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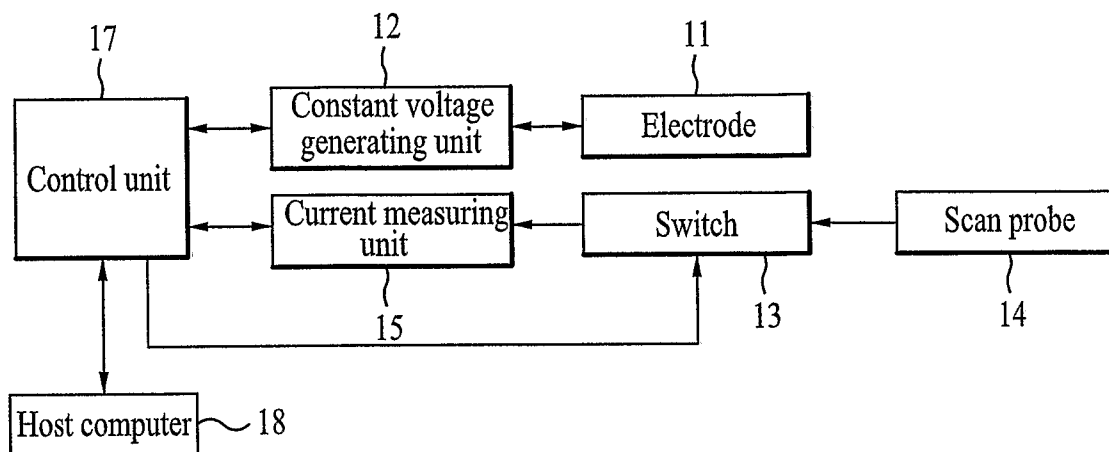
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(54) Title: APPARATUS FOR DETECTING ANOMALY AND METHOD THEREOF



(57) Abstract: An apparatus for detecting an anomaly and method thereof are disclosed, by which a size and location of an anomaly of a breast cancer and the like can be precisely detected as well as a presence or non-presence of the anomaly based on data measured on a surface of a body. The present invention includes supplying a first frequency voltage having a first frequency to a measurement target, detecting a first signal induced by the first frequency voltage from the measurement target, supplying a second frequency voltage having a second frequency to the measurement target, detecting a second signal induced by the second frequency voltage from the measurement target, correcting the first and second signals based on slopes of the detected first and second signals, and calculating a location and size of the anomaly within the measurement target based on the corrected first and second signals.

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[DESCRIPTION]**APPARATUS FOR DETECTING ANOMALY AND METHOD THEREOF**TECHNICAL FIELD

5 The present invention relates to an apparatus for detecting an anomaly and method thereof. Although the present invention is suitable for a wide scope of applications, it is particularly suitable for detecting such an anomaly as a cancer, a tumor and the like using electrical characteristics
10 of a body.

BACKGROUND ART

 Generally, women's breast cancers or large intestine cancers tend to keep increasing. Specifically, morbidity of
15 breast cancer keeps increasing. In case of U.S.A., the breast cancer morbidity occupies 37.3% of morbidity of all kinds of cancers in 2001. In case of Japan, the breast cancer morbidity occupies 19.6% of morbidity of all kinds of cancers in 2001.

 A most preferable treatment of cancer is to give
20 corresponding medical treatment by detecting a tumor at an early stage before the tumor is transferred to another part of the body from an original site of disease. Yet, such an early diagnosis is possible in case of a presence of a secure and effective diagnostic technique. And, many efforts have been
25 made to develop the early diagnosis of breast cancer using various techniques.

 There are various early diagnostic techniques including

X-ray mammography, ultrasonic photography, thermal infrared photography, CT, etc, for which various medical video equipments are used.

In the globally used X-ray mammography, it is difficult
5 to diagnose a young woman's disease as a breast cancer due to X-ray characteristics since density of young woman's mammary glandular tissues is high. And, it is probable that the radioactivity used for the corresponding diagnosis may trigger a breast cancer.

10 In the ultrasonic photography, a video resolution is too low to be applied to an early diagnosis. And, the ultrasonic photography is still in dispute.

In case of the thermal infrared photography which uses a fact that a temperature of an inflamed or cancered cell is
15 higher than that of a normal cell, a temperature of a skin surface is mainly shown on video. So, it is difficult to diagnose the breast cancer precisely.

In case of MRI or CT, a corresponding diagnostic cost is very high. And, it is difficult to photograph a woman's breast
20 part only.

Recently, many efforts are made to detect breast cancer using a phenomenon that an electric conductivity of a normal tissue differs from that of a tumor tissue by three to ten times. So, a T-scan measurement technique is developed.

25 The T-scan measurement technique images a living tissue by measuring a current induced by a voltage applied to a human body. The T-scan measurement technique is identical to a

measurement technique that uses a frontal plane impedance camera, which can be the first instance of early EIT (electrical impedance tomography) studied in the early 1980's. In particular, by applying a constant voltage to one portion
5 of a human body via a surface electrode and maintaining a reference voltage of an electrode attached to another portion, a current bet measured to be imaged. And, a corresponding image is called a transfer admittance image. In T-scan, the transfer admittance image is outputted. And, a user decides a
10 presence or non-presence of a patient's breast cancer through a subjective interpretation based on the outputted image.

However, the diagnostic equipment such as T-scan is not provided with a function of analyzing data of measurement of a breast surface. So, it is difficult to precisely detect an
15 anomaly since a diagnostic result depends on a user's visual decision.

DISCLOSURE OF THE INVENTION

Accordingly, the present invention is directed to an
20 apparatus for detecting an anomaly and method thereof that substantially obviate one or more of the problems due to limitations and disadvantages of the related art.

