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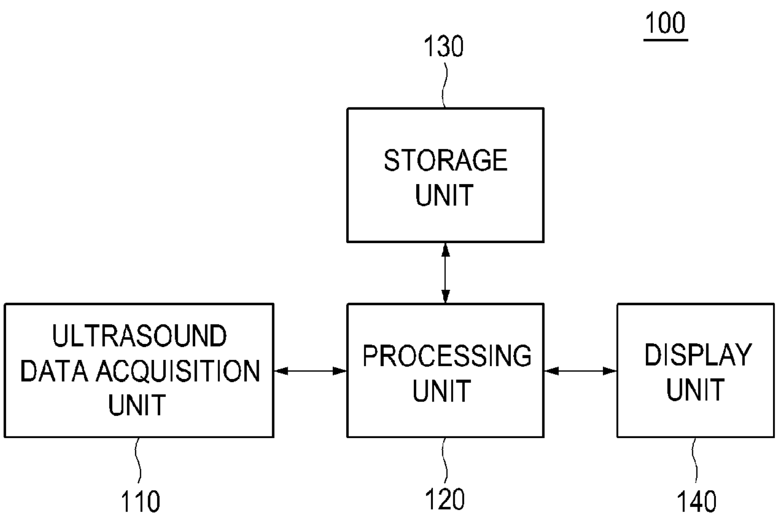
(54) Providing an elastic image in an ultrasound system

(57) Embodiments for providing an elastic image are disclosed. In one embodiment, an ultrasound system comprises: an ultrasound data acquisition unit (110) configured 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) configured to extract frames from a $(n-1)^{th}$ frame to a $(n-i)^{th}$ frame on a basis of a n^{th} frame, wherein n indicates an integer larger than one and i indicates a positive integer, detect an optimal frame for forming an elastic image among the extracted frames by using first displacement between the n^{th} frame and each of the extracted frames based on the ultrasound data, calculate second displacement between the optimal frame and the n^{th} frame based on the ultrasound data, and form the elastic image based on the second displacement.

FIG. 1



EP 2 394 581 A1

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority from Korean Patent Application No. 10-2010-0054143 filed on June 9, 2010.

TECHNICAL FIELD

[0002] The present disclosure generally relates to ultrasound systems, and more particularly to providing an elastic image in an ultrasound system.

BACKGROUND

[0003] Recently, an ultrasound system has been extensively used in the medical field due to its non-invasive and non-destructive nature. Modem high-performance ultrasound imaging systems and techniques are commonly used to produce two and three-dimensional ultrasound images of internal features of patients.

[0004] 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.

[0005] 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.

SUMMARY

[0006] Embodiments for forming an elastic image in an ultrasound system are disclosed herein. In one embodiment, by way of non-limiting example, an ultrasound system comprises: an ultrasound data acquisition unit configured 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 in communication with the ultrasound data acquisition unit, the processing unit being configured to extract frames from a $(n-1)^{th}$ frame to a $(n-i)^{th}$ frame on a basis of a n^{th} frame, wherein n indicates an integer larger than one and i indicates a positive integer, detect an optimal frame for forming an elastic image among the extracted frames by using first displacement between the n^{th} frame and each of the extracted frames based on the ultrasound data, calculate second displacement between the optimal frame and the n^{th} frame based on the ultrasound data, and form the elastic image based on the second displacement.

[0007] In another embodiment, there is provided a method of providing 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 $(n-1)^{th}$ frame to a $(n-i)^{th}$ 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 first displacement between the n^{th} frame and each of the extracted frames based on the ultrasound data; d) calculating 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.

[0008] 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.

FIG. 9 is a flow chart showing a process of forming an elastic image in accordance with a third embodiment.

FIG. 10 is a flow chart showing a process of forming an elastic image in accordance with a fourth embodiment.

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}-$_{l}$ to F_{i}-$_{6}$. The processing unit 120 is further configured to calculate the first displacements between the ROI of the current frame F; and the ROI of each of the extracted previous frames F_{i}-$_{1}$ to Fi-$_{6}$.

[0023] As yet another example, the processing unit 120 is configured to extract the predetermined number of the previous frames F_{i}-$_{1}$ to Fi-$_{6}$ based on the current frame F;. 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 Fi-$_{l}$ to F;-$_{6}$. 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;-$_{6}$ corresponding to the elastic images E_{i-1} to E;-$_{6}$ 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;-$_{6}$ based on the current frame F;. The processing unit 120 is further configured to set the ROI on the current frame F; and the previous frames F_{i}-$_{1}$ to F;-$_{6}$. 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; and each of the previous frames F_{i-1} to F;-$_{6}$. 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}-$_{l}$ 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 Si-$_{6}$, which are comprised in the strain threshold range S_{mm} 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 5410 in FIG. 4. For example, the processing unit 120 calculates standard deviation of the strain for the previous frames F;-$_{2}$, F;-$_{3}$ and F;-$_{6}$ 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 optima 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 5412 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 5416 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. 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. 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, ate 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. 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 optima 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

S 1012 in FIG. 10. The processing unit 120 is configured to form the optimal elastic image based on the strain, at step S 1014 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.

