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(54) Intravital-information imaging apparatus

Bildgebungsgerät für intravitale Informationen

Appareil d’imagerie d’informations intra-vitales

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to intravital-information imaging apparatuses.

Description of the Related Art

[0002] Generally, many imaging apparatuses that employ X-rays, ultrasound, or magnetic resonance imaging (MRI) are used in the medical field.

[0003] Furthermore, in the medical field, research is being conducted for optical imaging apparatuses for obtaining intravital information by irradiating a living body with light from a light source, such as a laser, so that the light propagates in the living body, and detecting the propagated light or the like.

[0004] As a type of optical imaging technique, photoacoustic tomography (PAT) has been proposed. Photoacoustic tomography is described, for example, in M. Xu and L. V. Wang, "Photoacoustic imaging in biomedicine", Review of Scientific Instruments, 77, 041101 (2006).

[0005] In photoacoustic tomography, a living body is irradiated with pulsed light emitted from a light source, an acoustic wave generated from a biological tissue having absorbed the energy of light propagated and diffused in the living body is detected at multiple points, and corresponding signals are analyzed to form a visual image representing intravital information. This makes it possible to obtain a distribution of optical characteristic values in the living body, particularly, a distribution of optical-energy absorption densities.

[0006] According to the reference mentioned above, in photoacoustic tomography, the sound pressure (P) of an acoustic wave generated from a light absorber in a living body in response to absorbed light can be expressed by equation (1) below:

$$P = \Gamma \cdot \mu_a \cdot \Phi \qquad (1)$$

where Γ denotes the Gruneisen coefficient, which is a value of elasticity characteristic determined by dividing the product of the thermal coefficient of volume expansion or isobaric volume expansion coefficient (β) and the square of the speed of light (c) by the specific heat at constant pressure (C_p).

[0007] μ_a denotes the absorption coefficient of the light absorber, and Φ denotes the amount of local light indicating the optical fluence (light with which the light absorber is irradiated).

[0008] Since it is known that Γ is substantially constant for a specific tissue, the distribution of the products of μ_a and Φ, i.e., the distribution of optical-energy absorption densities, can be obtained by measuring change in sound pressure P representing the magnitude of the acoustic wave at multiple points by time division.

[0009] In the photoacoustic tomography according to the related art described above, as will be understood from equation (1), in order to obtain a distribution of absorption coefficients (μ_a) in a living body from a measurement of change in sound pressure (P), it is necessary to obtain by some method the distribution of the local amounts of light with which a light absorber is irradiated. However, since light introduced in a living body is diffused, it is difficult to estimate the local amount of light with which the light absorber is irradiated. Thus, with ordinary measurement of sound pressures of a generated acoustic wave alone, it is only possible to make an image representing a distribution of optical-energy absorption densities ($\mu_a \times \Phi$).

[0010] That is, it is difficult to calculate a distribution of the amounts of light with which the light absorber is irradiated (Φ) and to accurately separate and generate an image of a distribution of absorption coefficients (μ_a) in a living body on the basis of a measurement of sound pressures of an acoustic wave.

[0011] As a result, it is difficult to accurately identify constituents of biological tissues or to measure density on the basis of the distribution of absorption coefficients (μ_a) in a living body.

[0012] Document US 6,567,688 B1 discloses a microwave-induced thermoacoustic tomography system and method to image biological tissue. Short microwave pulses irradiate tissue to generate acoustic waves by thermoelastic expansion. The microwave-induced thermoacoustic waves are detected with an ultrasonic transducer or transducer array. Each time-domain signal from the ultrasonic transducer is converted to a one dimensional image along the acoustic axis of the ultrasonic transducer. Scanning the system perpendicular to the acoustic axis generates multidimensional images.

[0013] R.O. Esenaliev et al. demonstrate in IEEE Journal of selected topics in quantum electronics, vol. 5, page 981-988 (1999) that laser optoacoustic imaging is capable of detecting and localizing phantom tumors with a diameter of 2mm at a depth of up to 60 mm.