An object of the present invention is to provide an apparatus for detecting an anomaly and method thereof, by
25 which a size and location of an anomaly of a breast cancer and the like can be precisely detected as well as a presence or non-presence of the anomaly based on data measured on a

surface of a body.

Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by
5 practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims thereof as well as the appended drawings.

To achieve these and other advantages and in accordance
10 with the purpose of the present invention, as embodied and broadly described, a method of detecting an anomaly according to the present invention includes the steps of supplying a first frequency voltage having a first frequency to a measurement target, detecting a first signal induced by the
15 first frequency voltage from the measurement target, supplying a second frequency voltage having a second frequency to the measurement target, detecting a second signal induced by the second frequency voltage from the measurement target, correcting the first and second signals based on slopes of the
20 detected first and second signals, and calculating a location and size of the anomaly within the measurement target based on the corrected first and second signals.

Preferably, the step of calculating the location and size of the anomaly within the measurement target based on the
25 corrected first and second signals includes the step of calculating the location of the anomaly within the measurement body based on a difference between the corrected first and

second signals.

More preferably, the step of calculating the location of the anomaly within the measurement body based on a difference between the corrected first and second signals includes the steps of deciding an anomaly point on a detecting means corresponding to the location of the anomaly within the measurement target based on the difference between the corrected first and second signals and calculating a distance between the location of the anomaly within the measurement target and the anomaly point on the detecting means based on a distance between the anomaly point on the detecting means and a random point on the detecting means, a difference between the first and second signals detected at the anomaly point on the detecting means and a difference between the first and second signals detected at the random point on the detecting means.

Preferably, the step of calculating the location and size of the anomaly within the measurement target based on the corrected first and second signals includes the step of calculating the size of the anomaly within the measurement target based on a difference between the first and second signals detected on an anomaly point of a detecting means and a distance between the location of the anomaly within the measurement body and the anomaly point on the detecting means.

Preferably, the step of correcting the first and second signals based on the slopes of the detected first and second signals includes the steps of comparing each of the slopes of

the first and second signals to a reference value and correcting the first and second signals according to a result of the comparing step.

Preferably, the step of supplying the second frequency voltage having the second frequency to the measurement target includes the step of if a supply of the first frequency voltage is terminated and if a time over one cycle of the first frequency voltage passes, supplying the second frequency voltage to the measurement target.

10 Preferably, the step of supplying the second frequency voltage having the second frequency to the measurement target includes the step of supplying the second frequency voltage having a frequency band higher than that of the first frequency voltage to the measurement target.

15 To further achieve these and other advantages and in accordance with the purpose of the present invention, an apparatus for detecting an anomaly includes a voltage generating unit supplying a first frequency voltage having a first frequency and a second frequency voltage having a second
20 frequency to a measurement target, a detecting means for detecting a first signal induced by the first frequency voltage and a second signal induced by the second frequency voltage, a signal correcting unit correcting the first and second signals based on slopes of the detected first and
25 second signals, and a control unit calculating a location and size of the anomaly within the measurement target based on the corrected first and second signals.

Preferably, the control unit calculates the location of the anomaly within the measurement body based on a difference between the corrected first and second signals.

More preferably, the control unit decides an anomaly
5 point on the detecting means corresponding to the location of the anomaly within the measurement target based on the difference between the corrected first and second signals and calculates a distance between the location of the anomaly within the measurement target and the anomaly point on the
10 detecting means based on a distance between the anomaly point on the detecting means and a random point on the detecting means, a difference between the first and second signals detected at the anomaly point on the detecting means and a difference between the first and second signals detected at
15 the random point on the detecting means.

Preferably, the control unit calculates the size of the anomaly within the measurement target based on a difference between the first and second signals detected on an anomaly point of a detecting means and a distance between the location
20 of the anomaly within the measurement body and the anomaly point on the detecting means.

Preferably, the signal correcting unit compares each of the slopes of the first and second signals to a reference value and then corrects the first and second signals according
25 to a result of the comparing step.

Preferably, if a supply of the first frequency voltage is terminated and if a time over one cycle of the first frequency

voltage passes, the voltage generating unit supplies the second frequency voltage to the measurement target.

Preferably, the voltage generating unit supplies the second frequency voltage having a frequency band higher than
5 that of the first frequency voltage to the measurement target.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

10

BRIEF DESCRIPTION OF DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate
15 embodiments of the invention and together with the description serve to explain the principles of the invention.

In the drawings:

FIG. 1 is a block diagram of an anomaly detecting apparatus according to an embodiment of the present invention;

20 FIG. 2 is a diagram for explaining a detecting method according to one embodiment of the present invention using an anomaly detecting apparatus of the present invention;

FIG. 3 is a block diagram of a constant voltage generating unit shown in FIG. 1;

25 FIG. 4 is a diagram of a scan probe according to one embodiment of the present invention;

FIG. 5 is an exemplary block diagram of a current

measuring unit shown in FIG. 1;

FIG. 6 is another exemplary block diagram of a current measuring unit shown in FIG. 1; and

FIG. 7 is a flowchart of a method of detecting an anomaly
5 according to the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are
10 illustrated in the accompanying drawings.

FIG. 1 is a block diagram of an anomaly detecting apparatus according to an embodiment of the present invention and FIG. 2 is an exemplary diagram for explaining a detecting method according to one embodiment of the present invention
15 using an anomaly detecting apparatus of the present invention. In FIG. 1 and FIG. 2, elements required for explaining a technical idea of the present invention are shown only.

