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(54) **Region setting for intima media thickness measurement in an ultrasound system**

Regionseinstellung zur Messung der Intima-Media-Dicke in einem Ultraschallsystem

Configuration de la région pour la mesure de l'épaisseur de l'intima-média dans un système à ultrasons

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(56) References cited:
EP-A1- 0 958 784 **EP-A1- 1 728 471**
US-A- 5 469 850 **US-A1- 2007 038 084**
US-A1- 2008 051 658

- **WENDELHAG I ET AL: "A new automated computerized analyzing system simplifies readings and reduces the variability in ultrasound measurement of intima-media thickness" STROKE, LIPPINCOTT WILLIAMS & WILKINS, US, vol. 28, no. 11, 1 November 1997 (1997-11-01), pages 2195-2200, XP009126865 ISSN: 0039-2499**

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Description

BACKGROUND OF THE INVENTION

[Technical Field]

[0001] the present invention generally relates to ultrasound systems, and more particularly to an ultrasound system for setting intima-media thickness (IMT) measuring region.

[Background Art]

[0002] The ultrasound system has become an important and popular diagnostic tool due to its non-invasive and non-destructive nature. Modern high-performance ultrasound imaging diagnostic systems and techniques are commonly used to produce two or three-dimensional images oaf internal features of patients.

[0003] Carotid is one of the arteries in a human body, which connects the main artery of the heart with the cerebral artery to supply blood to the brain. Two carotids exist at left and right sides of the neck. About 80% of the blood, which is supplies to the brain, may pass through the carotid. The carotid has been frequently examined using an ultrasound system to accurately evaluate carotid stenosis and arteriosclerosis. Intima-media thickness (IMT) has been used as an index to indicate the degrees of carotid arteriosclerosis. The IMT represents a thickness between lining membrane and media of the carotid.

[0004] Generally, the IMT is repeatedly measured for a small region. However, this requires significant time and effort. Thus, various IMT measurement applications for automatically measuring the IMT have been developed to achieve easy and fast measurement. However, the user is required to directly set a measuring region, which makes it highly difficult to accurately measure the IMT.

[0005] EP 0 958 784 A1 describes an apparatus for measuring an intima-media thickness of a blood vessel. The apparatus includes an ultrasound device for outputting digital image data representing an image of the blood vessel produced by scanning the blood vessel with an ultrasound and a data analyzing device for receiving the output digital image data and calculating the intima-media thickness of the blood vessel according to the received digital image data.

[0006] US 2008/051658 A1 discloses an apparatus for defining the lumen-intima interface and media-adventitia interface of a blood vessel, for example the carotid artery, and includes means for acquisition of a two-dimensional representation, for example a B-mode representation generated by an ultrasonographic machine, of a cross section of the vessel. The two-dimensional representation is given by means of a analog or digital video output transmitter to a calculator for being computed by a specific algorithm. In particular, the calculator has peripheral devices, such as a keyboard and a mouse, which allow defining, in a manual or semi-automatic way, in a two-dimensional representation, a region of interest (ROI) including the interface lumen-intima and the interface media-adventitia of the vessel.

[0007] A medical imaging diagnosis apparatus for measuring the composite thickness of the tunica intima and the tunica media of a blood vessel of a subject by acquiring image data on the blood vessel is known from EP 1 728 471 A1. In order to improve the accuracy of the IMT measurement of the composite thickness, the medical imaging diagnosis apparatus has extracting means for extracting the tunica intima and the tunica exterma of the blood vessel on the basis of the brightness information of the image data to measure the composite thickness of the tunica intima and the tunica exterma of the vessel in reference to the two extracted regions.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

FIG. 1 is a block diagram showing an illustrative embodiment of an ultrasound system.
FIG, 2 is a block diagram showing an ultrasound diagnosis unit.
FIG. 3 is a schematic diagram showing an ultrasound image including a plurality of pixels.
FIG. 4 is a block diagram showing a processor.
FIG. 5 is a schematic diagram showing a first graph.
FIG. 6 is a schematic diagram showing a second graph and an inflection point.
FIG, 7 is a schematic diagram showing a third graph and an inflection point.

DETAILED DESCRIPTION OF THE INVENTION

[0009] FIG. 1 is a block diagram showing an illustrative embodiment of an ultrasound system. The ultrasound system 100 may include an ultrasound diagnosis unit 110, a processor 120 and a display unit 130.

[0010] The ultrasound diagnosis unit 110 may be configured to transmit ultrasound signals to a target object and receive ultrasound echo signals reflected from the target object. The ultrasound diagnosis unit 110 may be further configured to form ultrasound images of the target object based on the received ultrasound echo signals.

[0011] FIG. 2 is a block diagram showing the ultrasound diagnosis unit 110. The ultrasound diagnosis unit 110 may include a transmit (Tx) signal generating section 111, an ultrasound probe 112 including a plurality of transducer elements (not shown), a beam former 113, a signal processing section 114 and an ultrasound image forming section 115.

