



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.01.2010 Bulletin 2010/03

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

(21) Application number: **09164404.7**

(22) Date of filing: **02.07.2009**

(84) Designated Contracting States:
**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 SE SI SK SM TR**

(30) Priority: **16.07.2008 KR 20080068909**

(71) Applicant: **MEDISON CO., LTD.**
Kangwon-do 250-870 (KR)

(72) Inventors:
• **Kim, Jong Sik**
135-851 Seoul (KR)
• **Shin, Dong Kuk**
135-851 Seoul (KR)

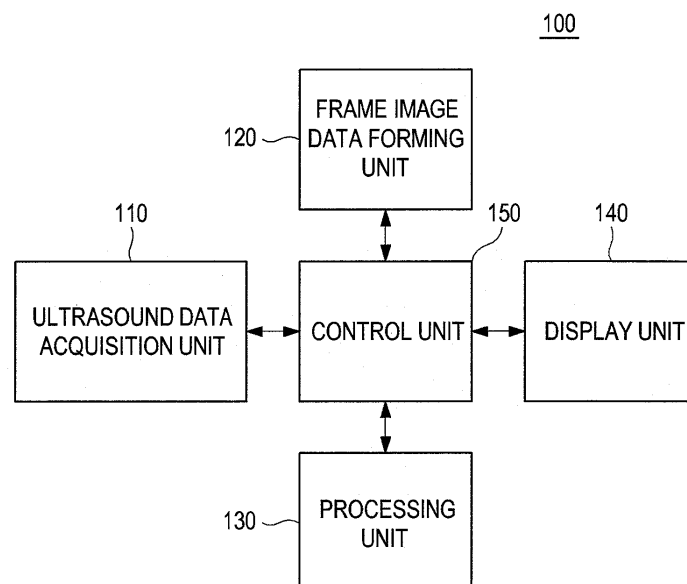
(74) Representative: **Schmid, Wolfgang**
Lorenz & Kollegen
Patentanwälte Partnerschaftsgesellschaft
Alte Ulmer Straße 2
89522 Heidenheim (DE)

(54) **Formation of an elastic image using an ultrasound apparatus**

(57) Embodiments for forming an elastic image in an ultrasound system are disclosed. In one embodiment, an ultrasound data acquisition unit is configured to transmit/receive ultrasound signals to/from a target object to thereby output first ultrasound data. The ultrasound data acquisition unit is configured to transmit/receive ultrasound signals to/from the target object while applying pressure to the target object to thereby output second ultrasound data. A frame image data forming unit is configured to form a first frame image data based on the first

ultrasound data. The frame image data forming unit is configured to form a second frame image data based on the second ultrasound data. A processing unit is configured to calculate strain data based on the first and second frame image data. The processing unit is configured to set a reference value based on the strain data. The processing unit is configured to form an elastic image based on the reference value. A control unit is coupled to the ultrasound data acquisition unit, the frame image data forming unit and the processing unit.

FIG. 1



Description

[0001] The present application claims priority from Korean Patent Application No. 10-2008-0068909 filed on July 16, 2008, the entire subject matter of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure generally relates to ultrasound systems, and more particularly to the formation of 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. Modern high-performance ultrasound imaging systems and techniques are commonly used to produce two dimensional ultrasound images 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 application of 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 be varied 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/receive ultrasound signals to/from a target object to thereby output first ultrasound data and to transmit/receive ultrasound signals to/from the target

object while applying pressure to the target object to thereby output second ultrasound data; a frame image data forming unit configured to form a first frame image data based on the first ultrasound data, the frame image data forming unit being further configured to form a second frame image data based on the second ultrasound data; a processing unit configured to calculate strain data based on the first and second frame image data and to set a reference value based on the strain data, the processing unit being further configured to form an elastic image based on the reference value; and a control unit coupled to the ultrasound data acquisition unit, the frame image data forming unit and the processing unit, the control unit being configured to control transmission/reception of the ultrasound signals and formation of the first and second frame image data.

[0007] In another embodiment, there is provided a method of forming an elastic image in an ultrasound system, comprising: a) transmitting/receiving by using an ultrasound data acquisition unit within the ultrasound system ultrasound signals to/from a target object to thereby output first ultrasound data; b) forming by using a processing unit within the ultrasound system a first frame image data based on the first ultrasound data; c) transmitting/receiving by using the ultrasound data acquisition unit within the ultrasound system ultrasound signals to/from the target object while applying pressure to the target object to thereby output second ultrasound data; d) forming by using the processing unit within the ultrasound system a second frame image data based on the second ultrasound data; and e) calculating by using the processing unit within the ultrasound system strain data based on the first and second frame data, setting a reference value based on the strain data, and forming an elastic image based on the reference value.