Referring to FIG. 2, a reference electrode 11 to apply a voltage is brought into contact with a portion of a body. And,
20 the voltage is applied to the body via the reference electrode 11. For instance, the voltage is applied to an internal part of the body via such a body portion as a hand.

A constant voltage generating unit 12 supplies a voltage to the reference electrode 11. The constant voltage generating
25 unit 12 generates at least one sine wave constant voltage of a specific frequency and then provides the generated sine wave constant voltage to the reference electrode 11.

FIG. 3 is a block diagram of the constant voltage generating unit shown in FIG. 1.

Referring to FIG. 3, the constant voltage generating unit 12 includes a digital waveform generator 121 based on FPGA (field programmable gate array), a 16-bit digital-to-analog converter (DAC) 122 and an 8-bit digital-to-analog converter (DAC) 123.

The digital waveform generator 121 outputs a sine wave and is able to adjust a frequency of the sine wave in a range between 10Hz and 500KHz according to a command of a control unit 17. And, the 8-bit DAC 123 is able to adjust a size of the sine wave in a range between 0V and 2.5V. Hence, the constant voltage generating unit 12 is able to output the sine wave differing in size and frequency variously.

A scan probe 14 is brought into contact with a body portion to be checked and detects an electrical signal, i.e., a current flowing between the check portion and the reference electrode 11. For instance, in case of checking up a breast cancer, the scan probe 14 scans a current flowing through a chest.

And, the scan probe 14 includes a planar array of electrodes. Each of the planar array electrodes detects a current flowing through the check portion by maintaining a reference potential.

FIG. 4 is a diagram of a scan probe according to one embodiment of the present invention.

Referring to FIG. 4, a scan probe 14 includes a plurality

of cylinder or disc type detect electrodes 143 periodically arranged with a predetermined gap in-between. For instance, the scan probe 14 includes 320 gold-plated detect electrodes 143. In this case, a diameter of each of the detect electrodes 143 is about 2mm.

In order to arrange the detect electrodes 143 evenly spaced apart from one another, a shielding case 142 is needed to fix the detect electrodes 143 thereto. The shielding case 142 is formed of PCB. A plurality of holes are provided to the shielding case 142 to have the detect electrodes 143 inserted therein, respectively. And, the shielding case 142 is formed of an insulator to electrically isolate the detect electrodes 143 from one another.

A frame 141 formed of metal is provided to an outer circumference of the shielding case 142.

A current flowing from the reference electrode 11 to the scan probe 14 spreads through the entire body and then gathers into the scan probe 14. In this case, a current value inputted to the detect electrode 143 located in the vicinity of an outer side of the scan probe 14 is considerably greater than a current value inputted to another detect electrode 143 located at a center of the scan probe 14. So, an input value of the scan probe 14 is distorted. And, it is difficult to measure a microscopic current variation. To solve these problems metal frame (guard electrode) is provided. The metal frame 141 enables the detect electrodes 143 and their peripheries to keep a reference potential (0V).

A current measuring unit 15 selectively receives currents detected by the detect electrodes 143 via a switch 13 and then measures a size of each of the detected currents.

FIG. 5 is an exemplary block diagram of the current measuring unit shown in FIG. 1.

Referring to FIG. 5, the current measuring unit 15 includes a current-to-voltage converter 152 converting the current received via the switch 13 to a voltage, an analog-to-digital converter (ADC) 153 converting an analog voltage signal outputted from the current-to-voltage converter 152 to a digital voltage signal and a digital phase detect demodulator measuring sizes of microscopic currents detected by the detect electrodes 143 based on the signal outputted from the analog-to-digital converter 153.

The AD153 converts the analog voltage signal to the digital voltage signal with 10MHz sampling frequency.

In order to measure the sizes of the currents, the current measuring unit 15 can include a plurality of current measuring modules each of which includes at least one current-to-voltage converter 152, at least one ADC 153 and at least one demodulator 154.

For instance, if the current measuring unit 15 includes sixteen modules, each of the modules is able to be connected to a corresponding one of twenty detect electrodes 143 via the switch 13.

And, the current measuring unit 15 is able to further include a correction unit compensating a gain difference, a

phase difference and the like off the current measuring modules.

FIG. 6 is another exemplary block diagram of the current measuring unit shown in FIG. 1.

5 Referring to FIG. 6, the current measuring unit 15 can include a plurality of current measuring modules.

Each of a plurality of the current measuring modules includes a current-to-voltage converter 261, a band pass filter 263, a voltage amplifier 264, an A/D (analog/digital)
10 converter 265 and a microcomputer 266.

The current-to-voltage converter 261 receives a current detected by each of the detect electrodes 143 according to a command of the microcomputer 266 and then converts the received current to a voltage.

15 A voltage signal outputted from the current-to-voltage converter 261 undergoes band path filtering by the band pass filter 263 and is then provided to the voltage amplifier 264 having a variable gain.

The voltage amplifier 264 includes a digital
20 potentiometer having a maximum gain of 2,500.

A signal amplified by the voltage amplifier 264 is digitalized into a 10MHz sampling frequency by the 12-bit A/D converter 265 according to a non-uniform sampling technique. By the non-uniform sampling technique, each amplified signal is
25 sampled with a different timing for each of the amplified signals. For instance, assuming that one cycle of a signal is '1', the signal is sampled for each of 0.1, 0.3, 0.5, 0.7 and

0.9 cycles during an odd cycle. And, the signal is sampled for each of 0.2, 0.4, 0.6, 0.8 and 1.0 cycles during an even cycle.

The microcomputer 266 is configured with FPGA and includes a half-duplex sync type serial port for infra-network,
5 a spike noise removing digital filter and an auto-gain controller.