[0012] The Tx signal generating section 111 may generate Tx signals according to an image mode set in the ultrasound system 100. The image mode may include a brightness (B) mode, a Doppler (D) mode, a color flow mode, etc. In one embodiment, the B mode is set in the ultrasound system 100 to obtain a B mode image.

[0013] The ultrasound probe 112 may generate ultrasound signals, which may travel into the target object, in response to the Tx signals received from the Tx signal generating section 111. The ultrasound probe 112 may further receive ultrasound echo signals reflected from the target object and convert them into electrical receive signals. In such a case, the electrical receive signals may be analog signals. The electrical receive signals may correspond to a plurality of ultrasound image frames, which are obtained by repeatedly performing the transmission and reception of the ultrasound signals. The ultrasound probe 112 may be one of a three-dimensional probe, a two-dimensional probe, a one-dimensional probe and the like.

[0014] The beam former 113 may convert the electrical receive signals outputted from the ultrasound probe 112 into digital signals. The beam former 113 may further apply delays to the digital signals in consideration of distances between the transducer elements and focal points to thereby output receive-focused beams.

[0015] The signal processing section 114 may form a plurality of ultrasound data corresponding to the ultrasound image frames by using the receive-focused beams. The plurality of ultrasound data may be radio frequency (RF) data or IQ data.

[0016] The ultrasound image forming section 115 may form an ultrasound image of the target object based on the plurality of ultrasound data. Referring to FIG. 3, the ultrasound image may be formed with a plurality of pixels, each having an intensity of a gray level denoted by h_{11}-h_{mn}.

[0017] The processor 120, which is shown in FIG. 1, may analyze the ultrasound image to set an intima-media thickness (IMT) measuring region on the ultrasound image. The analysis of the ultrasound image for setting the IMT measuring region will be described in detail with reference to FIG. 4.

[0018] FIG. 4 is a schematic diagram showing the configuration of the processor 120. In one embodiment, the processor 120 may include a first graph forming section 121, a second graph forming section 122, a third graph forming section 123 and an IMT measuring region setting section 124.

[0019] In one embodiment, the first graph forming section 121 may compute average intensities of the pixels at each row in the ultrasound image to thereby form a first graph. The average intensities f_k may be computed by using the following equation (1).

$$f_k = \frac{h_{k1} + h_{k2} + \cdots + h_{k(n-1)} + h_{kn}}{n} \quad (1)$$

wherein "k" indicates a row of pixels in the ultrasound image, wherein "k" ranges from 1 to m, and wherein "n" indicates a number of pixels in the same row.

[0020] In another embodiment, the first graph forming section 121 may compute sum intensities of the pixels at each row and form the first graph of the sum intensities with respect to the row of pixels in the ultrasound image.

[0021] As shown in FIG. 5, the first graph forming section 121 may form the first graph of the average intensities with respect to the row of pixels in the ultrasound image.

[0022] The second graph forming section 122, which is shown in FIG. 4, may compute first moving averages of the average intensities for first subsets of the rows by dividing the intensities by a thickness of a blood vessel. As shown in FIG. 6, the second graph forming section 122 may form a second graph of the first moving averages with respect to the row of pixels in the ultrasound image. The blood vessel may be a carotid, although it is certainly not limited thereto. The first moving averages MA_{1l}-MA_{1m} may be computed by using the following equation (2).

$$MA_{11} = \frac{f_1 + f_2 + \ldots + f_{i-1} + f_i}{i}$$

$$MA_{12} = \frac{f_2 + f_3 + \ldots + f_i + f_{i+1}}{i}$$

$$MA_{1(m-i+1)} = \frac{f_{m-i+1} + f_{m-i+2} + \cdots + f_{m-1} + f_m}{i} \quad (2)$$

wherein "i" indicates the number of pixels included within the thickness of blood vessel and "m" indicates the number of first moving averages. Generally, the thickness of the blood vessel may range from 2 to 5 mm. For example, assuming that the thickness of the carotid is about 3 mm and the height of the pixel is 0.5 mm, "i" becomes 6.

[0023] FIG. 6 shows the second graph of the first moving averages with respect to the rows of pixels in the ultrasound image. Referring back to FIG. 4, the IMT measuring region setting section 124 may detect a plurality of inflection points at which an inclination of curvatures on the second graph changes and selects the inflection point ("I_l" in FIG. 6) having a smallest moving average on the second graph.

[0024] The third graph forming section 123 may compute second moving averages of the average intensities for second subsets of the rows by dividing the intensities by a thickness of a vascular wall. As shown in FIG. 7, the third graph forming section 123 may form a third graph of the first moving averages with respect to the row of pixels in the ultrasound image. The second moving averages MA_{2l}-MA_{2m} may be computed by using the following equation (3).

$$MA_{21} = \frac{f_1 + f_2 + \ldots + f_{j-1} + f_j}{j}$$

$$MA_{22} = \frac{f_2 + f_3 + \ldots + f_j + f_{j+1}}{j}$$

$$MA_{2(m-j+1)} = \frac{f_{m-j+1} + f_{m-j+2} + \cdots + f_{m-1} + f_m}{j} \quad (3)$$

wherein "j" indicates the number of pixels included within the thickness of the vascular wall and "m" indicates the number of second moving averages. Generally, the thickness of the carotid wall ranges from 0.5 to 1.5 mm. For example, assuming that the thickness of the carotid wall is 1mm and the height of the pixel is 0.5mm, "j" becomes 2. FIG. 7 shows the third graph of the second moving averages with respect to the row of pixels in the ultrasound image. In FIG. 7, "I_m" represents an inflection point having the largest second moving average on the third graph.

