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Lee et al.

(54) **REGION SETTING FOR INTIMA MEDIA THICKNESS MEASUREMENT IN AN ULTRASOUND SYSTEM**

(75) Inventors: **Jin Yong Lee**, Seoul (KR); **Jae Yoon Shim**, Seoul (KR)

Correspondence Address:
JONES DAY
222 EAST 41ST ST
NEW YORK, NY 10017 (US)

(73) Assignee: **Medison Co., Ltd.**

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(57) **ABSTRACT**

The present invention relates to an ultrasound system and a method of setting an intima-media thickness (IMT) measuring region. The ultrasound system comprises an ultrasound diagnosis unit 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 based on the ultrasound echo signals, each pixel having an intensity of gray level. The ultrasound system further comprises a processor configured to compute intensities of the pixels at each row in the ultrasound image to form a first graph, compute first moving averages of the intensities for first subsets of rows in the ultrasound image by dividing the intensities by a thickness of a blood vessel to form a second graph, compute second moving averages of the intensities for second subsets of rows in the ultrasound image by dividing the intensities by a thickness of a vascular wall to form a third graph, and set an intima-media thickness (IMT) measuring region by using inflection points from the second and third graphs.

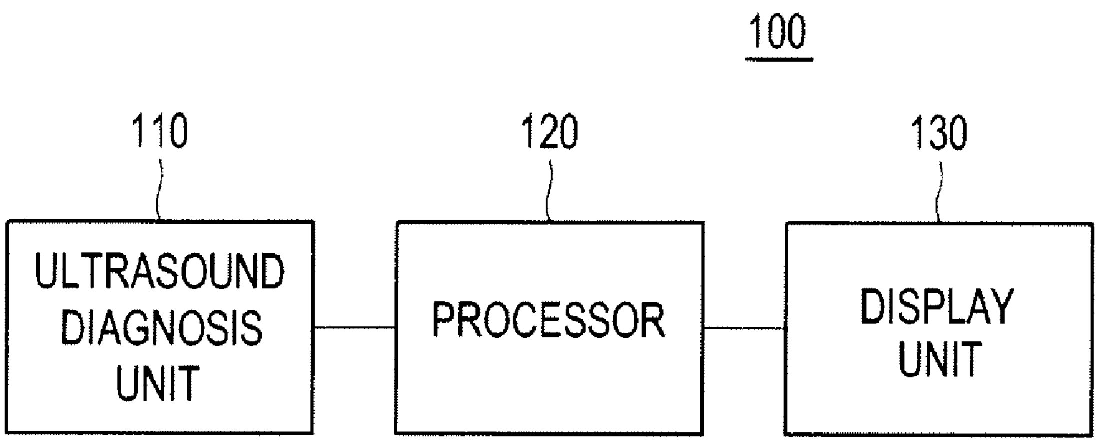


FIG. 1

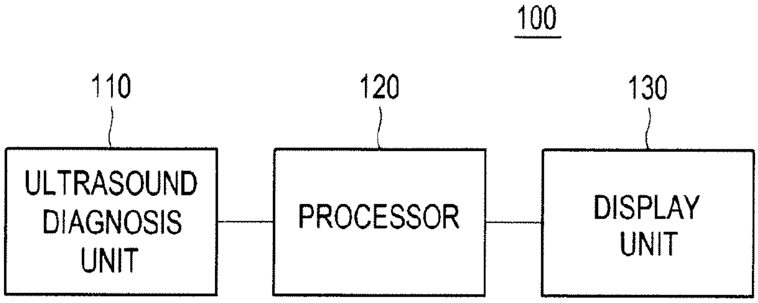

100
110
120
130
ULTRASOUND DIAGNOSIS UNIT
PROCESSOR
DISPLAY UNIT

FIG. 2

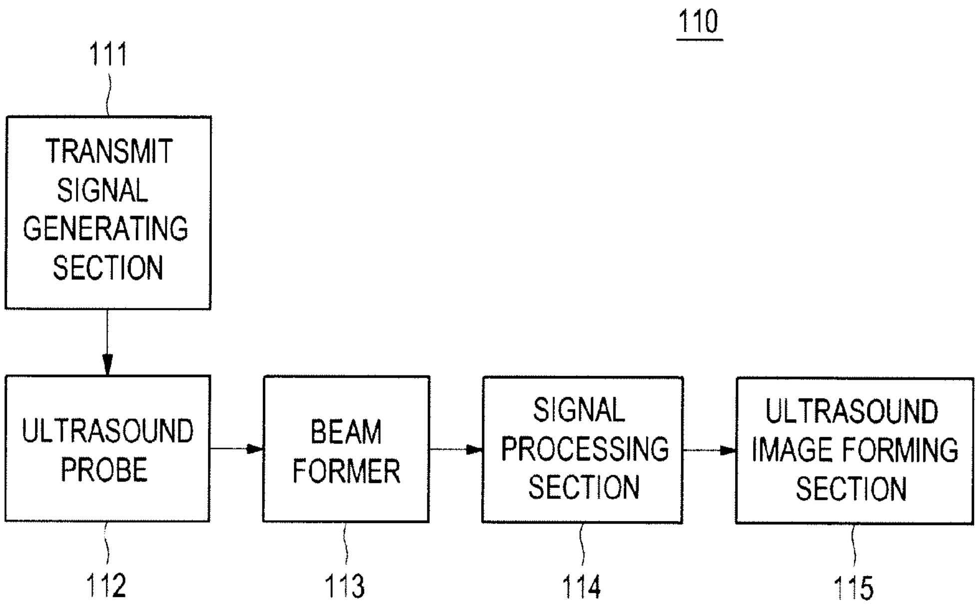

110
111
TRANSMIT SIGNAL GENERATING SECTION
ULTRASOUND PROBE
BEAM FORMER
SIGNAL PROCESSING SECTION
ULTRASOUND IMAGE FORMING SECTION
112
113
114
115