The microcomputer 266 computes a slope of voltage data inputted to the A/D converter 265 continuously. If the computed slope exceeds a threshold (slope of sine wave), the
10 microcomputer 266 decides that noise is included in the voltage data. The microcomputer 266 then replaces the corresponding voltage data by a new value using the noise removing digital filter. For instance, the replacement value is an ideal value estimated based on a current value supplied
15 to the reference electrode 11.

The microcomputer 266 detects a peak value of the voltage data during at least one cycle of a sine wave outputted from the A/D converter 265.

The microcomputer 266s a gain of the voltage amplifier
20 264 to have the detected peak value reach 90% of an output of the A/D converter 265 within a range between 1 and 2,500.

And, the microcomputer 266 controls a variable resistance included in the voltage amplifier 264 to adjust the gain (or, amplification rate) of the voltage amplifier 264. Besides, the
25 control unit 17 is able to perform functions of the microcomputer 266 as well.

The control unit 17 outputs a clock signal to synchronize

the constant voltage generating unit 12 and the current measuring unit 15 together. For instance, the control unit 17 transfers a clock signal of 40MHz to the constant voltage generating unit 12 and the current measuring unit 15.

5 And, the control unit 17 is connected to a host computer 18 via a USB port and transfers current associated data measured by the current measuring unit 154 to the host computer 18. In this case, the host computer 18 includes a personal computer or a server connected to various anomaly
10 detecting devices.

 The host computer 18 detects a real-number component (in-phase) and an imaginary component (quadrature or out-of-phase) of each of the currents transferred by the control unit 17 and then computes transfer admittance data based on the detected
15 components. Since current preferentially flows through such an anomaly as a cancer, a tumor and the like rather than a normal tissue, a presence or non-presence of anomaly can be decided using the transfer admittance data proportional to a size of current.

20 And, the host computer 18 computes a location and size of anomaly using the transfer admittance data and is then able to image a checked internal portion of body into a 3-dimensional image based on the computed values. This image offers information for conductivity and permittivity of a living
25 tissue of the checked internal portion and enables a user to precisely know a location and size of anomaly as well as a presence or non-presence of such an anomaly as a cancer, a

tumor and the like.

Alternatively, if the host computer 18 is not connected to an anomaly detecting device, the control unit 17 is able to perform a function of computing a location and size of anomaly
5 based on the transfer admittance data.

A method of detecting a location and size of anomaly based on the transfer admittance data is explained with reference to FIG. 7 as follows.

FIG. 7 is a flowchart of a method of detecting an anomaly
10 according to the present invention.

Referring to FIG. 7, the constant voltage generating unit 12 generates a sine wave voltage of a first frequency according to a command of the control unit 17 and then transfers the generated voltage to the reference electrode 11
15 (S71). In this case, the constant voltage generating unit 12 outputs a sine wave voltage having a frequency corresponding to a range between 10Hz and 500KHz, e.g., a 50KHz sine wave voltage.

If the sine wave voltage of the first frequency is
20 introduced into a measurement target via the reference electrode 11, each of the detect electrodes 143 of the scan probe 14 detects a current at a portion to be examined (S72).

Subsequently, the current detected by each of the detect electrodes 143 is transferred to the current measuring unit 15.
25 The current measuring unit 15 then measures levels of the currents detected by the detect electrodes 143, respectively. The current measuring unit 15 delivers all real-number and

imaginary number components of the measured current values to the control unit 17.

If so, the control unit 17 transfers the measured current values to the host computer 18.

5 After a predetermined time has passed, the constant voltage generating unit 12 outputs a sine wave voltage of a second frequency (e.g., 500MHz) different from the first frequency (50MHz) of the former sine wave voltage. After the output of the sine wave voltage of the first frequency has
10 been terminated, the constant voltage generating unit 12 outputs the sine wave voltage of the second frequency if a time corresponding to a prescribed cycle (e.g., two cycles (180°)) of the sine wave voltage of the first frequency is passed or if a sum of the currents detected by the detect
15 electrodes 143 becomes zero (S73).

In the same manner, the sine wave voltage of the second frequency is inputted to the measurement target and a current according to the sine wave voltage of the second frequency is then detected (S74).

20 The current measuring unit 15 calculates a slope of a first current signal attributed to the first frequency voltage and a slope of a second current signal attributed to the second frequency voltage (S75).

Based on the slopes of the calculated first and second
25 current signals, the current measuring unit 15 decides whether noise exists in each of the first and second current signals (S76). For instance, each of the slopes of the first and

second current signals is compared to a threshold and a presence or non-presence of noise is then decided according to a result of the comparison. If the noise exists in the first or second current signal, the current measuring unit 15
 5 corrects the first or second current signal to remove the corresponding noise component from the corresponding signal (S77).

Optionally, the current measuring unit 15 may determine whether noise exists in the first current signal before the
 10 constant voltage generating unit 12 outputs the second frequency voltage.

Subsequently, a location and size of an anomaly is computed based on the first and second current signals (S78). Transfer admittance data is computed based on current values
 15 generated from the sine wave voltages differing from each other in frequency. Algorithm for computing the location and size of the anomaly based on the computed transfer admittance data is explained as follows.

First of all, in case of using two sine wave voltages
 20 differing from each other in frequency, let's assume that transfer admittance distributions corresponding to two frequencies ω and ω' are $g(x,y)$ and $g'(x,y)$, respectively and that complex conductivities of normal tissue and tumor tissue corresponding to the frequency ω' are $\tau'_1 = \sigma_1 + j\omega'\epsilon_1$ and
 25 $\tau'_2 = \sigma_2 + j\omega'\epsilon_2$, respectively.