[0025] The IMT measuring region setting section 124 may detect the inflection points I_l and I_m on the second and third graphs. The IMT measuring region setting section 124 may detect a plurality of inflection points at which an inclination of curvatures on the second graph changes and selects the inflection point I_l having the smallest first moving average value. The IMT measuring region setting section 124 may detect a plurality of inflection points at which an inclination of curvatures on the third graph changes and selects the inflection point I_m having the largest second moving average value. The IMT measuring region setting section 124 may set the inflection points I_l and I_m on the ultrasound image. In one embodiment, the IMT measuring region setting section 124 may set the region between I_l and I_m. as the IMT measuring region.

[0026] Referring back to FIG. 1, the display unit 130 may display the ultrasound image on which the IMT measuring region is set. The display unit 130 may include liquid crystal display (LCD), cathode ray tube (CRT) and the like.

[0027] Any reference in this specification to "one embodiment," "an embodiment," "example embodiment," "illustrative embodiment," etc. means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. The appearances of such phrases in various places in the specification are not necessarily all referring to the same embodiment. Further, when a particular feature, structure or characteristic is described in connection with any embodiment, it is submitted that it is within the purview of one skilled in the art to affect such feature, structure or characteristic in connection with other ones of the embodiments.

[0028] 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 (100), comprising:

an ultrasound diagnosis unit (110) configured to transmit ultrasound signals to a target object, receive ultrasound echo signals reflected from the target object and form an ultrasound image including a plurality of pixels arrayed in rows and columns based on the ultrasound echo signals, each pixel having an intensity of gray level; and
a processor (120) configured to

compute average intensities of pixels included in each of the rows in the ultrasound image, to form a first graph,
compute a first plurality of moving averages by using a first plurality of intensity subsets, each of which includes a first number of values, which is determined based on a thickness of a blood vessel of a carotid and a size of the pixel, from among the average intensities, to form a second graph,
compute a second plurality of moving averages by using a second plurality of intensity subsets, each of which includes a second number of values, which is determined based on a thickness of a vascular wall of the carotid and the size of the pixel, from among the average intensities, to form a third graph ,

wherein the processor (120) is further configured to set an intima-media thickness (IMT) measuring region by using inflection points from the second and third graphs.

2. The ultrasound system (100) of Claim 1, wherein the processor (120) is further configured to
detect a plurality of inflection points at which an inclination of curvatures on the second graph changes, select a first inflection point having a smallest moving average from among the inflection points in the second graph,
detect a plurality of inflection points at which an inclination of curvatures on the third graph changes, select a second inflection point having a largest moving average from among the inflection points in the third graph, and
set the IMT measuring region based on the first and second inflection points on the ultrasound image.

3. A method of setting intima-media thickness (IMT) measuring region in an ultrasound system (100), comprising:

a) obtaining an ultrasound image including a plurality of pixels arrayed in rows and columns by an ultrasound diagnosis unit (110) within the ultrasound system (100);
b) computing average intensities of pixels included in each of the rows in the ultrasound image to form a first graph by a processor (120) within the ultrasound system (100);
c) computing a first plurality of moving averages by using a first plurality of intensity subsets, each of which includes a first number of values, which is determined based on a thickness of a blood vessel of a carotid and a size of the pixel, from among the average intensities, to form a second graph ;
d) computing a second plurality of moving averages by using a second plurality of intensity subsets, each of which includes a second number of values, which is determined based on a thickness of a vascular wall of the carotid and the size of the pixel, from among the average intensities, to form a third graph;
e) detecting inflection points from the second and third graphs by the processor (120) within the ultrasound system (100); and
f) setting an intima-media thickness (IMT) measuring region by using the inflection points by the processor (120) within the ultrasound system (100).

4. The method of claim 3, wherein the step e) comprising:

e1) detecting a plurality of inflection points at which an inclination of curvatures on the second graph changes;
e2) selecting a first inflection point having a smallest moving average from among the inflection points in the second graph;
e3) detecting a plurality of inflection points at which an inclination of curvatures on the third graph changes; and
e4) selecting a second inflection point having a largest moving average from among the inflection points in the third graph.

5. The method of claim 4, wherein the step f) comprises setting the IMT measuring region based on the first and second inflection points on the ultrasound image.

6. A computer readable medium comprising instructions that, when executed by a processor performs a method of any of claims 3 - 5.