[0058] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the scope of the principles of this disclosure. More particularly, numerous variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

Claims

1. An ultrasound system, comprising:

an ultrasound data acquisition unit configured 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 in communication with the ultrasound data acquisition unit, the processing unit being configured to extract frames from a (n-1)th frame to a (n-i) ^{t}h frame on a basis of a nth frame, wherein n indicates an integer larger than one and i indicates a positive integer, detect an optimal frame for forming an elastic image among the extracted frames by using first displacement between the nth frame and each of the extracted frames based on the ultrasound data, calculate second displacement between the optimal frame and the nth frame based on the ultrasound data, and form the elastic image based on the second displacement.

2. The ultrasound system of Claim 1, wherein the processing unit is configured to:

calculate the first displacement between the nth frame and each of the extracted frames based on the ultrasound data;

calculate first strain based on the first displacement;

calculate strain mean values based on the first strain;

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;

detect the optimal frame base on the at least one strain mean value;

calculate the second displacement between the nth frame and the optimal frame based on the ultrasound data; and

form the elastic image based on the second displacement.

3. The ultrasound system of Claim 2, wherein the processing unit is configured to:

calculate standard deviation of the first strain for at least one frame corresponding to the at least one strain mean value; and

extract a frame corresponding to minimum standard deviation as the optimal frame.

4. The ultrasound system of Claim 2, wherein the processing unit is further configured to:

set a region of interest on each of the frames from the nth frame to the (n-i) th frame; and

calculate the first displacement corresponding to the region of interest.

5. The ultrasound system of Claim 2, wherein the processing unit is further configured to:

perform motion tracking between the nth frame and each of the extracted frames to calculate axial motion; and

calculate the first displacement based on the axial motion.

6. The ultrasound system of Claim 2, wherein the processing unit is further configured to:

set a region of interest on each of the frames from the nth frame to the (n-i) th frame;

perform motion tracking between the region of interest corresponding to the nth 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.

7. The ultrasound system of Claim 1, the processing unit is configured to;
perform motion tracking between the nth frame and

each of the extracted frames based on the ultrasound data to calculate lateral motion or elevation motion; and
detect the optimal frame corresponding to minimum lateral or elevation motion among the extracted frames based on the lateral motion or elevation motion.

8. The ultrasound system of Claim 1, the processing unit is configured to:

calculate the first displacement between the n^{th} frame and each of the extracted frames based on the ultrasound data;
calculate first strain based on each of the first displacement;
calculate strain mean values based on the first strain;
compare the strain mean values with a predetermined strain threshold range to detect at least one strain mean value corresponding to the strain threshold range;
perform motion tracking between the n^{th} frame and at least one frame corresponding to the at least one strain mean value to detect lateral motion or elevation motion;
detect the optimal frame corresponding to minimum lateral or elevation motion from the at least one frame corresponding to the at least one strain mean value based on the lateral motion or the elevation motion;
calculate the second displacement between the optimal frame and the n^{th} frame based on the ultrasound data;
calculate second strain based on the second displacement; and
form the elastic image based on the second strain.

9. The ultrasound system of Claim 1, the processing unit is configured to:

calculate the first displacement between the n^{th} frame and each of the extracted frames based on the ultrasound data;
calculate displacement mean values based on each of the first displacement;
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;
detect the optimal frame corresponding to minimum standard deviation based on the at least one displacement mean value corresponding to the displacement threshold range;
calculate the second displacement between the optimal frame and the n^{th} frame based on the ultrasound data;
calculate second strain based on the second displacement; and
form the elastic image based on the second strain.

10. 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 $(n-1)^{th}$ frame to a $(n-i)^{th}$ 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 first displacement between the n^{th} frame and each of the extracted frames based on the ultrasound data;
d) calculating 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.

11. The method of Claim 10, 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 first strain based on the first displacement;
c3) calculate strain mean values based on the first strain;
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; and
c5) detecting the optimal frame base on the at least one strain mean value.

12. The method of Claim 11, wherein the step c5) comprises:

calculating standard deviation of the first strain for at least one frame corresponding to the at least one strain mean value; and
extracting a frame corresponding to minimum standard deviation as the optimal frame.

13. The method of Claim 10, wherein the step c) comprises:

performing motion tracking between the n^{th} frame and each of the extracted frames based

on the ultrasound data to calculate lateral motion or elevation motion; and
detecting the optimal frame corresponding to minimum lateral or elevation motion among the extracted frames based on the lateral motion or elevation motion.