A relation between a location and size of anomaly and the transfer admittance distributions corresponding to the two

frequencies is defined by Formula 1.

[Formula 1]

$$g'(x,y)-g(x,y) = A \frac{18\alpha(\tau_2-\tau'_2)}{(2\tau_1+\tau_2)(2\tau'_1+\tau'_2)} \frac{2d^2-(x-\xi_1)^2-(y-\xi_2)^2}{4\pi[(x-\xi_1)^2-(y-\xi_2)^2+d^2]^{5/2}}$$

5

In this case, symbols used in Formula 1 are as follows:

'A' is a volume of anomaly;

'(x,y)' is a random point in a plane Γ of the scan probe

14;

10 ' α ' is a mean value of transfer admittance distribution
g(x,y) in the plane of the scan probe 14;

'(ξ_1, ξ_2)' is a point on the plane of the scan probe 14
corresponding to an anomaly within a body; and

15 'd' is a vertical distance from a point (ξ_1, ξ_2) in the
plane of the scan probe 14 to a weight center of anomaly.

In $\tau_1 = \sigma_1 + j\omega\epsilon_1$, σ_1 is a mean conductivity of a normal
tissue, ϵ_1 is a mean permittivity of a normal tissue, and ω is a
frequency of a sine wave voltage.

20 In $\tau_2 = \sigma_2 + j\omega\epsilon_2$, σ_2 is a mean conductivity of a tumor
tissue, ϵ_2 is a mean permittivity of a tumor tissue, and ω is a
frequency of a sine wave voltage.

[Formula 2]

$$(\xi_1, \xi_2) = \arg \max_{(x,y) \in H_L} |g'(x,y) - g(x,y)|$$

25

By Formula 2, a point (ξ_1, ξ_2) in the plane of the scan

probe 14 corresponding to a location of an anomaly can be found. The point (ξ_1, ξ_2) in the plane of the scan probe 14 is the point at which the absolute value $|g'(x,y) - g(x,y)|$ has a maximum value in the plane of the scan probe 14. In order to
 5 find the point (ξ_1, ξ_2) , the control unit 17 compares the admittance distribution $g'(x,y)$ corresponding to the frequency ω' and the admittance distribution $g(x,y)$ corresponding to the frequency ω to each other. The control unit 17 then decides a point, which has a maximum value among the differences between
 10 the two admittance distributions, in the plane of the scan probe 14 as the point (ξ_1, ξ_2) .

[Formula 3]

$$\left| \frac{g'(\xi_1 - \xi_2) - g(\xi_1 - \xi_2)}{g'(x, y) - g(x, y)} \right| = \frac{\left| 2 - \frac{l^2}{d^2} \right|}{2\left(\frac{l^2}{d^2} + 1\right)^{\frac{1}{2}}}$$

15

By Formula 3, a depth d of anomaly can be found. In Formula 3, (x, y) is a random point in the plane of the scan probe 14 in the vicinity of the point (ξ_1, ξ_2) , a distance l is a distance between the points (x, y) and (ξ_1, ξ_2) , i.e.,
 20 $l = \sqrt{(x - \xi_1)^2 + (y - \xi_2)^2}$. The control unit 17 calculates the distance l between the points (x, y) and (ξ_1, ξ_2) . The control unit 17 then calculates a distance d to an actual anomaly from the point (ξ_1, ξ_2) in the plane of the scan probe 14 based on the two admittance values $g'(\xi_1 - \xi_2)$ and $g(\xi_1 - \xi_2)$ measured at the
 25 point (ξ_1, ξ_2) , the two admittance values $g'(x, y)$ and $g(x, y)$

measured at the random point (x,y) and the calculated distance l . Like Formula 3, it can be seen that the distance d varies according to a ratio of the difference $g'(x,y)-g(x,y)$ between the two admittance values to the difference between the two admittance values $g'(\xi_1-\xi_2)-g(\xi_1-\xi_2)$ and that the distance d varies according to the distance l . Once the point (ξ_1, ξ_2) in the plane of the scan probe 14 corresponding to the location of the anomaly and the distance d to the anomaly from the point (ξ_1, ξ_2) are known, it is able to know a precise location of the anomaly existing within a body.

[Formula 4]

$$A = \frac{\pi |2\tau_1 + \tau_2| |2\tau'_1 + \tau'_2| |g'(\xi_1 - \xi_2) - g(\xi_1 - \xi_2)| d^3}{9|\alpha| |\tau_2 - \tau'_2|}$$

A size (volume) of anomaly can be found by Formula 4. Once the distance d to the anomaly from the point (ξ_1, ξ_2) in the plane of the scan probe 14 is calculated, the control unit 17 is able to find the volume A of the anomaly. As expressed in Formula 4, the volume A of the anomaly depends on the distance d , the difference $g'(\xi_1 - \xi_2) - g(\xi_1 - \xi_2)$ between the two admittance values and the mean value α of the transfer admittance distribution in the plane of the scan probe 14 and also depends on the conductivity and permittivity associated data τ_1, τ_2, τ'_1 and τ'_2 corresponding to the two sine wave voltages.

INDUSTRIAL APPLICABILITY

Accordingly, the present invention provides the following effects or advantages.

First of all, the present invention is able to decide
5 whether an anomaly exists within a body based on admittance data and detect a location and size of the anomaly.

Secondly, the present invention is able to manufacture an instrument less harmful and less expensive than a conventional breast cancer diagnostic instrument detecting a breast cancer.

10 Thirdly, since constant voltages differing from each other in frequency are sequentially applied to a body with a prescribed duration, it is able to precisely detect a location and size of an anomaly without noise generated from interference between two constant voltages.