Patentansprüche

1. Ultraschallsystem (100), welches Folgendes aufweist:

eine Ultraschalldiagnoseeinheit (110), die dafür vorgesehen ist, Ultraschallsignale zu einem Zielobjekt zu übertragen, von dem Zielobjekt reflektierte Ultraschallechosignale zu empfangen und ein Ultraschallbild, das eine Vielzahl von in Reihen und Spalten angeordnete Pixel aufweist, basierend auf den Ultraschallechosignalen zu erzeugen, wobei jedes Pixel eine Intensität einer Graustufe aufweist; und
einen Prozessor (120), der dafür vorgesehen ist,
durchschnittliche Intensitäten von Pixeln zu berechnen, die in jeder der Reihen in dem Ultraschallbild enthalten sind, um ein erstes Diagramm zu erzeugen;
eine erste Vielzahl von sich bewegenden Durchschnitten unter Verwendung einer ersten Vielzahl von Intensitätsuntermengen zu berechnen, von denen jede eine erste Anzahl an Werten aufweist, die basierend auf einer Dicke von Blutgefäßen einer Halsschlagader und einer Größe der Pixel unter den durchschnittlichen Intensitäten ermittelt wird, um ein zweites Diagramm zu erzeugen, eine zweite Vielzahl von sich bewegenden Durchschnitten unter Verwendung einer zweiten Vielzahl von Intensitätsuntermengen zu berechnen, von denen jede eine zweite Anzahl von Werten beinhaltet, die basierend auf einer Dicke einer Gefäßwand der Halsschlagader und der Größe des Pixels unter den durchschnittlichen Intensitäten ermittelt wird, um ein drittes Diagramm zu erzeugen, wobei der Prozessor (120) des Weiteren dafür vorgesehen ist, einen Intima-Media-Dicke-(IMT)-Messbereich durch Verwendung von Wendepunkten von den zweiten und dritten Diagrammen festzulegen.

2. Ultraschallsystem (100) nach Anspruch 1, wobei der Prozessor (120) des Weiteren dafür vorgesehen ist,
eine Vielzahl von Wendepunkten zu ermitteln, an denen sich eine Steigung von Krümmungen auf dem zweiten Diagramm ändert, einen ersten Wendepunkt auszuwählen, der einen kleinsten sich bewegenden Durchschnitt unter den Wendepunkten in dem zweiten Diagramm aufweist,
eine Vielzahl von Wendepunkten zu ermitteln, an denen sich eine Steigung von Krümmungen auf dem dritten Diagramm ändert, einen zweiten Wendepunkt auszuwählen, der einen größten sich bewegenden Durchschnitt unter den Wendepunkten in dem dritten Diagramm aufweist, und
den IMT-Messbereich basierend auf den ersten und zweiten Wendepunkten auf dem Ultraschallbild festzulegen.

3. Verfahren zum Festlegen der Intima-Media-Dicke (IMT)-Messbereichs in einem Ultraschallsystem (100), welches folgendes aufweist:

a) Erlangen eines Ultraschallbilds einschließlich einer Vielzahl von in Reihen und Spalten angeordneten Pixeln mittels einer Ultraschalldiagnoseeinheit (110) innerhalb des Ultraschallschallsystems (100);
b) Berechnen von durchschnittlichen Intensitäten von Pixeln, die in jeder der Reihen in dem Ultraschallbild enthalten sind, um ein erstes Diagramm mittels eines Prozessors (120) innerhalb des Ultraschallsystems (100) zu erzeugen;
c) Berechnen einer ersten Vielzahl von sich bewegenden Durchschnitten unter Verwendung einer ersten Vielzahl von Intensitätsuntermengen, von denen jede eine erste Anzahl von Werten aufweist, die basierend auf einer Dicke eines Blutgefäßes einer Halsschlagader und einer Größe des Pixels unter den durchschnittlichen Intensitäten ermittelt wird, um ein zweites Diagramm zu erzeugen;
d) Berechnen einer zweiten Vielzahl von sich bewegenden Durchschnitten unter Verwendung einer zweiten Vielzahl von Intensitätsuntermengen, von denen jede eine zweite Anzahl von Werten beinhaltet, die basierend

auf einer Dicke einer Gefäßwand der Halsschlagader und der Größe des Pixels unter den durchschnittlichen Intensitäten ermittelt wird, um ein drittes Diagramm zu erzeugen;
e) Detektieren von Wendepunkten aus den zweiten und dritten Diagrammen mittels des Prozessors (120) innerhalb des Ultraschallsystems (100); und
f) Festlegen eines Intima-Media-Dicken-(IMT)-Messbereichs durch Verwendung der Wendepunkte mittels des Prozessors (120) innerhalb des Ultraschallsystems (100).