[0014] J.A. Viator et al. disclose in IEEE Journal of selected topics in quantum electronics, vol. 5, page 989-996 (1999) detecting acoustic waves generated by a Nd:YAG laser in a target, and converting these measurements to an initial laser induced pressure and temperature as functions of depth in the material. An algorithm was developed to extract information about the absorption coefficient as a function of depth in the samples.

SUMMARY OF THE INVENTION

[0015] The present invention provides an intravital-information imaging apparatus with which it is possible to obtain a high-resolution distribution of optical characteristic values in a living body, particularly a distribution of optical absorption coefficients, or an average effective attenuation coefficient of a living body.

[0016] The present invention provides an intravital-information imaging apparatus as specified in claims 1 to 7.

[0017] With the intravital-information imaging apparatus according to the present invention, it is possible to obtain a high-resolution distribution of optical characteristic values in a living body, particularly a distribution of optical absorption coefficients, or an average effective attenuation coefficient of a living body, and to generate images accurately representing such information.

[0018] Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Figs. 1A and 1B are diagrams showing an example of the configuration of an intravital-information imaging apparatus according to a first embodiment of the present invention.

Fig. 2 is a diagram showing an example of the result of analyzing signals obtained by the intravital-information imaging apparatus according to the first embodiment of the present invention.

Fig. 3 is a diagram showing an example of the configuration of an intravital-information imaging apparatus according to a second embodiment of the present invention.

Fig. 4 is a diagram showing a state in the second embodiment of the present invention, where light from one or more light sources is blocked and a living body is simultaneously irradiated with light from the other light sources, and an acoustic wave generated from a light absorber is detected.

Fig. 5 is a diagram showing an example of the result of analyzing signals obtained by the intravital-information imaging apparatus according to the second embodiment of the present invention.

DESCRIPTION OF THE EMBODIMENTS

[0020] Now, embodiments of the present invention will be described with reference to the drawings.

First Embodiment

[0021] Figs. 1A and 1B show an example of the configuration of an intravital-information imaging apparatus according to a first embodiment.

[0022] Referring to Fig. 1A, when a living body 11 is irradiated with pulsed light 13 from a first light source 10, an acoustic wave 14 is generated from a light absorber 12 inside the living body 11. The acoustic wave 14 is detected by an acoustic-wave detector 15 in the form of an electric signal. The detected electric signal is analyzed by a signal processor 16.

[0023] The initial sound pressure P_1 of the acoustic wave 14 generated from the light absorber 12 in the living body 11 when the living body 11 is irradiated with the pulsed light 13 from the first light source 10 can be expressed by equation (2) below:

$$P_1 = \Gamma \cdot \mu_a \cdot \Phi = \Gamma \cdot \mu_a \cdot \Phi_0 \cdot \exp(-\mu_{eff} \cdot d_1) \qquad (2)$$

where Γ denotes the Grüneisen coefficient of the light absorber 12, μ_a denotes the absorption coefficient of the light absorber 12, Φ denotes the amount of local light absorbed by the light absorber 12, μ_{eff} denotes an average effective attenuation coefficient of the living body 11, and Φ_0 denotes the amount of light that irradiates the surface of the living body 11 from the first light source 10.

[0024] Furthermore, d_1 denotes the distance (first distance) from a region where the living body 11 is irradiated with the pulsed light 13 from the first light source 10 (irradiation region) to the light absorber 12, i.e., the depth.

[0025] Assuming that the Grüneisen coefficient (Γ) of the light absorber 12 is known since the Grüneisen coefficient (Γ) for a specific tissue of the body is substantially constant, through time-resolved measurement of the sound pressure (P) by the acoustic-wave detector 15, it is possible to find the distribution of acoustic-wave generating sources and the distribution of the products of the absorption coefficient (μ_a) and the amount of light (Φ) (the distribution of optical-energy absorption densities).

[0026] It is assumed here that the amount of light Φ_0 from each of the light sources with which the living body 11 is irradiated is constant, and that light propagates through the living body 11 like a plane wave since a region that is large enough in relation to the thickness of the living body 11 is irradiated with light. The amount of light Φ_0 with which the living body 11 is irradiated can be maintained constant by emitting a constant amount of light from the light source.

[0027] Furthermore, by performing time-resolved measurement of change in sound pressure (P) at multiple points, it is possible to estimate the distribution of acoustic-wave generating sources or the distribution of optical-energy absorption densities.