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

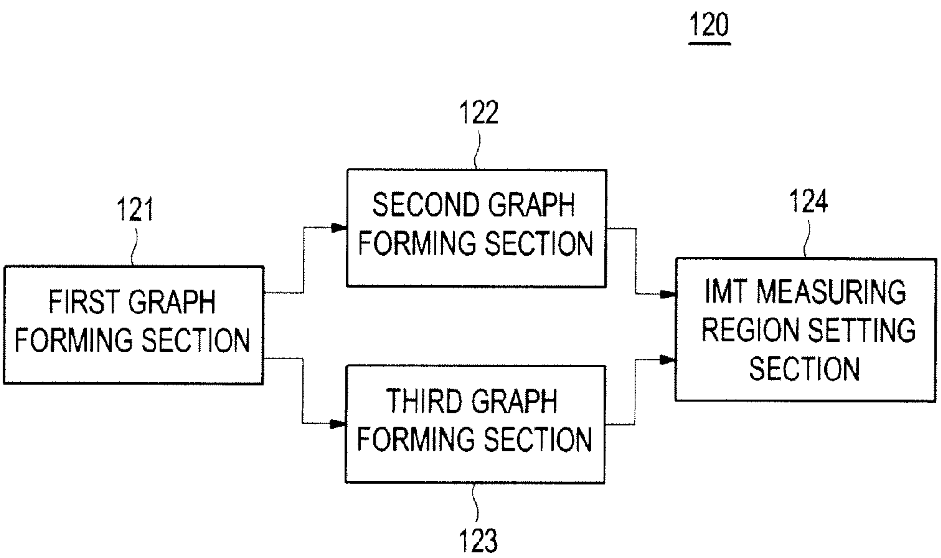


FIG. 5

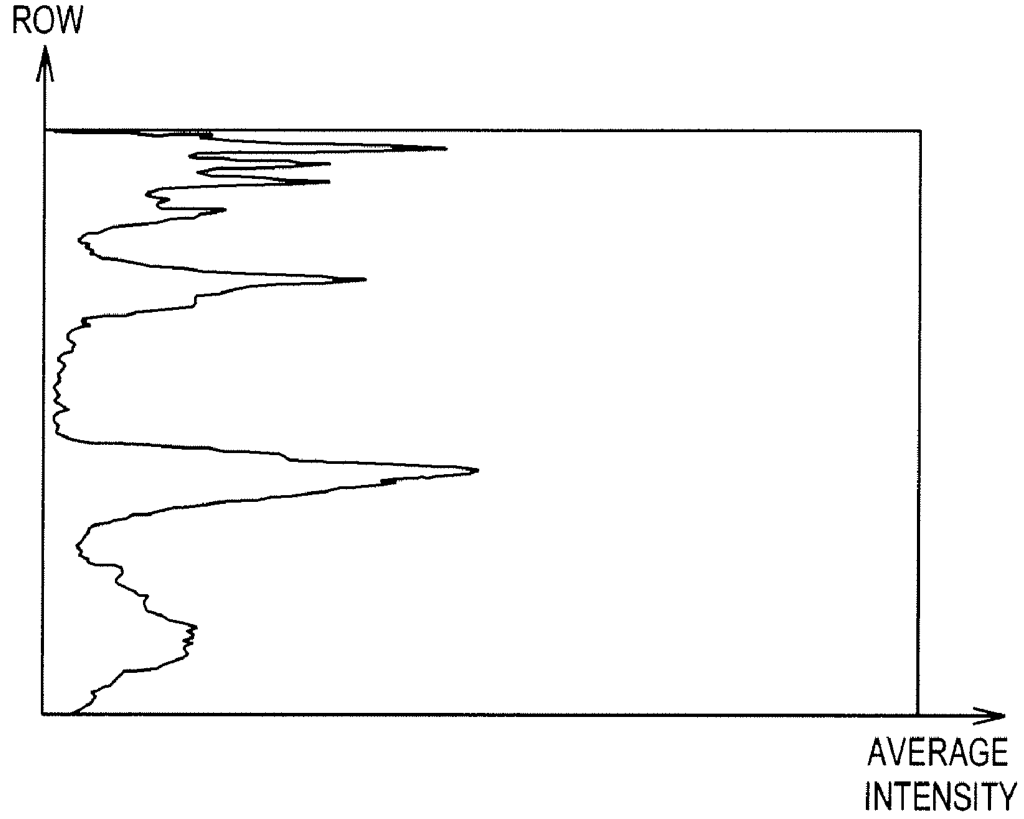


FIG. 6

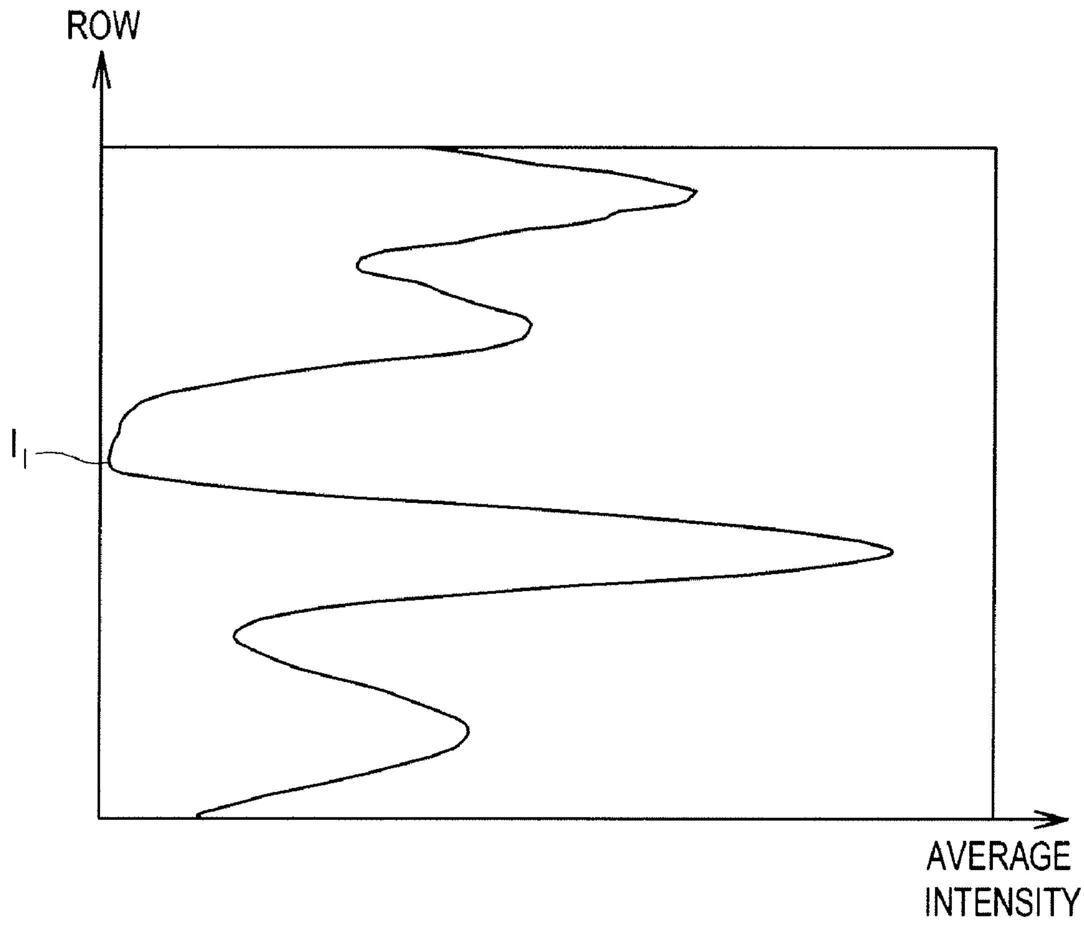
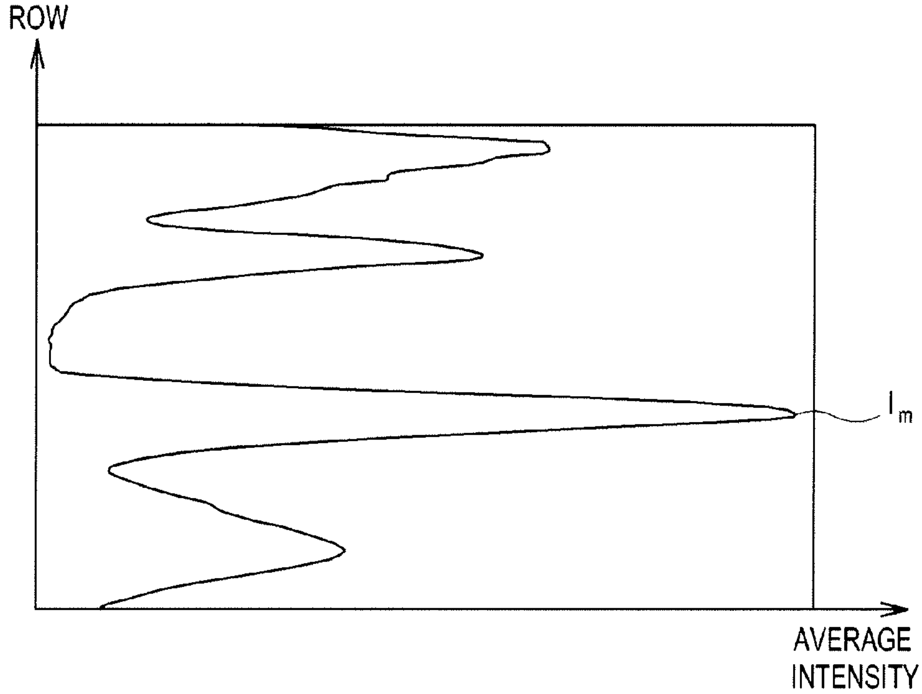


FIG. 7



REGION SETTING FOR INTIMA MEDIA THICKNESS MEASUREMENT IN AN ULTRASOUND SYSTEM

[0001] The present application claims priority from Korean Patent Application No. 10-2008-0115332 filed on Nov. 19, 2008, the entire subject matter of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Technical Field

[0003] The present invention generally relates to ultrasound systems, and more particularly to an ultrasound system for setting an intima-media thickness (IMT) measuring region.