4. Verfahren nach Anspruch 3,
wobei der Schritt e) Folgendes aufweist:

e1) Ermitteln einer Vielzahl von Wendepunkten, an denen sich eine Steigung von Krümmungen auf dem zweiten Diagramm ändert;
e2) Auswählen eines ersten Wendepunkts, der einen kleinsten sich bewegenden Durchschnitt unter den Wendepunkten in dem zweiten Diagramm aufweist;
e3) Ermitteln einer Vielzahl von Wendepunkten, an denen sich eine Steigung von Krümmungen auf dem dritten Diagramm ändert; und
e4) Auswählen eines zweiten Wendepunkts, der einen größten sich bewegenden Durchschnitt unter den Wendepunkten in dem dritten Diagramm aufweist.

5. Verfahren nach Anspruch 4, wobei der Schritt f) das Festlegen des IMT-Messbereichs basierend auf den ersten und zweiten Wendepunkten auf dem Ultraschallbild beinhaltet.

6. Computerlesbares Medium, das Befehle enthält, die, wenn sie von einem Prozessor ausgeführt werden, ein Verfahren nach einem der Ansprüche 3 bis 5 durchführen.

Revendications

1. Système ultrasonique (100) comportant :

une unité de diagnostic ultrasonique (110) configurée pour transmettre des signaux ultrasoniques vers un objet cible, recevoir des signaux d'écho ultrasoniques réfléchis par un objet cible et pour former une image ultrasonique comprenant une pluralité de pixels disposés en rangées et en colonnes basés sur les signaux d'écho ultrasoniques, chaque pixel ayant une intensité de niveau de gris; et
un processeur (120) configuré pour

calculer les intensités moyennes de pixels dans chacune des rangées de l'image ultrasonique, pour former un premier graphique,
calculer une première pluralité de moyennes mobiles en utilisant une première pluralité de sous-ensembles d'intensité dont chacun comprend un premier nombre de valeurs, qui est déterminé sur base de l'épaisseur d'un vaisseau sanguin de la carotide et une dimension du pixel, parmi les intensités moyennes pour former un deuxième graphique,
calculer une deuxième pluralité de moyennes mobiles en utilisant une deuxième pluralité de sous-ensembles d'intensité dont chacun comprend un deuxième nombre de valeurs, qui est déterminé sur base de l'épaisseur d'une paroi vasculaire de la carotide et la dimension du pixel, parmi les intensités moyennes pour former un troisième graphique,

dans lequel le processeur (120) est en outre configuré pour déterminer une région de mesure de l'épaisseur de l'intime-média (IMT) en utilisant des points d'inflexion des deuxième et troisième graphiques.

2. Système ultrasonique (100) selon la revendication 1, dans lequel le processeur (120) est en outre configuré pour
détecter une pluralité de points d'inflexion auxquels l'inclinaison de la courbure du deuxième graphique change, pour sélectionner un premier point d'inflexion ayant la plus petite moyenne mobile parmi les points d'inflexion du deuxième graphique,
détecter une pluralité de points d'inflexion auxquels l'inclinaison de la courbure du troisième graphique change, pour sélectionner un deuxième point d'inflexion ayant la plus grande moyenne mobile parmi les points d'inflexion du troisième graphique, et
déterminer la région de mesure du IMT, sur la base des premier et deuxième points d'inflexion sur l'image ultraso-

nique.

3. Procédé pour déterminer une région de mesure de l'épaisseur de l'intime-média (IMT) dans un système ultrasonique (100), comprenant :

a) l'obtention d'une image ultrasonique comprenant une pluralité de pixels disposés en rangées et colonnes dans l'image ultrasonique, par une unité de diagnostic ultrasonique (110), dans le système ultrasonique (100),
b) le calcul des intensités moyennes de pixels contenus dans chacune des rangées de l'image ultrasonique pour former un premier graphique par un processeur (120) dans le système ultrasonique (100) ;
c) le calcul d'une première pluralité de moyennes mobiles en utilisant une première pluralité de sous-ensembles d'intensités dont chacun comprend un premier nombre de valeurs, qui est déterminé sur base de l'épaisseur d'un vaisseau sanguin de la carotide et d'une dimension du pixel, parmi les intensités moyennes pour former un deuxième graphique,
d) le calcul d'une deuxième pluralité de moyennes mobiles en utilisant une deuxième pluralité de sous-ensembles d'intensité dont chacun comprend un deuxième nombre de valeurs, qui est déterminé sur base de l'épaisseur d'une paroi vasculaire de la carotide et la dimension du pixel, parmi les intensités moyennes pour former un troisième graphique,
e) la détection de points d'inflexion sur les deuxième et troisième graphiques au moyen du processeur (120), dans le système ultrasonique (100) ; et
f) la détermination de la région de mesure du IMT, en utilisant les points d'inflexion au moyen du processeur (120) dans le système ultrasonique (100).

4. Procédé selon la revendication 3, dans lequel la phase e) comprend :

e1) la détection d'une pluralité de points d'inflexion auxquels l'inclinaison de la courbure change sur le deuxième graphique ;
e2) la sélection d'un premier point d'inflexion ayant la plus petite moyenne mobile parmi les points d'inflexion du deuxième graphique,
e3) la détection d'une pluralité de points d'inflexion auxquels l'inclinaison de la courbure change sur le troisième graphique ; et
e4) la sélection d'un deuxième point d'inflexion ayant la plus grande moyenne mobile parmi les points d'inflexion du troisième graphique.