14. The method of Claim 10, the step c) comprises:

calculating the first displacement between the n^{th} frame and each of the extracted frames based on the ultrasound data;
calculating first strain based on each of the first displacement;
calculating strain mean values based on the first strain;
comparing the strain mean values with a predetermined strain threshold range to detect at least one strain mean value corresponding to the strain threshold range;
performing motion tracking between the n^{th} frame and at least one frame corresponding to the at least one strain mean value to detect lateral motion or elevation motion; and
detecting the optimal frame corresponding to minimum lateral or elevation motion from the at least one frame corresponding to the at least one strain mean value based on the lateral motion or the elevation motion.

15. The method of Claim 10, the step c) comprises:

calculating the first displacement between the n^{th} frame and each of the extracted frames based on the ultrasound data;
calculating displacement mean values based on each of the first displacement;
comparing the displacement mean values with a predetermined displacement threshold range to detect at least one displacement mean value corresponding to the displacement threshold range; and
detecting the optimal frame corresponding to minimum standard deviation based on the at least one displacement mean value corresponding to the displacement threshold range.

FIG. 1

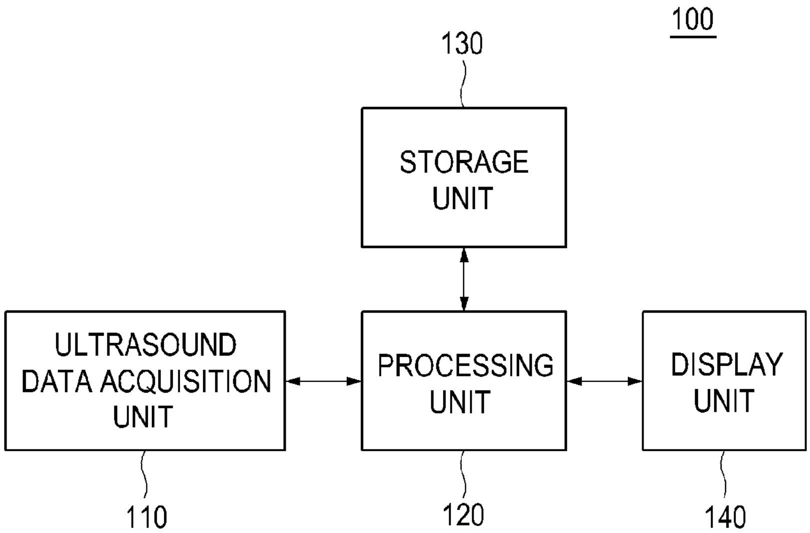

100
130
STORAGE UNIT
ULTRASOUND DATA ACQUISITION UNIT
PROCESSING UNIT
DISPLAY UNIT
110
120
140

FIG. 2

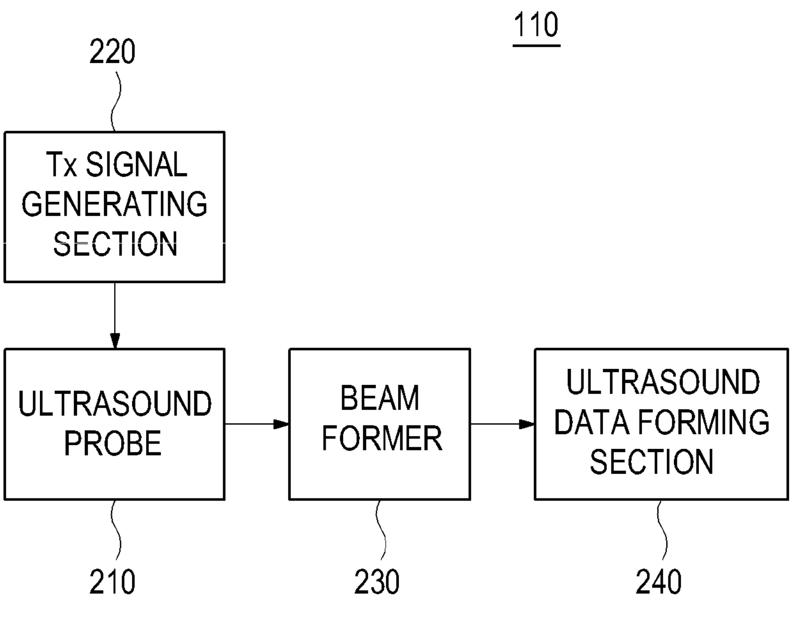

110
220
Tx SIGNAL GENERATING SECTION
ULTRASOUND PROBE
BEAM FORMER
ULTRASOUND DATA FORMING SECTION
210
230
240

FIG. 3

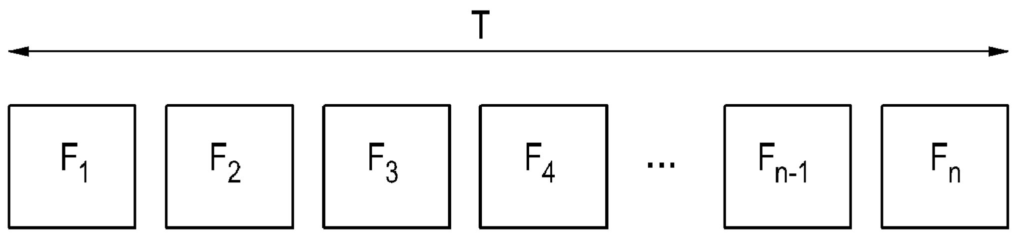


FIG. 4

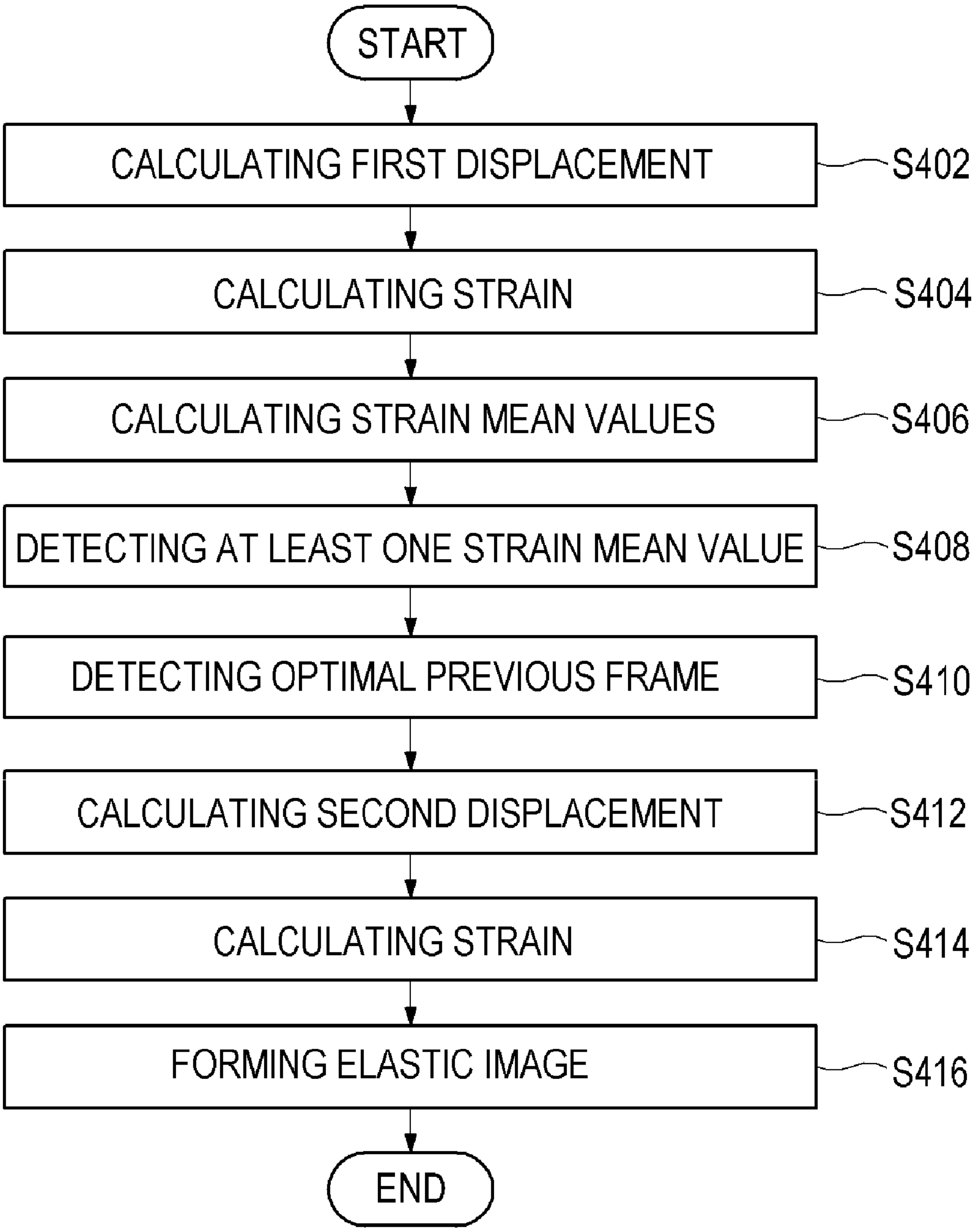

START
CALCULATING FIRST DISPLACEMENT
S402
CALCULATING STRAIN
S404
CALCULATING STRAIN MEAN VALUES
S406
DETECTING AT LEAST ONE STRAIN MEAN VALUE
S408
DETECTING OPTIMAL PREVIOUS FRAME
S410
CALCULATING SECOND DISPLACEMENT
S412
CALCULATING STRAIN
S414
FORMING ELASTIC IMAGE
S416
END