[0028] Referring next to Fig. 1B, the living body 11 is irradiated with pulsed light 23 from a second light source 20, which is provided at a position different from the position of the first light source 10. In this case, assuming that the light absorber 12 is not located at the center of the living body 11, the distance between the irradiation region of the living body 11 and the light absorber 12 differs between the first light source 10 and the second light source 20.

[0029] When the living body 11 is irradiated with the pulsed light 23, an acoustic wave 24 is generated from the light absorber 12 inside the living body 11. The acoustic wave 24 is detected by an acoustic-wave detector 25 in the form of an electric signal. The detected electric signal is processed by a signal processor 26.

[0030] The initial sound pressure P_2 of the acoustic wave 24 generated from the light absorber 12 in response to the pulsed light 23 emitted from the second light source 20, whose distance from the light absorber 12 inside the living body 11 differs from that of the first light source 10, can be expressed by equation (3) below:

$$P_2 = \Gamma \cdot \mu_a \cdot \Phi = \Gamma \cdot \mu_a \cdot \Phi_0 \cdot \exp(-\mu_{eff} \cdot d_2) \qquad (3)$$

where d_2 denotes the distance (second distance) from a region where the living body 11 is irradiated with the pulsed light 23 from the second light source 20 to the light absorber 12, i.e., the depth. As described earlier, it is possible to estimate the distribution of acoustic-wave generating sources or the distribution of optical-energy absorption densities through time-resolved measurement of change in sound pressure (P).

[0031] Taking the logarithm of both sides of equation (2) yields equation (4) below:

$$\mathrm{Log}(P_1) = \mathrm{Log}(\Gamma \cdot \mu_a \cdot \Phi_0) - \mu_{eff} \cdot d_1 \qquad (4)$$

[0032] Furthermore, taking the logarithm of both sides of equation (3) yields equation (5) below:

$$\mathrm{Log}(P_2) = \mathrm{Log}(\Gamma \cdot \mu_a \cdot \Phi_0) - \mu_{eff} \cdot d_2 \qquad (5)$$

[0033] The sound pressures P_1 and P_2 can be determined from measured values. Furthermore, the first distance d_1 and the second distance d_2 can be determined through time-resolved measurement of sound pressures.

[0034] Fig. 2 shows a graph in which the horizontal axis represents a distance d between a region where the living body 11 is irradiated with light and the light absorber 12 in the living body 11, the vertical axis represents the logarithm of the sound pressure of the resulting acoustic wave, and points are plotted using these values as coordinate values.

[0035] By identifying a straight line on the basis of the coordinate values in Fig. 2 by the least square method or the like, it is possible to obtain an average effective attenuation coefficient (μ_{eff}) of the living body 11 from the slope of the straight line.

[0036] By obtaining the average effective attenuation coefficient (μ_{eff}) of the living body 11 as described above, as will be understood from equation (2), it is possible to obtain the amount of light Φ with which the light absorber 12 is irradiated. Accordingly, it is possible to convert the distribution of optical-energy absorption densities, which are the products of the absorption coefficients (μ_a) and the amounts of light (Φ), into a distribution of absorption coefficients. Furthermore, it becomes possible to accurately identify the constituents of biological tissues or to accurately measure density on the basis of the distribution of absorption coefficients in the living body 11, which has been difficult with existing techniques of photoacoustic tomography.

[0037] The method of calculation described above is only an example, and without limitation to the specific method, the point of the present invention is to calculate information representing a distribution of optical characteristic values of a living body using relative position information of a light absorber and an irradiation region and the sound pressure of an acoustic wave generated from the light absorber. That is, any method of calculation can be used as long as it is possible to calculate an average effective attenuation coefficient (μ_{eff}) of a living body.

[0038] For example, in the embodiment, the regions of irradiation with light from light sources are varied to detect sound pressures in cases where the distances between the irradiation regions and a light absorber are varied, the logarithms of the detected sound pressures are plotted in relation to the distances, and an effective attenuation coefficient is obtained from the slope of the plotted points. Alternatively, it is possible to obtain an effective attenuation coefficient by directly finding a change curve that fits the exponential function according to equation (2) or (3) without taking the logarithms of sound pressures. As described above, it is possible to obtain an effective attenuation coefficient in various ways.