5. Procédé selon la revendication 4, dans lequel l'étape f) comprend la détermination de la région de mesure du IMT, sur la base des premier et deuxième points d'inflexion de l'image ultrasonique.

6. Support informatique lisible par un ordinateur comportant les instructions pour qu'il applique le procédé selon l'ensemble des revendications 3 - 5 lorsqu'il est mis en oeuvre par un processeur.

FIG. 1

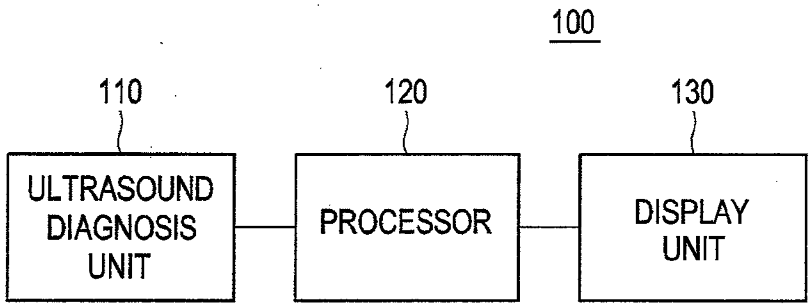

100
110
120
130
ULTRASOUND DIAGNOSIS UNIT
PROCESSOR
DISPLAY UNIT

FIG. 2

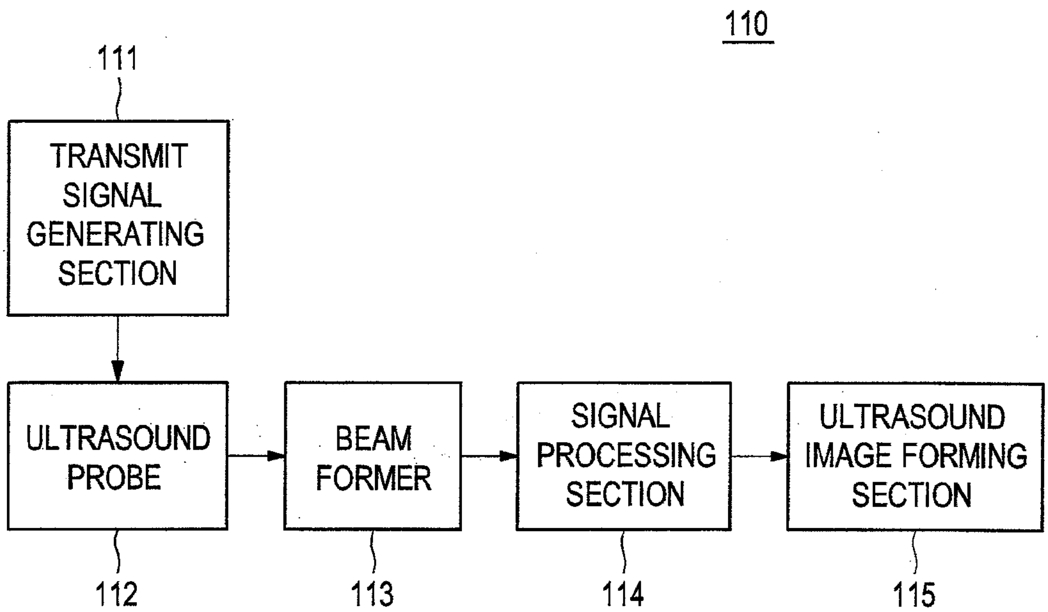

110
111
TRANSMIT SIGNAL GENERATING SECTION
ULTRASOUND PROBE
BEAM FORMER
SIGNAL PROCESSING SECTION
ULTRASOUND IMAGE FORMING SECTION
112
113
114
115

FIG. 3

h_{11}	h_{12}	h_{13}	···	$h_{1(n-1)}$	h_{1n}
h_{21}	h_{22}	h_{23}	···	$h_{2(n-1)}$	h_{2n}
h_{31}	h_{32}	h_{33}	···	$h_{3(n-1)}$	h_{3n}
h_{41}	h_{42}	h_{43}	···	$h_{4(n-1)}$	h_{4n}
⋮	⋮	⋮	···	⋮	⋮
$h_{(m-1)1}$	$h_{(m-1)2}$	$h_{(m-1)3}$	···	···	$h_{(m-1)(n-1)}$
h_{m1}	h_{m2}	h_{m3}	···	$h_{m(n-1)}$	h_{mn}