FIG. 5

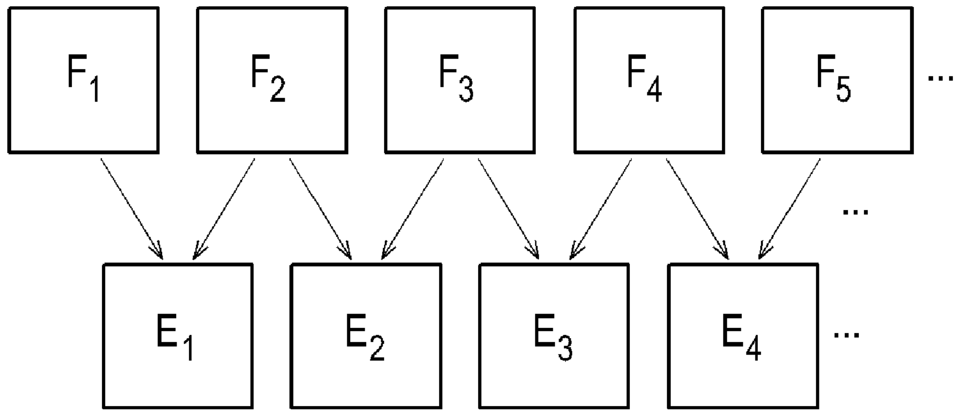

F_1
F_2
F_3
F_4
F_5
...
...
E_1
E_2
E_3
E_4
...

FIG. 6

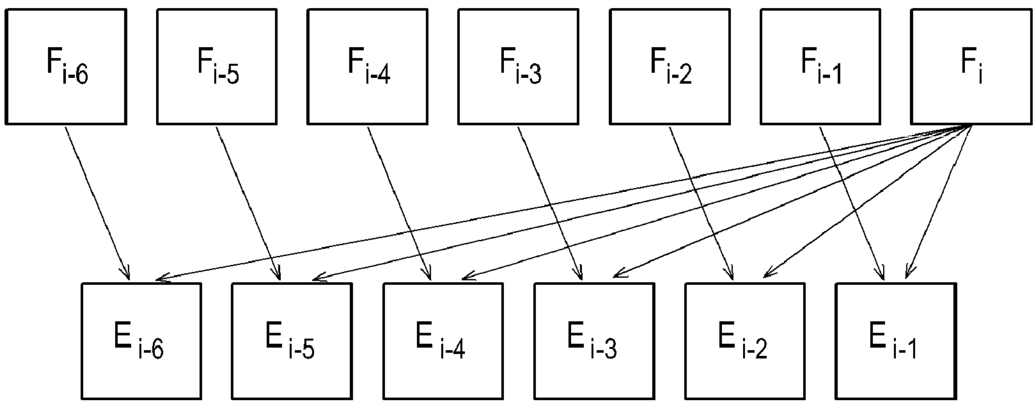

F_{i-6}
F_{i-5}
F_{i-4}
F_{i-3}
F_{i-2}
F_{i-1}
F_i
E_{i-6}
E_{i-5}
E_{i-4}
E_{i-3}
E_{i-2}
E_{i-1}

