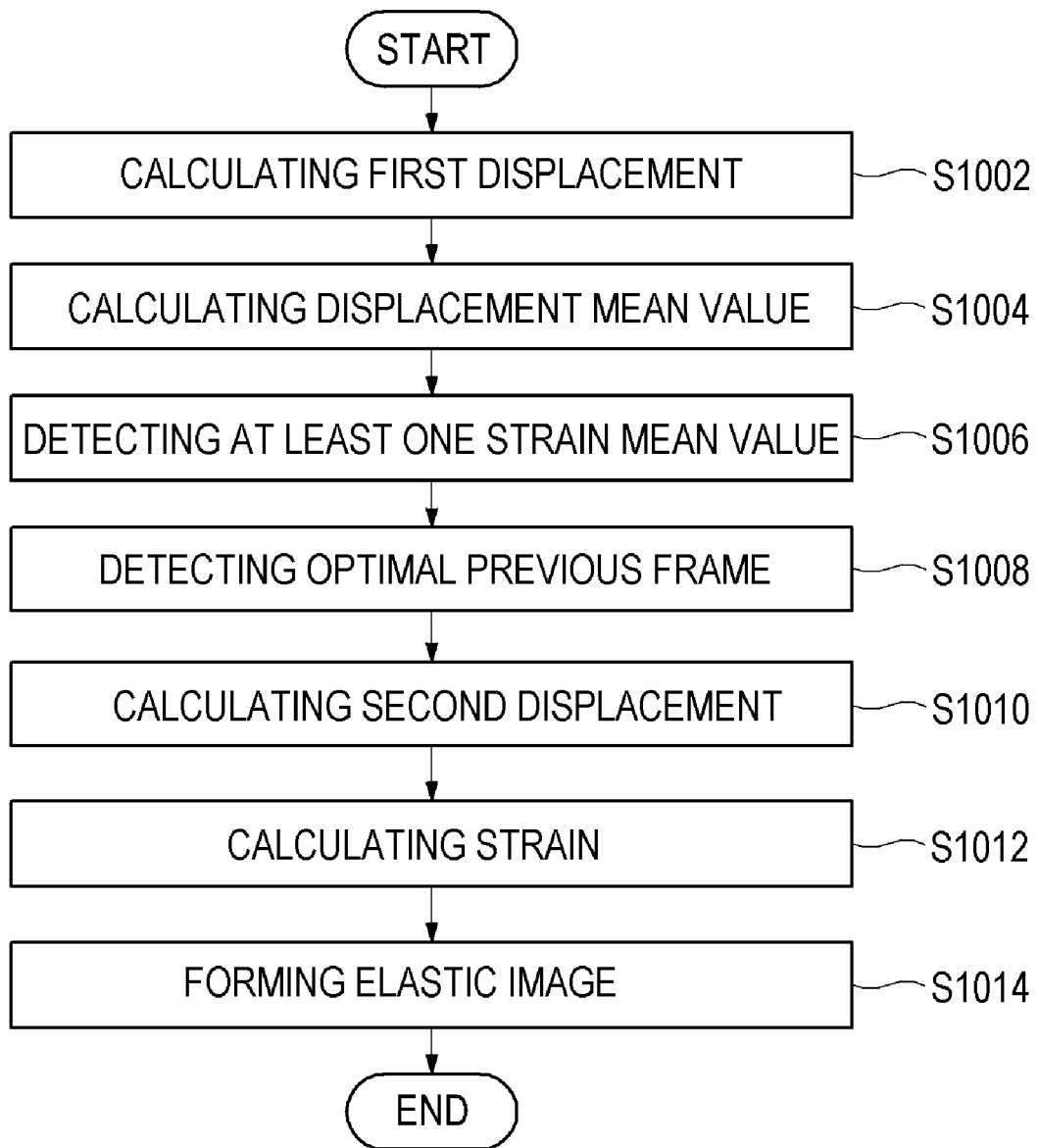


FIG. 10



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 1665987 A1 [0005]

专利名称(译)	在超声系统中提供弹性图像		
公开(公告)号	EP2394581B1	公开(公告)日	2018-03-28
申请号	EP2011168935	申请日	2011-06-07
[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	A61B8/08		
CPC分类号	A61B5/0053 A61B8/0833 A61B8/485 G01S7/52042 A61B5/0048		
代理机构(译)	SCHMID , WOLFGANG		
优先权	1020100054143 2010-06-09 KR		
其他公开文献	EP2394581A1		
外部链接	Espacenet		

摘要(译)

公开了用于提供弹性图像的实施例。在一个实施例中，超声系统包括：超声数据获取单元（110），被配置为向生物体发送超声信号并从生物体接收超声信号，以在对生物体施加压力的同时输出对应于多个帧的超声数据；处理单元（120），用于基于第s帧从第（n-1）帧到第（n）帧提取帧，其中n表示大于1的整数，i表示正整数，通过使用基于超声数据的第n帧与每个提取的帧之间的第一位移，检测用于在提取的帧中形成弹性图像的最佳帧，基于超声计算最佳帧与第n帧之间的第二位移数据，并基于第二位移形成弹性图像。

FIG. 1

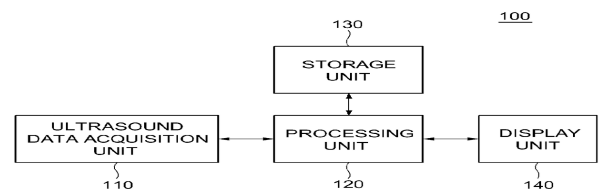


FIG. 2