[0008] In yet another embodiment, there is provided a computer readable medium comprising computer executable instructions configured to perform the following acts: a) transmitting/receiving ultrasound signals to/from a target object to thereby output first ultrasound data; b) forming a first frame image data based on the first ultrasound data; c) transmitting/receiving ultrasound signals to/from the target object while applying pressure to the target object to thereby output second ultrasound data; d) forming a second frame image data based on the second ultrasound data; and e) calculating strain data based on the first and second frame data, setting a reference value based on the strain data, and forming an elastic image based on the reference value.

[0009] 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

[0010]

- 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 block diagram showing an illustrative embodiment of a processing unit.
- FIG. 4 is a schematic diagram showing an example of a histogram.

DETAILED DESCRIPTION

[0011] 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. Other embodiments of the present invention may readily suggest themselves to such skilled persons having the benefit of this disclosure.

[0012] Referring to FIG. 1, an ultrasound system 100 in accordance with an illustrative embodiment is shown. As depicted therein, the ultrasound system 100 may include an ultrasound data acquisition unit 110. The ultrasound data acquisition unit 110 may be operable to transmit/receive ultrasound signals to/from a target object to thereby output ultrasound data. The ultrasound data acquisition unit 110 may include a transmit (Tx) signal generating section 111, as shown in FIG. 2.

[0013] Referring to FIG. 2, the Tx signal generating section 111 may be operable to generate first Tx signals before applying pressure to the target object. The Tx signal generating section 111 may be further operable to generate second Tx signals while applying the pressure to the target object.

[0014] The ultrasound data acquisition unit 110 may further include an ultrasound probe 112 containing a plurality of elements for reciprocally converting between ultrasound signals and electrical signals. The ultrasound probe 112 may be operable to transmit ultrasound signals into the target object in response to the first Tx signals. The ultrasound probe 112 may be further operable to receive echo signals reflected from the target object to thereby output first received signals. The received signals may be analog signals. The ultrasound probe 112 may be further operable to transmit ultrasound signals into the target object in response to the second Tx signals. The ultrasound probe 112 may be further operable to receive echo signals reflected from the target object to thereby output second received signals.

[0015] The ultrasound data acquisition unit 110 may further include a beam former 113. The beam former 113 may be operable to convert the first received signals into first digital signals. The beam former 113 may be further operable to apply delays to the first digital signals in con-

sideration of distance between the elements and focal points to thereby output first digital receive-focused signals. The beam former 113 may be further operable to convert the second received signals into second digital signals.

The beam former 113 may be further operable to apply delays to the second digital signals in consideration of distance between the elements and focal points to thereby output second digital receive-focused signals.

[0016] The ultrasound data acquisition unit 110 may further include an ultrasound data forming section 114. The ultrasound data forming section 114 may be operable to form first ultrasound data based on the first digital receive-focused signals. The ultrasound data forming section 114 may be further operable to form second ultrasound data based on the second digital receive-focused signals.

[0017] Referring back to FIG. 1, the ultrasound system 100 may further include a frame image data forming unit 120 that may be operable to form frame image data. The frame image may include a brightness mode (B-mode) image represented with gray scales based on reflectivity of the ultrasound signals in the target object. The frame image data forming unit 120 may be operable to form first frame image data of a first frame image based on the first ultrasound data. The frame image data forming unit 120 may be further operable to form second frame image data of a second frame image based on the second ultrasound data.

[0018] The ultrasound system 100 may further include a processing unit 130 that may be operable to form an elastic image. The processing unit 130 may include a displacement calculating section 131, as shown in FIG. 3.

[0019] Referring to FIG. 3, the displacement calculating section 131 may be operable to calculate displacements between the first and second frame image data. The displacement may be calculated on pixel-by-pixel or block-by-block basis between the first and second frame images by using the first and second frame image data. Also, the displacement may be calculated by using a cross-correlation or an auto-correlation.

[0020] The processing unit 130 may further include a strain data calculating section 132. The strain data calculating section 132 may be operable to calculate strain data based on the displacements.