FIG. 7

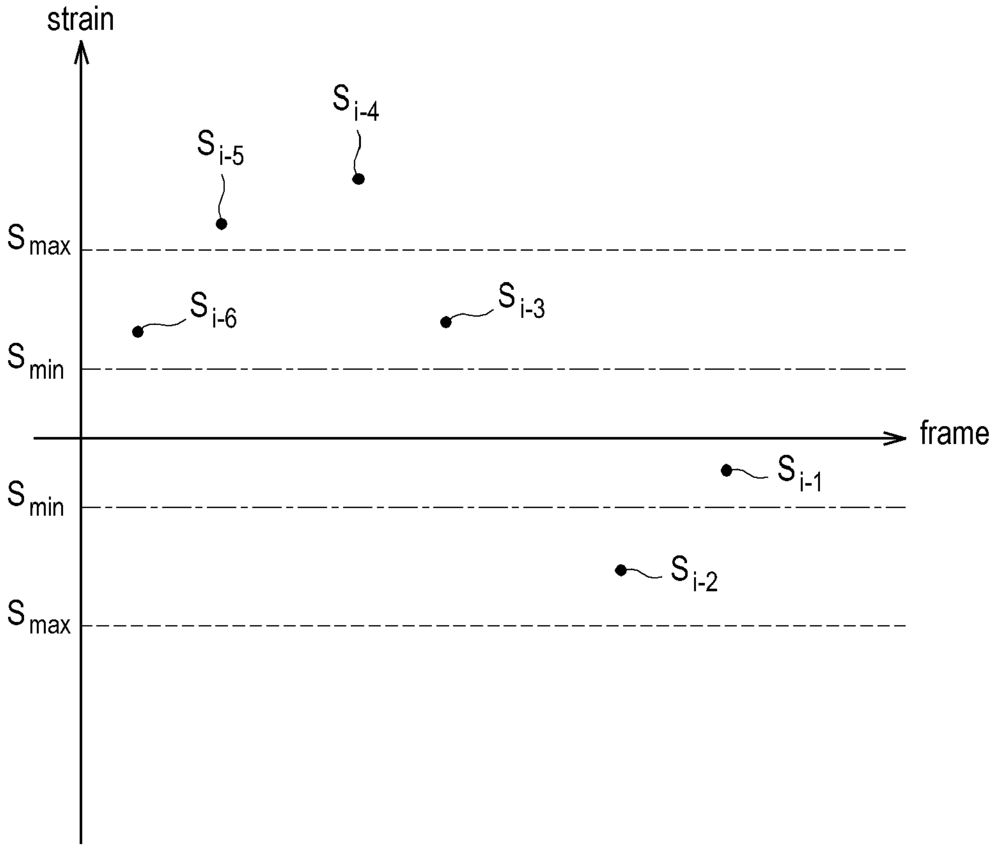


FIG. 8

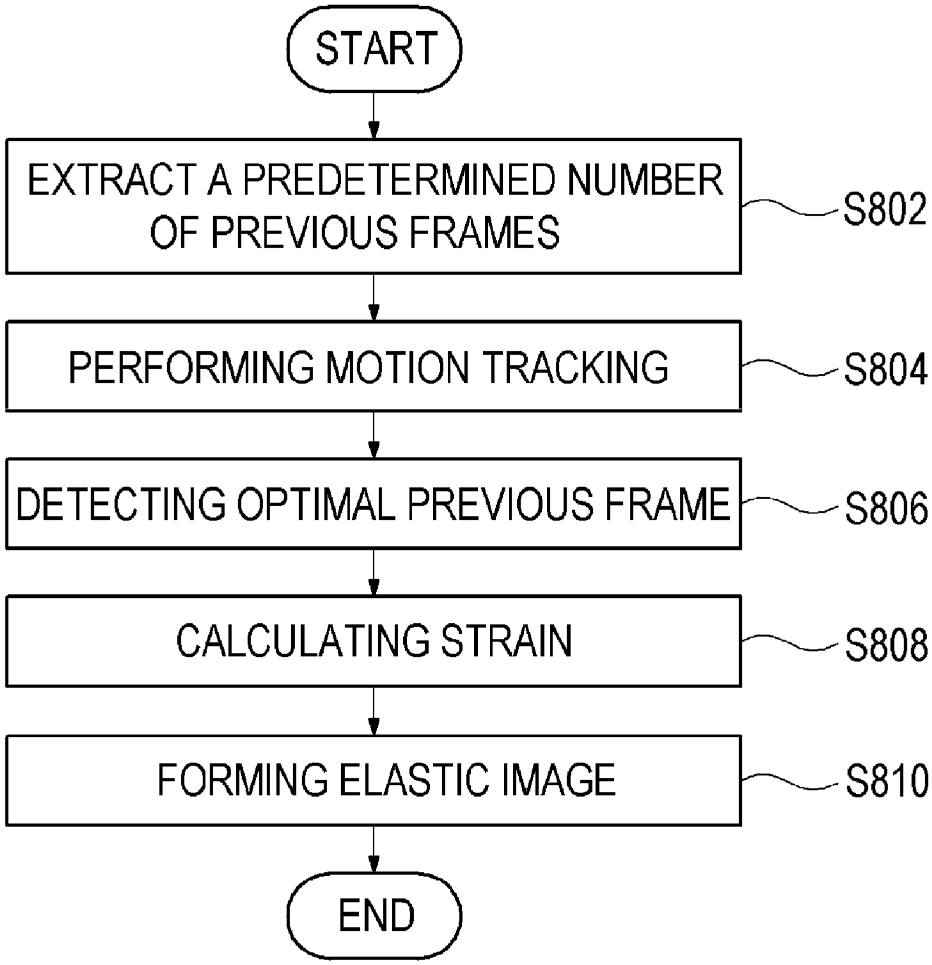

START
EXTRACT A PREDETERMINED NUMBER OF PREVIOUS FRAMES
S802
PERFORMING MOTION TRACKING
S804
DETECTING OPTIMAL PREVIOUS FRAME
S806
CALCULATING STRAIN
S808
FORMING ELASTIC IMAGE
S810
END