[0004] 2. Background Art

[0005] 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 of internal features of patients.

[0006] The 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 supplied 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.

[0007] 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.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a block diagram showing an illustrative embodiment of an ultrasound system.

[0009] FIG. **2** is a block diagram showing an ultrasound diagnosis unit.

[0010] FIG. **3** is a schematic diagram showing an ultrasound image including a plurality of pixels.

[0011] FIG. **4** is a block diagram showing a processor.

[0012] FIG. **5** is a schematic diagram showing a first graph.

[0013] FIG. **6** is a schematic diagram showing a second graph and an inflection point.

[0014] FIG. **7** is a schematic diagram showing a third graph and an inflection point.

DETAILED DESCRIPTION OF THE INVENTION

[0015] 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**.

[0016] 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.

[0017] 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**.

[0018] 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.

[0019] 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.

[0020] 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.

[0021] 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.

[0022] 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}.

[0023] 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**.

[0024] 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**.

[0025] 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).

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

[0026] 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.

[0027] 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.

[0028] 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.

[0029] 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_{11}-MA_{1m}, may be computed by using the following equation (2).

$$MA_{11} = \frac{f_1 + f_2 + \ldots + f_{i-1} + f_i}{i} \tag{2}$$

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

$$\vdots$$

$$MA_{1m} = \frac{f_{m-i+1} + f_{m-i+2} + \ldots + f_{m-1} + f_m}{i}$$

[0030] 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.

[0031] 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_1" in FIG. **6**) having a smallest moving average on the second graph.

[0032] 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_{21}-MA_{2m} may be computed by using the following equation (3).

$$MA_{21} = \frac{f_1 + f_2 + \ldots + f_{j-1} + f_j}{j} \tag{3}$$

-continued

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

$$\vdots$$

$$MA_{2m} = \frac{f_{m-j+1} + f_{m-j+2} + \ldots + f_{m-1} + f_m}{j}$$

[0033] 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 1 mm and the height of the pixel is 0.5 mm, "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.

[0034] The IMT measuring region setting section **124** may detect the inflection points I_1 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_1 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_1 and I_m on the ultrasound image. In one embodiment, the IMT measuring region setting section **124** may set the region between I_1 and $I_{m.}$ as the IMT measuring region.

[0035] 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

[0036] 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.

[0037] 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.

What is claimed is:

1. An ultrasound system, comprising:

an ultrasound diagnosis unit 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 based on the ultrasound echo signals, each pixel having an intensity of gray level; and

a processor configured to compute intensities of the pixels at each row in the ultrasound image to form a first graph, compute first moving averages of the intensities for first subsets of rows in the ultrasound image by dividing the intensities by a thickness of a blood vessel to form a second graph, compute second moving averages of the intensities for second subsets of rows in the ultrasound image by dividing the intensities by a thickness of a vascular wall to form a third graph, and set an intima-media thickness (IMT) measuring region by using inflection points from the second and third graphs.

2. The ultrasound system of claim **1**, wherein the first graph is formed by averaging the intensities of the pixels per each row in the ultrasound image.

3. The ultrasound system of claim **1**, wherein the first graph is formed by summing the intensities of the pixels per each row.

4. The ultrasound system of claim **1**, wherein the processor is further configured to detect a plurality of inflection points at which an inclination of curvatures on the second graph changes, select a smallest value of the inflection points in the second graph as a first inflection point, detect a plurality of inflection points at which an inclination of curvatures on the third graph changes, select a largest value of the inflection points in the third graph as a second inflection point, and set the first and second inflection points on the ultrasound image as the IMT measuring region.