15 Therefore, the present invention is usefully applicable to the diagnosis of breast cancer.

While the present invention has been described and illustrated herein with reference to the preferred embodiments thereof, it will be apparent to those skilled in the art that
20 various modifications and variations can be made therein without departing from the spirit and scope of the invention. Thus, it is intended that the present invention covers the modifications and variations of this invention that come within the scope of the appended claims and their equivalents.

[CLAIMES]

1. A method of detecting an anomaly, comprising the steps of:

- 5 supplying a first frequency voltage having a first frequency to a measurement target;
- detecting a first signal induced by the first frequency voltage from the measurement target;
- supplying a second frequency voltage having a second
- 10 frequency to the measurement target;
- detecting a second signal induced by the second frequency voltage from the measurement target;
- correcting the first and second signals based on slopes of the detected first and second signals; and
- 15 calculating a location and size of the anomaly within the measurement target based on the corrected first and second signals.

2. The method of claim 1, the step of calculating the
- 20 location and size of the anomaly within the measurement target based on the corrected first and second signals, comprising the step of calculating the location of the anomaly within the measurement body based on a difference between the corrected first and second signals.

25

3. The method of claim 2, the step of calculating the location of the anomaly within the measurement body based on a

difference between the corrected first and second signals, comprising the steps of:

deciding an anomaly point on a detecting means corresponding to the location of the anomaly within the measurement target based on the difference between the corrected first and second signals; and

calculating a distance between the location of the anomaly within the measurement target and the anomaly point on the detecting means based on a distance between the anomaly point on the detecting means and a random point on the detecting means, a difference between the first and second signals detected at the anomaly point on the detecting means and a difference between the first and second signals detected at the random point on the detecting means.

15

4. The method of claim 1, the step of calculating the location and size of the anomaly within the measurement target based on the corrected first and second signals, comprising the step of calculating the size of the anomaly within the measurement target based on a difference between the first and second signals detected on an anomaly point of a detecting means and a distance between the location of the anomaly within the measurement body and the anomaly point on the detecting means.

25

5. The method of claim 1, the step of correcting the first and second signals based on the slopes of the detected

first and second signals, comprising the steps of:

comparing each of the slopes of the first and second signals to a reference value; and

correcting the first and second signals according to a
5 result of the comparing step.

6. The method of claim 1, the step of supplying the second frequency voltage having the second frequency to the measurement target, comprising the step of if a supply of the
10 first frequency voltage is terminated and if a time over one cycle of the first frequency voltage passes, supplying the second frequency voltage to the measurement target.

7. The method of claim 1, the step of supplying the
15 second frequency voltage having the second frequency to the measurement target, comprising the step of supplying the second frequency voltage having a frequency band higher than that of the first frequency voltage to the measurement target.

20 8. An apparatus for detecting an anomaly, comprising:
a voltage generating unit supplying a first frequency voltage having a first frequency and a second frequency voltage having a second frequency to a measurement target;

a detecting means for detecting a first signal induced by
25 the first frequency voltage and a second signal induced by the second frequency voltage;

a signal correcting unit correcting the first and second

signals based on slopes of the detected first and second signals; and

a control unit calculating a location and size of the anomaly within the measurement target based on the corrected
5 first and second signals.

9. The apparatus of claim 8, wherein the control unit calculates the location of the anomaly within the measurement body based on a difference between the corrected first and
10 second signals.

10. The apparatus of claim 9, wherein the control unit decides an anomaly point on the detecting means corresponding to the location of the anomaly within the measurement target
15 based on the difference between the corrected first and second signals and calculates a distance between the location of the anomaly within the measurement target and the anomaly point on the detecting means based on a distance between the anomaly point on the detecting means and a random point on the
20 detecting means, a difference between the first and second signals detected at the anomaly point on the detecting means and a difference between the first and second signals detected at the random point on the detecting means.

25 11. The apparatus of claim 8, wherein the control unit calculates the size of the anomaly within the measurement target based on a difference between the first and second

signals detected on an anomaly point of a detecting means and a distance between the location of the anomaly within the measurement body and the anomaly point on the detecting means.

5 12. The apparatus of claim 8, wherein the signal correcting unit compares each of the slopes of the first and second signals to a reference value and then corrects the first and second signals according to a result of the comparing step.

10

 13. The apparatus of claim 8, wherein if a supply of the first frequency voltage is terminated and if a time over one cycle of the first frequency voltage passes, the voltage generating unit supplies the second frequency voltage to the
15 measurement target.

 14. The apparatus of claim 8, wherein the voltage generating unit supplies the second frequency voltage having a frequency band higher than that of the first frequency voltage
20 to the measurement target.