FIG. 9

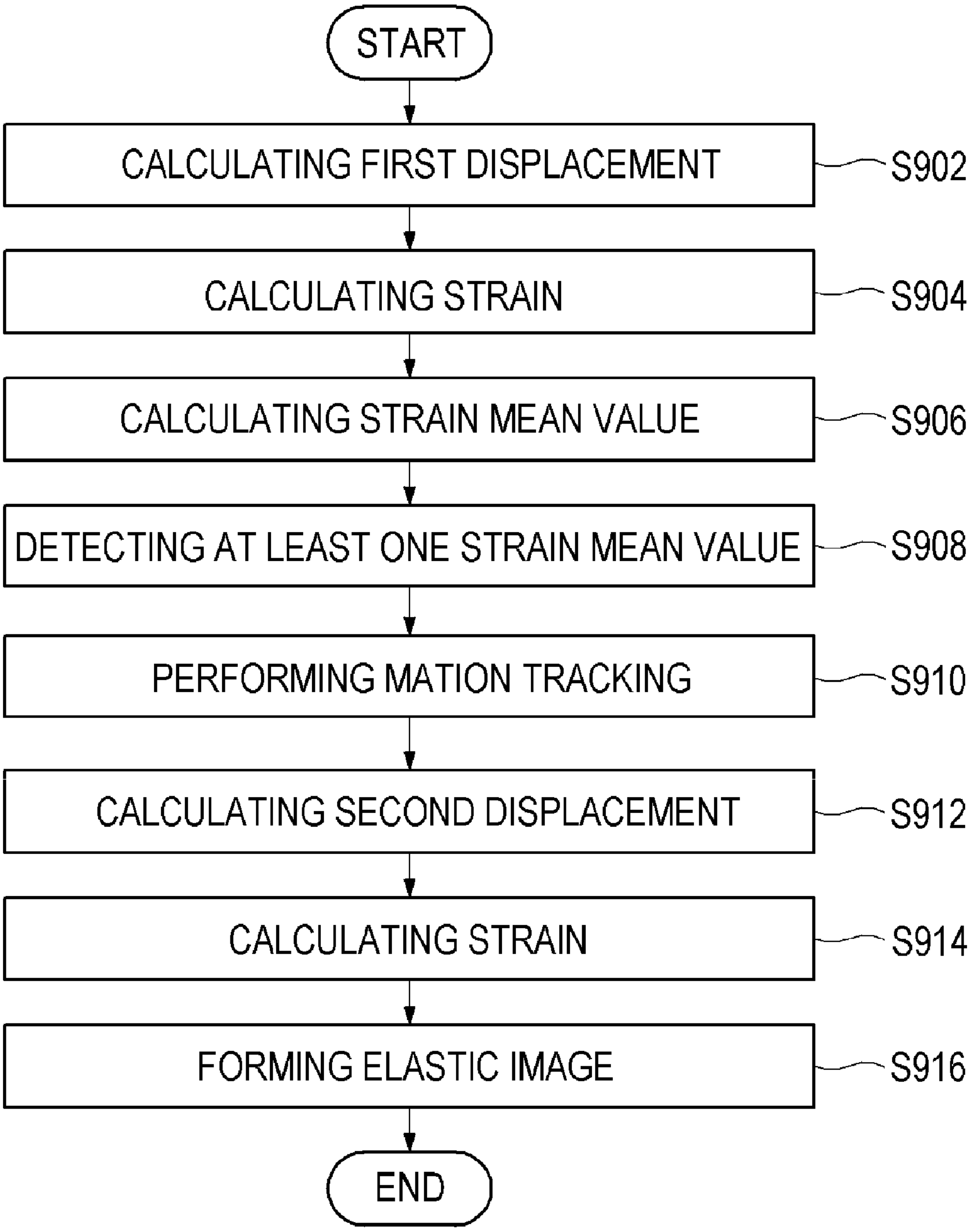
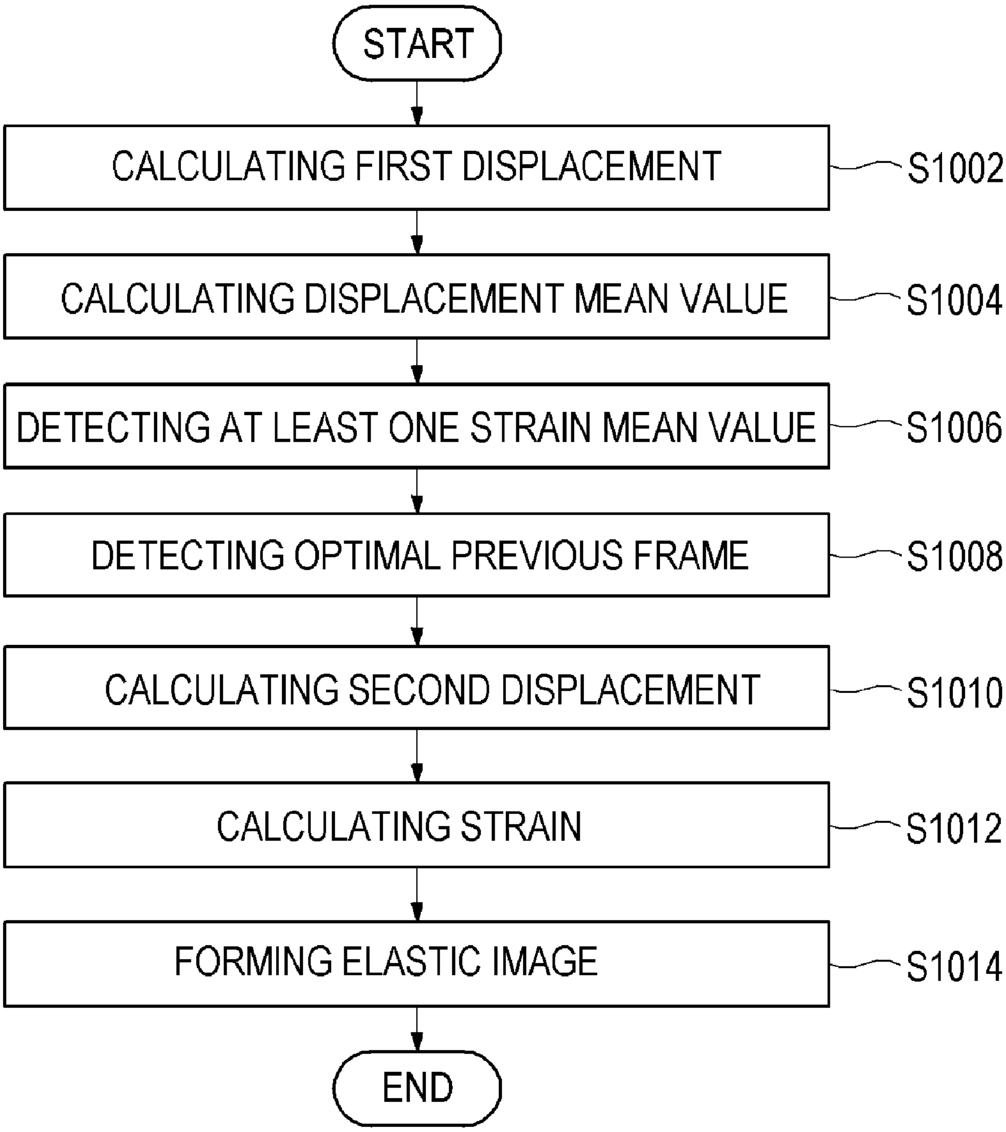