[0021] The processing unit 130 may further include a reference value setting section 133 that may be operable to set a reference value. The reference value may include one of a maximum value of frequency numbers of numerical values of the strain data and a mean value of the numerical values of the strain data. In one embodiment, the reference value setting section 133 may be operable to normalize the strain data to thereby form a histogram by using the strain data, as shown in FIG. 4. The reference value setting section 133 may be further operable to analyze the histogram to thereby detect a maximum value of frequency numbers of the numerical values of the strain data. The reference value setting section 133

may be operable to set the detected maximum value as the reference value. In one embodiment, the reference value setting section 133 may be operable to calculate a mean value of the numerical values of the strain data. The reference value setting section 133 may be further operable to set the mean value as the reference value.

[0022] The processing unit 130 may further include an elastic image forming section 134.

The elastic image forming section 134 may be operable to form an elastic image based on the reference value. In one embodiment, the elastic image forming section 134 may be operable to detect strain data that are less than the reference value. The elastic image forming section 134 may be further operable to form the elastic image based on the detected strain data. The elastic image may be an elastic image of a stiff tissue (e.g., lesion). In one embodiment, the elastic image forming section 134 may be operable to detect strain data that are greater than the reference value. The elastic image forming section 134 may be further operable to form the elastic image based on the detected strain data. The elastic image may be an elastic image of a soft tissue. In one embodiment, the elastic image forming section 134 may be operable to detect strain data that are less and greater than the reference value. The elastic image forming section 134 may be further operable to form the elastic image based on the detected strain data.

[0023] Referring back to FIG. 1, the ultrasound system 100 may further include a display unit 140. The display unit 140 may be operable to display the elastic image formed in the processing unit 130.

[0024] The ultrasound system 100 may further include a control unit 150. The control unit 150 may be operable to control the transmission/reception of the ultrasound signals and formation of the ultrasound data in the ultrasound data acquisition unit 110. The control unit 150 may be further operable to control the formation of first and second frame image data in the frame image data forming unit 120. The control unit 150 may be further operable to control the formation of the elastic image in the processing unit 130. The control unit 150 may be further operable to control the display of the elastic image.

[0025] 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 spirit and 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/receive ultrasound signals to/from a target object to thereby output first ultrasound data and to transmit/receive ultrasound signals to/from the target object while applying a pressure to the target object to thereby output second ultrasound data;
a frame image data forming unit configured to form a first frame image data based on the first ultrasound data and to form a second frame image data based on the second ultrasound data;
a processing unit configured to calculate strain data based on the first and second frame image data and to set a reference value based on the strain data, the processing unit being further configured to form an elastic image based on the reference value; and
a control unit coupled to the ultrasound data acquisition unit, the frame image data forming unit and the processing unit, the control unit being configured to control transmission/reception of the ultrasound signals and formation of the first and second frame image data.

2. The ultrasound system of Claim 1, wherein the processing unit comprises:

a displacement calculating section configured to calculate displacements between the first and second frame image data;
a strain data calculating section configured to calculate the strain data based on the displacements;
a reference value setting section configured to set the reference value based on the strain data; and
an elastic image forming section configured to form the elastic image based on the reference value.

3. The ultrasound system of Claim 2, wherein the reference value setting section is configured to detect a maximum value of frequency numbers of numerical values of the strain data and to set the detected maximum value as the reference value.

4. The ultrasound system of Claim 2, wherein the reference value setting section is configured to calculate a mean value of numerical values of the strain data and to set the mean value as the reference value.

5. The ultrasound system of Claim 2, wherein the elastic image forming section is configured to detect

strain data that are less than the reference value and to form the elastic image based on the detected strain data.

6. The ultrasound system of Claim 2, wherein the elastic image forming section is configured to detect strain data that are greater than the reference value and to form the elastic image based on the detected strain data.

7. The ultrasound system of Claim 2, wherein the elastic image forming section is configured to detect strain data that are less and greater than the reference value and to form the elastic image based on the detected strain data.

8. A method of forming an elastic image in an ultrasound system, comprising:

- a) transmitting/receiving by using an ultrasound data acquisition unit within the ultrasound system ultrasound signals to/from a target object to thereby output first ultrasound data;
- b) forming by using a processing unit within the ultrasound system a first frame image data based on the first ultrasound data;
- c) transmitting/receiving by using the ultrasound data acquisition unit within the ultrasound system ultrasound signals to/from the target object while applying pressure to the target object to thereby output second ultrasound data;
- d) forming by using the processing unit within the ultrasound system a second frame image data based on the second ultrasound data; and
- e) calculating by using the processing unit within the ultrasound system strain data based on the first and second frame data, setting a reference value based on the strain data and forming an elastic image based on the reference value.