[0039] Next, the embodiment will be described in more detail.

[0040] Each of the first light source 10 and the second light source 20 emits pulsed light having a specific wavelength such that the light is absorbed in the light absorber 12 introduced in the living body 11. It is desired that the pulsed light is such light that satisfies stress confinement conditions.

[0041] Lasers can be used ass these light sources. Alternatively, for example, diodes can be used instead of lasers. As lasers, various types of lasers can be used, such as solid-state lasers, gas lasers, dye lasers, or semiconductor lasers.

[0042] In this embodiment, in order to measure the distribution of light absorption coefficients having wavelength dependence, it is possible to use light sources that are capable of emitting light having different wavelengths instead of light having a single wavelength.

[0043] In this case, for example, dye lasers or OPO (optical parametric oscillator) lasers that can change the wavelength of light that is emitted can be used.

[0044] For example, the wavelengths of light emitted from the light sources are in a range of 700 nm to 1100 nm, in which absorption that occurs in living bodies is small.

[0045] In the case where a distribution of optical characteristic values of a biological tissue in a region relatively close to the surface of a living body is to be obtained, it is possible to use a wider wavelength range than the above wavelength range, such as a wavelength range of 400 nm to 1600 nm.

[0046] If it is not possible to arrange the light sources in the proximity of a living body as a subject, it is possible to guide an irradiating portion to a living body using an optical guide system, such as an optical fiber.

[0047] In the embodiment described with reference to Figs. 1A and 1B, two light sources, namely, the first light source 10 and the second light source 20, are used. Alternatively, data of acoustic waves may be measured using a single light source by emitting light from different positions using an optical-path converter, such as a mirror. That is, information representing a distribution of optical characteristic values may be calculated from relative position information obtained based on a first distance corresponding to a first position from which light is emitted and a second distance corresponding to a second position from which light is emitted, different from the first position.

[0048] Furthermore, by measuring data of acoustic waves using three or more light sources, it is possible to obtain coordinate values of a larger number of points. This is beneficial in that a more accurate value can be obtained.

[0049] In this embodiment, the acoustic-wave detectors 15 and 25 detect the acoustic waves 14 and 24 generated from the light absorber 12 in the living body 11, having absorbed parts of energy of light from the light sources 10 and 20 with which the living body 11 is irradiated, and converts the acoustic waves 14 and 24 into electric signals. As the acoustic-wave detectors 15 and 25, any type of acoustic-wave detectors capable of detecting acoustic-wave signals may be used, such as transducers based on piezoelectric effects, transducers based on optical oscillation, or transducers based on capacitance change.

[0050] In the embodiment described with reference to Figs. 1A and 1B, two acoustic-wave detectors are provided individually in association with two light sources. Alternatively, acoustic waves generated in response to irradiation by two light sources may be detected by a single acoustic-wave detector.

[0051] If the amplitudes of the electric signals obtained by the acoustic-wave detectors are small, the signals may be amplified.

[0052] Between the acoustic-wave detectors and a tissue of a living body as a subject, an acoustic impedance matching medium may be provided to suppress reflection of acoustic waves.

[0053] In this embodiment, the signal processors 16 and 26 are capable of analyzing electric signals supplied from the acoustic-wave detectors 15 and 25 to obtain information representing a distribution of optical characteristic values of the living body 11. More specifically, it is possible to obtain a distribution of optical-energy absorption densities, a distribution of light absorption characteristic values, an average effective attenuation coefficient, or the like.

[0054] Without limitation, however, any type of signal processors that are capable of storing intensities of acoustic waves and temporal change thereof and converting the data into data representing a distribution of optical characteristic values through calculation may be used.

[0055] For example, an oscilloscope and a computer capable of analyzing data stored in the oscilloscope may be used.

[0056] Furthermore, although two signal processors are provided in the embodiment described with reference to Figs. 1A and 1B for convenience of description, information representing a distribution of optical characteristic values may be calculated by a single signal processor or three or more signal processors.