5. The ultrasound system of claim **1**, wherein the first subsets of rows are determined by dividing the thickness of the blood vessel by a size of the pixel.

6. The ultrasound system of claim **1**, wherein the second subsets of rows are determined by dividing the thickness of the vascular wall by a size of the pixel.

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

a) obtaining an ultrasound image including a plurality of pixels by an ultrasound diagnosis unit within the ultrasound system;

b) computing intensities of the pixels at each row in the ultrasound image to form a first graph by a processor within the ultrasound system;

c) computing first moving averages of the intensities for first subsets of rows in the ultrasound image by dividing the intensities by a thickness of a blood vessel to form a second graph by the processor within the ultrasound system;

d) computing second moving averages of the intensities for second subsets of rows in the ultrasound image by dividing the intensities by a thickness of a vascular wall to form a third graph by the processor within the ultrasound system;

e) detecting inflection points from the second and third graphs by the processor within the ultrasound system; and

f) setting an intima-media thickness (IMT) measuring region by using the inflection points by the processor within the ultrasound system.

8. The method of claim **7**, wherein the step b) comprises averaging the intensities of the pixels per each row in the ultrasound image by the processor.

9. The method of claim **7**, wherein the step b) comprises summing the intensities of the pixels per each row by the processor.

10. The method of claim **7**, wherein the step e) comprises:

e1) detecting a plurality of inflection points at which an inclination of curvatures on the second graph changes;

e2) selecting a smallest value of the plurality of inflection points in the second graph as a first inflection point;

e3) detecting a plurality of inflection points at which an inclination of curvatures on the third graph changes; and

e4) selecting a largest value of the plurality of inflection points in the third graph as a second inflection point.

11. The method of claim **10**, wherein the step f) comprises setting the first and second inflection points on the ultrasound image as the IMT measuring region.

12. The method of claim **7**, wherein the first subsets of rows are determined by dividing the thickness of the blood vessel by a size of the pixel.

13. The method of claim **7**, wherein the second subsets of rows are determined by dividing the thickness of the vascular wall by a size of the pixel.

14. A computer readable medium comprising instructions that, when executed by a processor, performs a method of setting an intima-media thickness (IMT) measuring region, causing the processor to perform steps comprising:

a) obtaining an ultrasound image, which includes a plurality of pixels;

b) computing intensities of the pixels at each row in the ultrasound image to form a first graph;

c) computing first moving averages of the intensities for first subsets of rows in the ultrasound image by dividing the intensities by a thickness of a blood vessel to form a second graph;

d) computing second moving averages of the intensities for second subsets of rows in the ultrasound image by dividing the intensities by a thickness of a vascular wall to form a third graph;

e) detecting inflection points from the second graph and the third graph; and

f) setting an intima-media thickness (IMT) measuring region by using the inflection points.

15. The computer readable medium of claim **14**, comprising instructions that cause step e) to comprise:

e1) detecting a plurality of inflection points at which an inclination of curvatures on the second graph changes;

e2) selecting a smallest value of the plurality of inflection points in the second graph as a first inflection point;

e3) detecting a plurality of inflection points at which an inclination of curvatures on the third graph changes; and

e4) selecting a largest value of the plurality of inflection points in the third graph as a second inflection point.

* * * * *

专利名称(译)	超声系统中内膜中层厚度测量的区域设置		
公开(公告)号	US20100125202A1	公开(公告)日	2010-05-20
申请号	US12/617166	申请日	2009-11-12
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	LEE JIN YONG SHIM JAE YOON		
发明人	LEE, JIN YONG SHIM, JAE YOON		
IPC分类号	A61B8/14		
CPC分类号	A61B5/02007 A61B8/0858 G06T2207/30101 G06T7/602 G06T2207/10132 G06T7/0012 G06T7/62		
优先权	1020080115332 2008-11-19 KR		
其他公开文献	US9510804		
外部链接	Espacenet USPTO		

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。