9. The method of Claim 8, wherein the step e) comprises:

- e1) calculating displacements between the first and second frame image data;
- e2) calculating the strain data based on the displacements;
- e3) setting the reference value based on the strain data; and
- e4) forming the elastic image based on the reference value.

10. The method of Claim 9, the step e3) comprises:

- detecting a maximum value of frequency numbers of numerical values of the strain data; and
- setting the detected maximum value as the reference value.

11. The method of Claim 9, wherein the step e3) comprises:

- calculating a mean value of numerical values of the strain data; and
- setting the mean value as the reference value.

12. The method of Claim 9, wherein the step e4) comprises:

- detecting strain data that are less than the reference value; and
- forming the elastic image based on the detected strain data.

13. The method of Claim 9, wherein the step e4) comprises:

- detecting strain data that are greater than the reference value; and
- forming the elastic image based on the detected strain data.

14. The method of Claim 9, wherein the step e4) comprises:

- detecting strain data that are less and greater than the reference value; and
- forming the elastic image based on the detected strain data.

FIG. 1

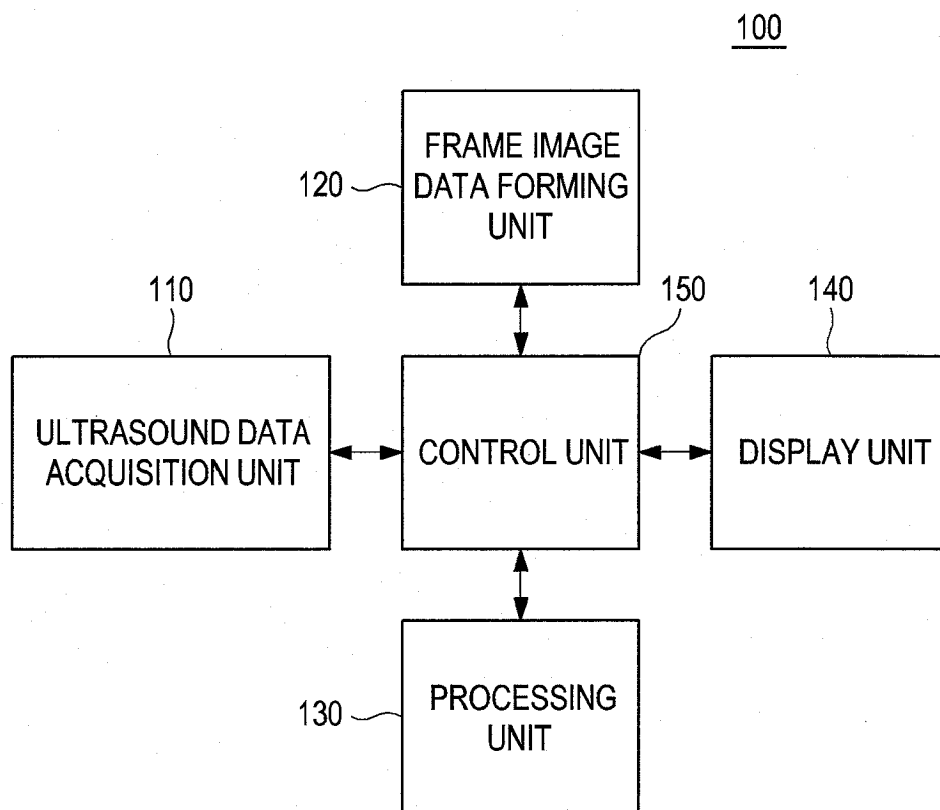


FIG. 2

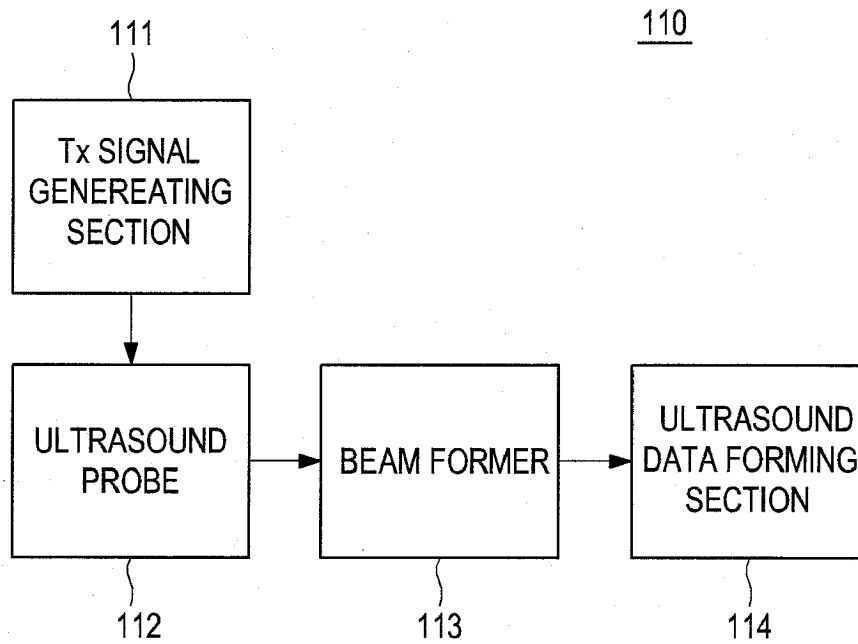


FIG. 3

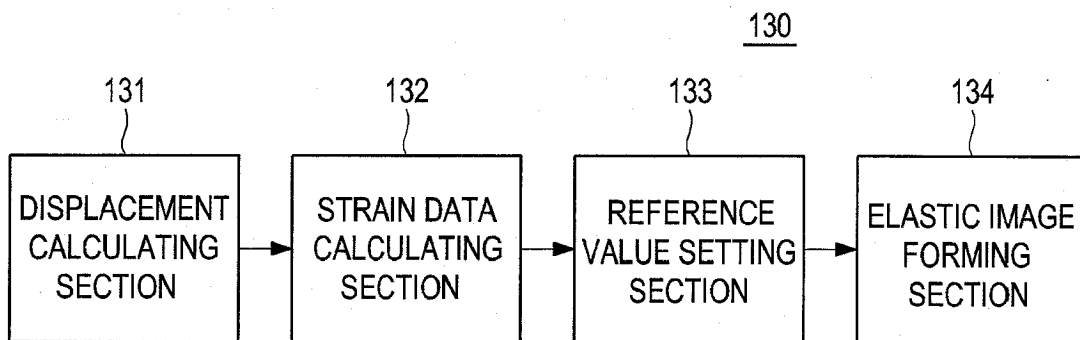
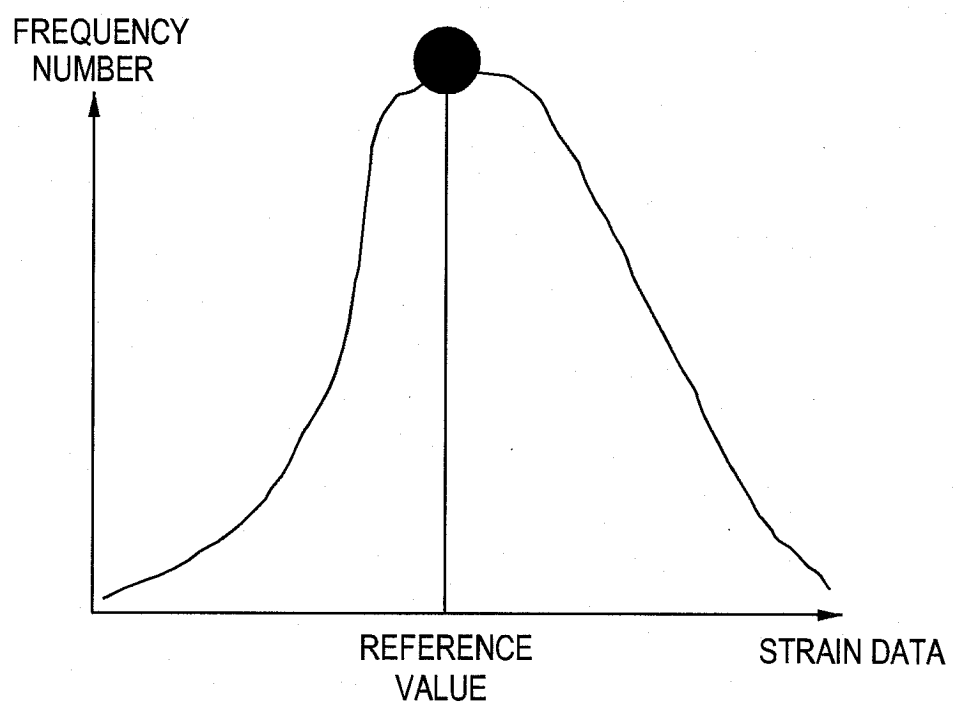