[0057] If a light source is capable of emitting light having different wavelengths and a living body is irradiated with the light with different wavelengths, it is possible to generate an image representing a distribution of densities of constituents of the living body using a distribution of optical characteristic values in the living body that vary depending on the individual wavelengths.

[0058] For example, it is possible to generate an image representing a distribution of densities of constituents of a living body by calculating a distribution of absorption coefficients and comparing their values with the wavelength dependency specific to each of the constituents of biological tissues (glucose, collagen, oxidized or reduced hemoglobin, and so forth).

[0059] The light absorber 12 exists inside the living body 11 and absorbs light. For example, the light absorber 12 may be tumors, blood vessels, or other tissues of the living body 11. When a molecular probe is used as the light absorber 12, generally, for example, indocyanine green (ICG) is used. However, any material may be used as long as the material generates a stronger acoustic wave than surrounding intravital constituents when irradiated with pulsed light.

[0060] By using such an intravital-information imaging apparatus, it is possible to generate an image representing a distribution of optical characteristics of the molecular probe introduced in a living body more accurately and readily than the related art.

Second Embodiment

[0061] In a second embodiment, a distribution of optical characteristic values is calculated from information representing a temporal change in sound pressures, obtained by simultaneous irradiation by a plurality of light sources.

[0062] Fig. 3 shows an example of the configuration of an intravital-information imaging apparatus according to the second embodiment.

[0063] In Fig. 3, 30 denotes light sources, 31 denotes a living body, 32 denotes a light absorber, 33 denotes pulsed light, 34 denotes an acoustic wave, 35 denotes acoustic-wave detectors, and 36 denotes a signal processor (information processor).

[0064] When the living body 31 is irradiated with the pulsed light 33 spreading from the n (e.g., four in Fig. 3) light sources 30, the sound pressure P_{total} of the acoustic wave 34 generated from the light absorber 32 inside the living body 31 can be expressed by equation (6) below:

$$P_{total} = \Gamma \cdot \mu_a \cdot \Phi = \Gamma \cdot \mu_a \cdot \sum_{i=1}^{n} \Phi_0 \cdot \exp(-\mu_{eff} \cdot d_i) \qquad (6)$$

where Γ denotes the Grüneisen coefficient of the light absorber 32, μ_a denotes the absorption coefficient of the light absorber 32, Φ denotes the amount of local light absorbed by the light absorber 32, μ_{eff} denotes an average effective attenuation coefficient of the living body 31, and Φ_0 denotes the amount of light that enters the living body 31 from the light sources 30.

[0065] Furthermore, d_i denotes the distance from a region where the living body 31 is irradiated with the pulsed light 33 from the i-th light source 30 to the light absorber 32.

[0066] Assuming that the Grüneisen coefficient (Γ) of the light absorber 32 is known since the Grüneisen coefficient (Γ) for a specific tissue of the body is substantially constant, through time-resolved measurement of the sound pressure (P) by the acoustic-wave detectors 35, it is possible to find the distribution of first acoustic-wave generating sources and the distribution of the products of the absorption coefficients (μ_a) and the amounts of light (Φ) (the distribution of first optical-energy absorption densities).

[0067] It is assumed here that the amount of light Φ_0 from each of the light sources is constant, and that light propagates through the living body 31 like a plane wave.

[0068] When light from the k-th light source among the light sources 30 is blocked as shown in Fig. 4, the living body 31 is irradiated with pulsed light from the other (n-1) light sources 30. The sound pressure P_k of an acoustic wave generated from the light absorber 32 in response to the pulsed light can be expressed by equation (7) below:

$$P_k = \Gamma \cdot \mu_a \cdot \Phi = \Gamma \cdot \mu_a \cdot \sum_{i=1}^{n} \Phi_0 \cdot \exp(-\mu_{eff} \cdot d_i) - \Gamma \cdot \mu_a \cdot \Phi_0 \cdot \exp(-\mu_{eff} \cdot d_k) \qquad (7)$$

where d_k denotes the distance from a region where the living body 31 is irradiated with the pulsed light 33 from the k-th light source 30 to the light absorber 32.

[0069] Through time-resolved measurement of change in sound pressure (P), it is possible to obtain a distribution of second acoustic-wave generating sources or a distribution of second optical-energy absorption densities.