FIG. 4

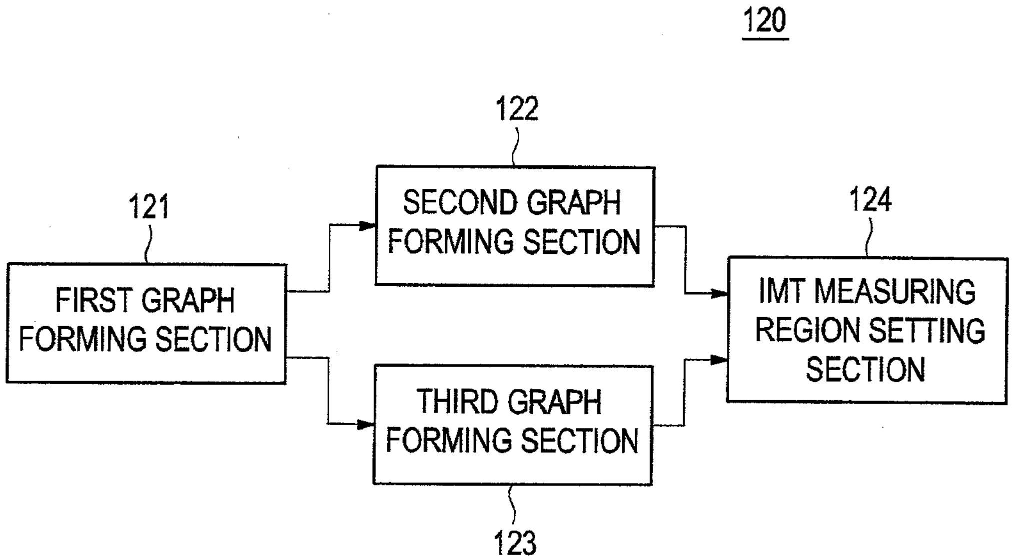


FIG. 5

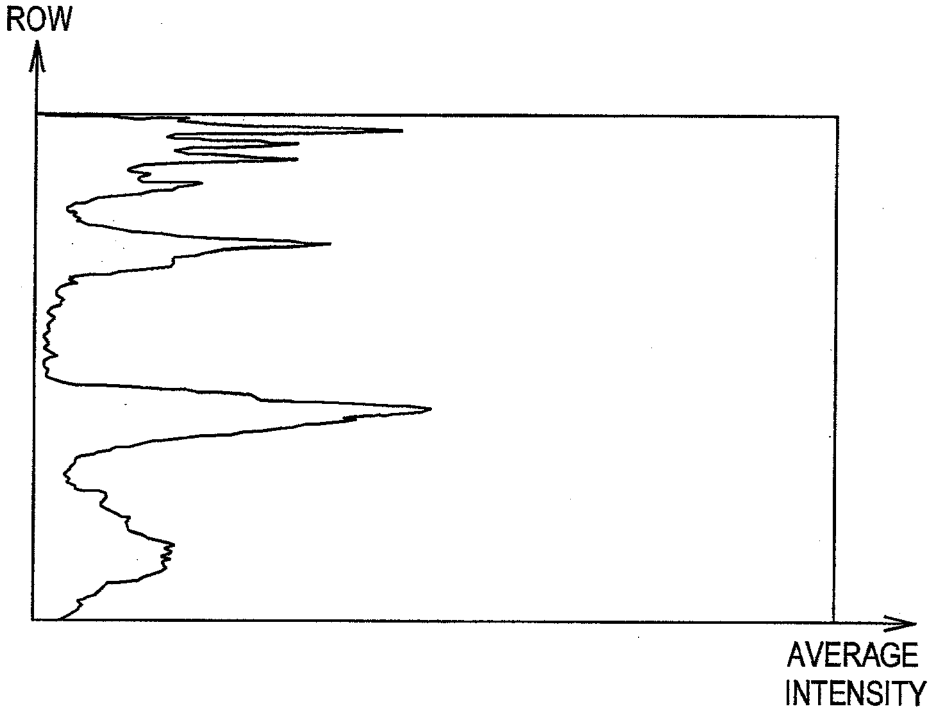


FIG. 6

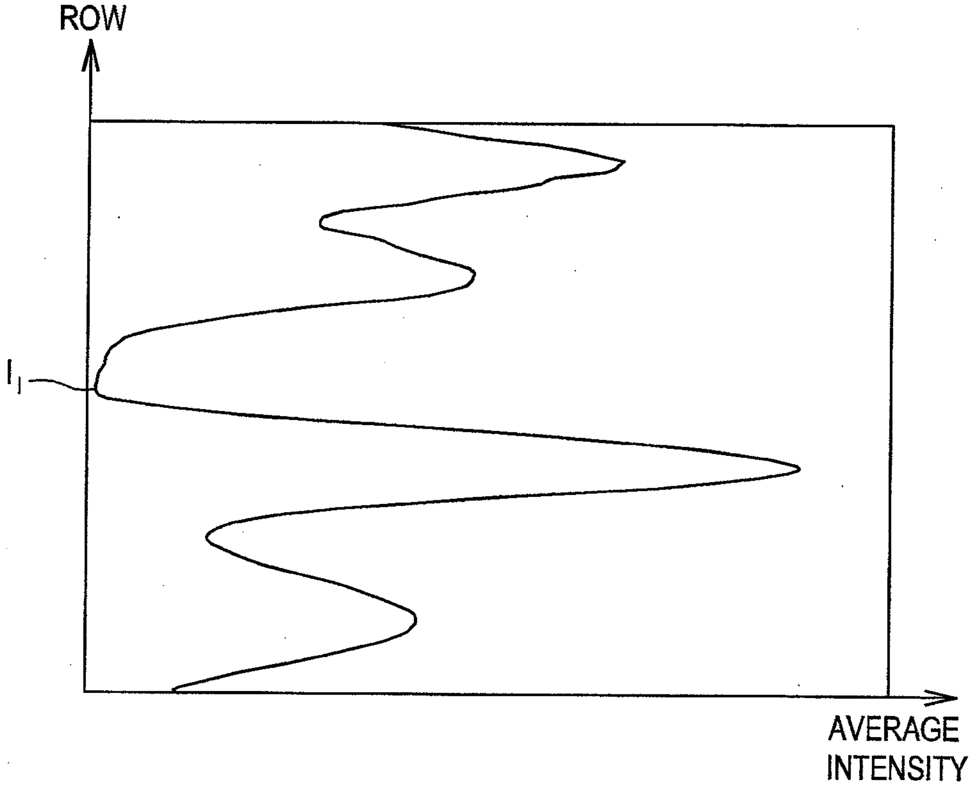
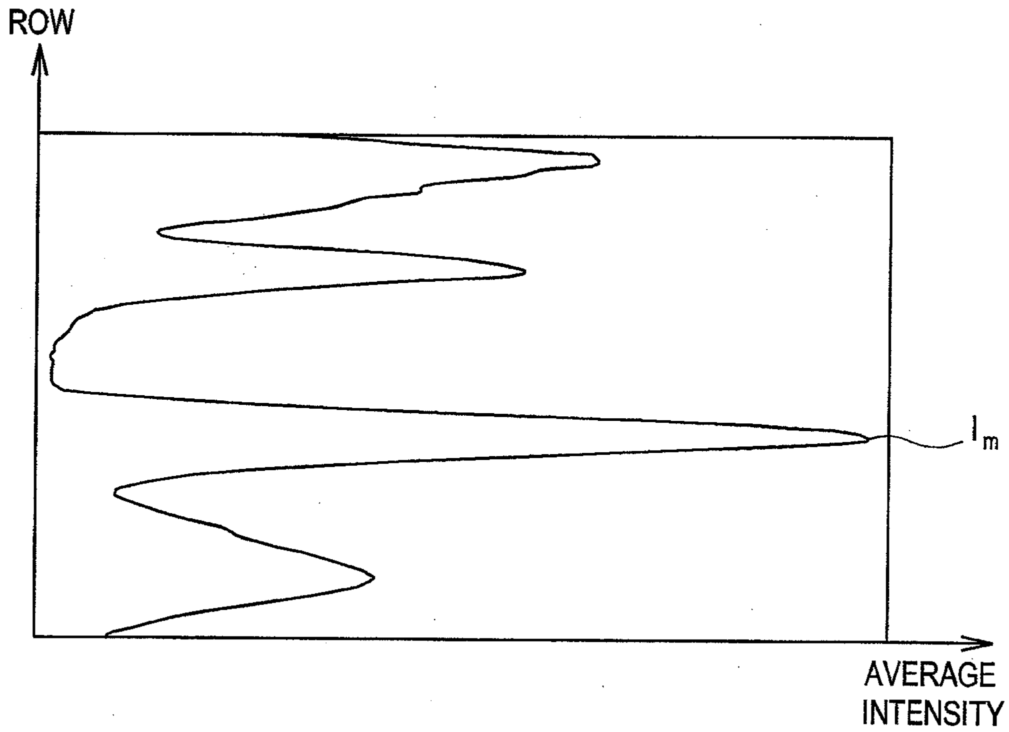


FIG. 7



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 0958784 A1 **[0005]**
- US 2008051658 A1 **[0006]**
- EP 1728471 A1 **[0007]**

专利名称(译)	超声系统中内膜中层厚度测量的区域设置		
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摘要(译)

超声系统和设置内膜中层厚度（IMT）测量区域的方法技术领域超声系统包括：超声诊断单元，被配置为将超声信号发送到目标对象，接收从目标对象反射的超声回波信号，并基于超声回波信号形成包括多个像素的超声图像，每个像素的强度为灰度。超声系统还包括处理器，该处理器被配置为计算超声图像中的每行处的像素的强度以形成第一图形，通过将强度除以厚度来计算超声图像中的第一行的子集的强度的第一移动平均值通过将血管壁的厚度除以血管壁的厚度以形成第三图，计算超声图像中第二行子集的强度的第二移动平均值，并设定内膜中层厚度（IMT）通过使用来自第二和第三图的拐点来测量区域。

$$I_k = \frac{I_{k1} + I_{k2} + \cdots + I_{k(n-1)} + I_{kn}}{n} \quad (1)$$