FIG. 4





EUROPEAN SEARCH REPORT

Application Number
EP 09 16 4404

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 938 754 A1 (HITACHI MEDICAL CORP [JP]) 2 July 2008 (2008-07-02) * abstract * * paragraph [0009] * * paragraph [0023] - paragraph [0028] * * paragraph [0067] * * paragraph [0072] - paragraph [0074] * * figures 1,10,13 * -----	1-14	INV. A61B8/08
X	EP 1 591 068 A1 (HITACHI MEDICAL CORP [JP]) 2 November 2005 (2005-11-02) * abstract * * paragraph [0007] - paragraph [0008] * * paragraph [0021] * * paragraph [0024] * * claim 9 * -----	1-2,4-6, 8-9, 11-13	
X	EP 1 554 982 A1 (HITACHI MEDICAL CORP [JP]) 20 July 2005 (2005-07-20) * abstract * * claim 1 * * paragraph [0033] - paragraph [0034] * * paragraph [0060] - paragraph [0064] * ----- -/--	1-2,5-9, 12-14	TECHNICAL FIELDS SEARCHED (IPC) A61B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 20 October 2009	Examiner Marteau, Frédéric
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

1
EPO FORM 1503 03.82 (P04C01)



EUROPEAN SEARCH REPORT

Application Number
EP 09 16 4404

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	TSUZUKI ET AL: "Optimal Region-of-Interest Settings for Tissue Characterization Based on Ultrasonic Elasticity Imaging" ULTRASOUND IN MEDICINE AND BIOLOGY, NEW YORK, NY, US, vol. 34, no. 4, 9 January 2008 (2008-01-09), pages 573-585, XP022547226 ISSN: 0301-5629 * abstract * * page 576, right-hand column, paragraph 1 * * page 576, right-hand column, paragraph 3 * * page 577, right-hand column, paragraph 1 * * figures 9c,d * -----	1-4,8-11	
			TECHNICAL FIELDS SEARCHED (IPC)
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		20 October 2009	Marteau, Frédéric
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

1
EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 09 16 4404

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

20-10-2009

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 1938754	A1	02-07-2008	CN 101291629 A	22-10-2008
			WO 2007046272 A1	26-04-2007
			US 2009143676 A1	04-06-2009

EP 1591068	A1	02-11-2005	CN 1738576 A	22-02-2006
			CN 101427932 A	13-05-2009
			JP 4314035 B2	12-08-2009
			JP 2004261198 A	24-09-2004
			WO 2004062503 A1	29-07-2004
			US 2009171211 A1	02-07-2009
			US 2006173306 A1	03-08-2006

EP 1554982	A1	20-07-2005	CN 1705460 A	07-12-2005
			CN 101427931 A	13-05-2009
			WO 2004039262 A1	13-05-2004
			JP 3932482 B2	20-06-2007
			JP 2004135929 A	13-05-2004
			US 2006052702 A1	09-03-2006

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- KR 1020080068909 [0001]

专利名称(译)	使用超声设备形成弹性图像		
公开(公告)号	EP2145583A1	公开(公告)日	2010-01-20
申请号	EP2009164404	申请日	2009-07-02
申请(专利权)人(译)	MEDISON CO. , LTD.		
当前申请(专利权)人(译)	三星MEDISON CO. , LTD.		
[标]发明人	KIM JONG SIK SHIN DONG KUK		
发明人	KIM, JONG SIK SHIN, DONG KUK		
IPC分类号	A61B8/08		
CPC分类号	A61B8/08 A61B8/485		
代理机构(译)	SCHMID , WOLFGANG		
优先权	1020080068909 2008-07-16 KR		
其他公开文献	EP2145583B1		
外部链接	Espacenet		

摘要(译)

公开了用于在超声系统中形成弹性图像的实施例。在一个实施例中，超声数据采集单元被配置为向/从目标对象发送/接收超声信号，从而输出第一超声数据。超声数据获取单元被配置为在向目标对象施加压力的同时向/从目标对象发送/接收超声信号，从而输出第二超声数据。帧图像数据形成单元被配置为基于第一超声数据形成第一帧图像数据。帧图像数据形成单元被配置为基于第二超声数据形成第二帧图像数据。处理单元被配置为基于第一帧图像数据和第二帧图像数据计算应变数据。处理单元被配置为基于应变数据设置参考值。处理单元被配置为基于参考值形成弹性图像。控制单元耦合到超声数据获取单元，帧图像数据形成单元和处理单元。

FIG. 1