[0070] The differences between sound pressures obtained with n light sources and sound pressures obtained with n - 1 light sources can be obtained by subtracting equation (7) from equation (6), and can be expressed by equation (8) below:

$$P_{total} - P_k = \Gamma \cdot \mu_a \cdot \Phi_0 \cdot \exp(-\mu_{eff} \cdot d_k) \qquad (8)$$

[0071] Taking the logarithms of both sides of equation (8) yields equation (9) below:

$$\mathrm{Log}(P_{total} - P_k) = \mathrm{Log}(\Gamma \cdot \mu_a \cdot \Phi_0) - \mu_{eff} \cdot d_k \qquad (9)$$

[0072] The left side of equation (9) can be determined from measured values of sound pressures. The distance d_k between a region of the living body 31 irradiated with light from the k-th blocked light source and the light absorber 32 can be determined through time-resolved measurement of sound pressures. Thus, using the distance d between the irradiation region and the light absorber 32 as the horizontal axis and the logarithm of the sound pressure of the acoustic wave as the vertical axis, a point having these values as coordinate values can be plotted as indicated by reference numeral 37 in Fig. 5.

[0073] Similarly, when light from the (k-1)-th light source is blocked, the living body 31 is irradiated with pulsed light from n - 2 light sources, and an acoustic wave P_{k-1} generated from the light absorber 32 is measured. Then, by obtaining the difference between the acoustic wave P_k and the acoustic wave P_{k-1} and the distance d_{k-1} between the region where the living body 31 is irradiated with light from the blocked (k-1)-th light source and the light absorber 32, a point can be plotted as indicated by reference numeral 38 in Fig. 5.

[0074] For example, by taking the difference between data obtained by irradiation with light from the first, second, and third (three) light sources and data obtained by irradiation with light from the first and second (two) light sources, a point can be plotted as indicated by reference numeral 37. Furthermore, by taking the difference between the data obtained by irradiation with light from the first and second (two) light sources and data obtained by irradiation with light from the first (one) light source, a point can be plotted as indicated by reference numeral 38.

[0075] Alternatively, it is possible to plot a point based on the difference between the data obtained by irradiation with light from the first and second (two) light sources and data obtained by irradiation with light from the first (one) light source, and then plot another point based on the data obtained by irradiation with light from the first light source. That is, in this embodiment, it suffices to provide at least two light sources.

[0076] By identifying a straight line by the least square method or the like on the basis of the coordinate values of the points plotted as described above and as shown in Fig. 5, it is possible to obtain an effective attenuation coefficient of the living body 31 on the basis of the slope of the straight line.

[0077] By obtaining the average effective attenuation coefficient (μ_{eff}) of the living body 11 as described above, as will be understood from equation (2), it is possible to obtain the amount of light Φ with which the light absorber 12 is irradiated. Accordingly, it is possible to convert the distribution of optical-energy absorption densities, which are the products of the absorption coefficients (μ_a) and the amounts of light (Φ), into a distribution of absorption coefficients. Furthermore, it becomes possible to accurately identify the constituents of biological tissues or to accurately measure density on the basis of the distribution of absorption coefficients in the living body 11, which has been difficult with existing techniques of photoacoustic tomography.

[0078] The method of calculation described above is only an example, and without limitation to the specific method, the point of the present invention is to calculate information representing a distribution of optical characteristic values of a living body using relative position information or difference in sound pressure obtained from an acoustic wave generated from a light absorber. That is, any method of calculation can be used as long as it is possible to calculate an average effective attenuation coefficient (μ_{eff}) of a living body.

[0079] For example, it is possible to obtain an effective attenuation coefficient by directly finding a change curve that fits the exponential function according to equation (8) or (3) without taking the logarithms of changes in sound pressures. As described above, it is possible to obtain an effective attenuation coefficient in various ways.

[0080] Next, the embodiment will be described in more detail.

[0081] The light sources 30 irradiate the living body 31 with the pulsed light 33, and are provided at multiple positions so that different regions of the living body 31 can be irradiated simultaneously. Furthermore, it is allowed to block light from at least two light sources. Light can be blocked by turning the light sources 30 ON or OFF, or by providing light blocking parts between the light sources 30 and the living body 31.