START
CALCULATING FIRST DISPLACEMENT
S902
CALCULATING STRAIN
S904
CALCULATING STRAIN MEAN VALUE
S906
DETECTING AT LEAST ONE STRAIN MEAN VALUE
S908
PERFORMING MATION TRACKING
S910
CALCULATING SECOND DISPLACEMENT
S912
CALCULATING STRAIN
S914
FORMING ELASTIC IMAGE
S916
END

FIG. 10


START
CALCULATING FIRST DISPLACEMENT
S1002
CALCULATING DISPLACEMENT MEAN VALUE
S1004
DETECTING AT LEAST ONE STRAIN MEAN VALUE
S1006
DETECTING OPTIMAL PREVIOUS FRAME
S1008
CALCULATING SECOND DISPLACEMENT
S1010
CALCULATING STRAIN
S1012
FORMING ELASTIC IMAGE
S1014
END

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 11 16 8935

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 1 665 987 A1 (HITACHI MEDICAL CORP [JP]) 7 June 2006 (2006-06-07) * paragraphs [0010], [0060] * * figures 1,13 * -----	1-15	INV. A61B8/08
A	WO 2009/001077 A2 (ISIS INNOVATION [GB]; KADOUR MICHAEL JOSEPH [GB] ISIS INNOVATION [GB];) 31 December 2008 (2008-12-31) * figure 2 * -----	1-15	
A	EP 1 815 796 A1 (HITACHI MEDICAL CORP [JP]) 8 August 2007 (2007-08-08) * figure 12 * -----	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

A61B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	20 September 2011	Willig, Hendrik

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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O : non-written disclosure
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 11 16 8935

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The members are as contained in the European Patent Office EDP file on
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20-09-2011

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EP 1665987 A1	07-06-2006	WO 2005025425 A1	24-03-2005
		JP 4685633 B2	18-05-2011
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WO 2009001077 A2	31-12-2008	EP 2160136 A2	10-03-2010
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Patent documents cited in the description

- KR 1020100054143 **[0001]**

专利名称(译)	在超声系统中提供弹性图像		
公开(公告)号	EP2394581A1	公开(公告)日	2011-12-14
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.		
当前申请(专利权)人(译)	三星MEDISON CO.，LTD.		
[标]发明人	PARK SANG SHIK		
发明人	PARK, SANG SHIK		
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	EP2394581B1		
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），用于根据第n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帧和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，基于超声数据计算最佳帧和第n帧之间的第二位移，并基于第二位移形成弹性图像。

FIG. 1