FIG. 1

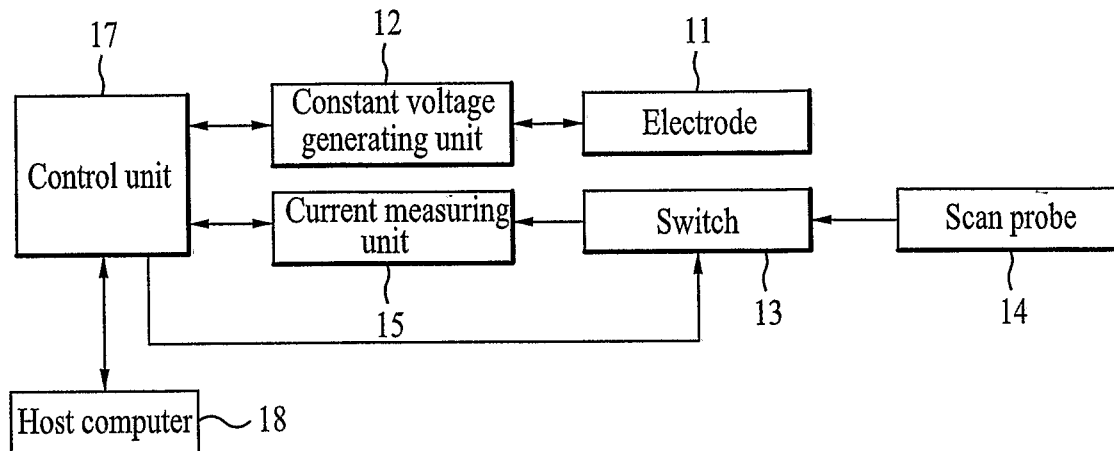


FIG. 2

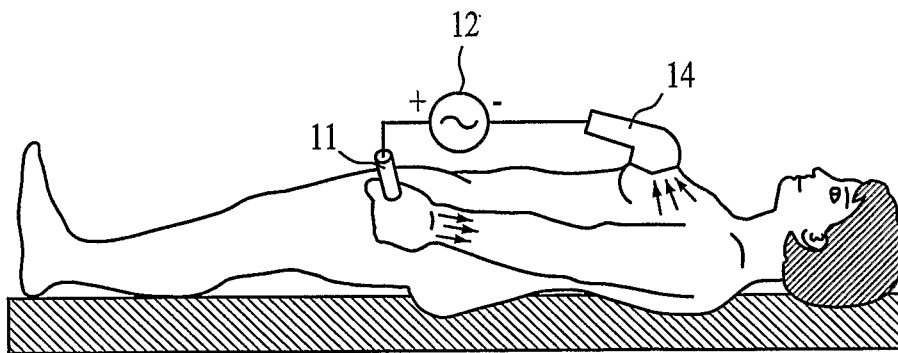


FIG. 3

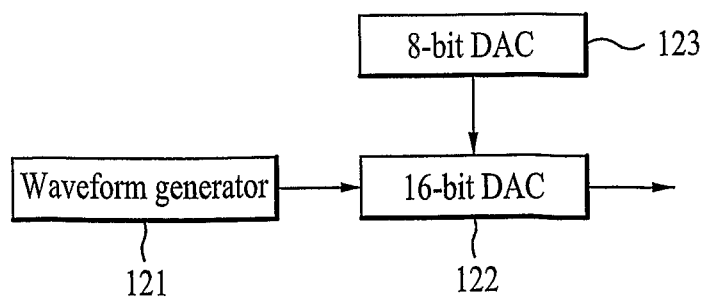


FIG. 4

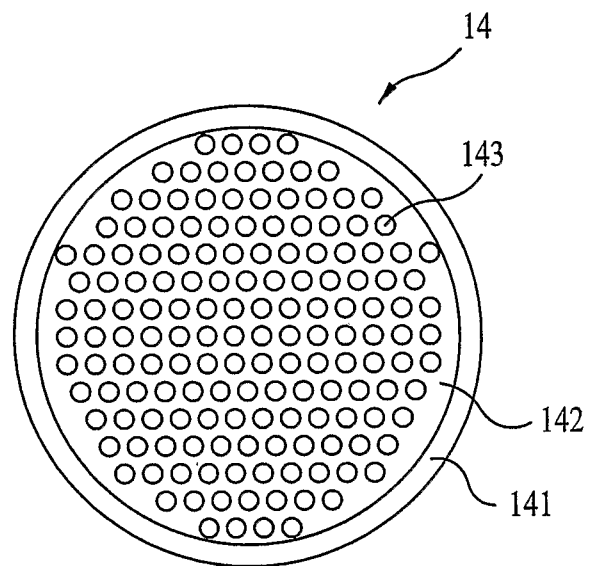


FIG. 5

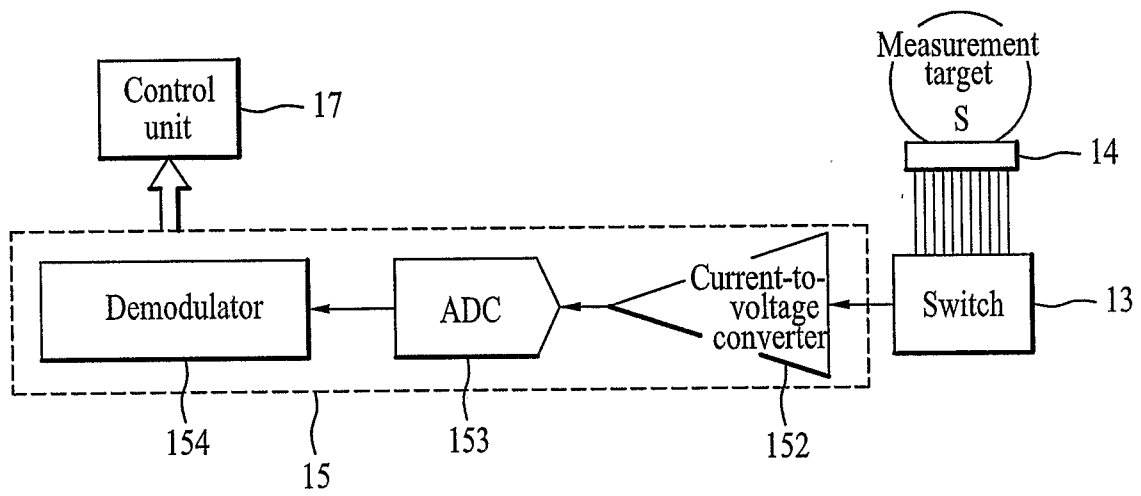
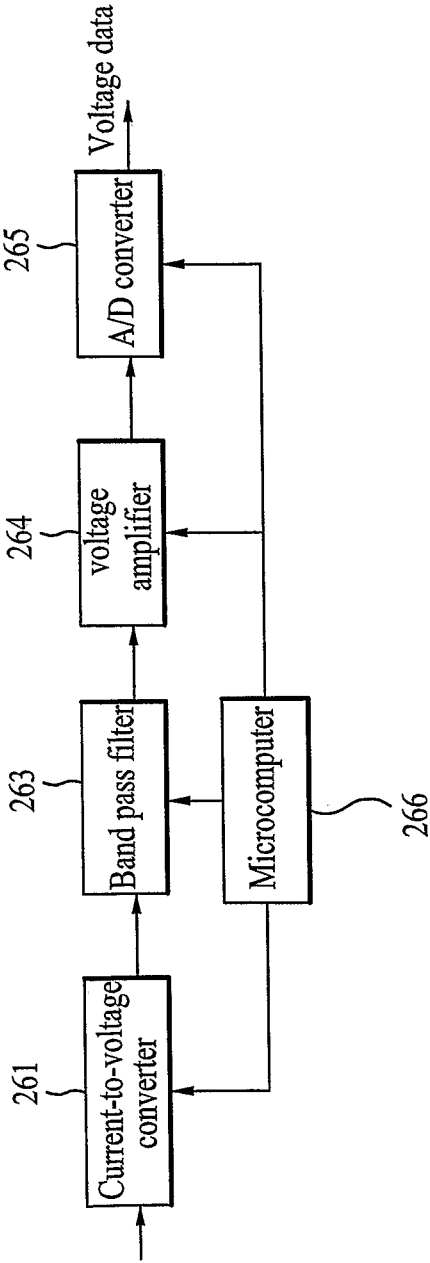
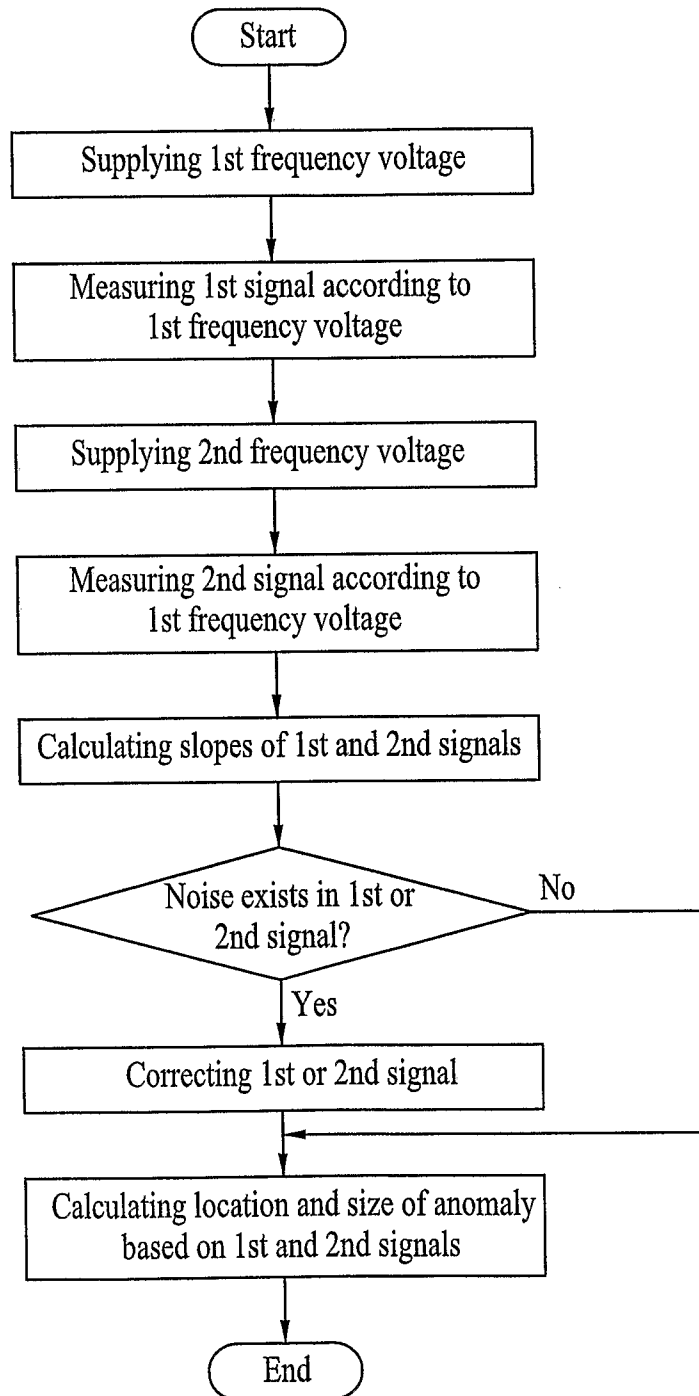


FIG. 6



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FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR 2006/002978

A. CLASSIFICATION OF SUBJECT MATTER

IPC⁸: **A61B 5/053** (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC⁸: A61B 5/053

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5810742 A (PEARLMAN) 22 September 1998 (22.09.1998) <i>whole document</i>	1,8
	--	
A	WO 2004/062464 A2 (KOHWANG FOUNDATION) 29 July 2004 (29.07.2004) <i>whole document</i>	1,8

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search
22 January 2007 (22.01.2007)Date of mailing of the international search report
28 February 2007 (28.02.2007)Name and mailing address of the ISA/ AT
Austrian Patent Office
Dresdner Straße 87, A-1200 ViennaAuthorized officer
NARDAI F.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2006/002978

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