[0082] As the light sources 30, the types of light sources described in relation to the first embodiment can be used.

[0083] The light absorber 32 exists in the living body 31 and absorbs light. For example, the light absorber 32 may be tumors, blood vessels, or other tissues in the living body 31. The light absorber 32 absorbs part of energy of the pulsed light 33 to generate the acoustic wave 34.

[0084] The acoustic-wave detectors 35 detects the acoustic waves 34 generated by the light absorber 32 having absorbed part of the energy of the pulsed light 33, and converts the acoustic wave 34 into an electric signal.

[0085] Although a plurality of acoustic-wave detectors are provided in the proximity of the surface of a living body, without limitation, other arrangements are possible as long as it is possible to detect an acoustic wave at multiple points.

[0086] That is, since the same effect can be achieved as long as it is possible to detect an acoustic wave at multiple points, the surface of a living body may be scanned two-dimensionally using a single acoustic-wave detector.

[0087] Furthermore, each acoustic-wave detector may be an array in which detectors are arrayed one-dimensionally or two-dimensionally.

[0088] Furthermore, an amplifier or an acoustic impedance matching agent, described in relation to the first embodiment, may be used.

[0089] The signal processor 36 analyzes the electric signal from the acoustic-wave detectors to obtain information representing a distribution of optical characteristic values of the living body 31. More specifically, it is possible to obtain a distribution of optical-energy absorption densities, a distribution of optical absorption characteristic values, an average effective attenuation coefficient, or the like.

[0090] As described in relation to the first embodiment, if light source is capable of emitting light having different wavelengths and a living body is irradiated with the light with different wavelengths, it is possible to generate an image representing a distribution of densities of constituents of the living body using a distribution of optical characteristic values in the living body that vary depending on the individual wavelengths.

[0091] According to the second embodiment, by simultaneous irradiation with light from a plurality of light sources, it is possible to increase the amount of light with which the light absorber 32 in the living body 31 is irradiated. Thus, compared with the related art, an acoustic wave signal having a greater magnitude can be obtained. Furthermore, by using difference information of measurement results, it is possible to reduce noise, for example, the effect of diffusion, reflection, or the like of the acoustic wave in the living body 31. Accordingly, the distribution of optical characteristic values in the living body 31 becomes insusceptible to measurement noise, so that accurate analysis can be achieved.

[0092] While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments.

[0093] An intravital-information imaging apparatus includes light sources (10, 20) for irradiating a living body with light, and acoustic-wave detectors (15, 25) that detect acoustic waves generated from a light absorber having absorbed part of energy of the light from the light sources, the light absorber existing in the living body. Furthermore, the intravital-information imaging apparatus includes signal processors (16, 26) that calculate information representing a distribution of optical characteristic values of the living body using sound pressures of the acoustic waves generated from the light absorber.

Claims

1. An intravital-information imaging apparatus that performs imaging using an acoustic wave generated by irradiating a living body with light, the intravital-information imaging apparatus comprising:

    a light source comprising one or more light sources (10, 20, 30) configured to irradiate a surface of the living body with light at a first irradiation region and a second irradiation region different from the first irradiation region;
    an acoustic-wave detector (15, 25) configured to detect a respective acoustic wave generated from a light absorber having absorbed a part of energy of the light irradiated at any of the first and second irradiation regions, the light absorber existing inside the living body; and
    a signal processor (16, 26) configured to obtain information representing a distribution of optical characteristic values using a first sound pressure of said respective acoustic wave when the light is irradiated at the first

irradiation region, a second sound pressure of said respective acoustic wave when the light is irradiated at the second irradiation region, a first relative position information based on a first distance (d_1) from the first irradiation region to the light absorber, and second relative position information based on a second distance (d_2) from the second irradiation region to the light absorber, wherein the first and second distances and the first and second sound pressures being obtained by analyzing time-resolved electric signals corresponding to the respective acoustic wave detected by said acoustic-wave detector when said respective irradiation region is irradiated with the light.

2. The information obtaining apparatus according to claim 1, wherein said signal processor is configured to obtain the information representing the distribution of the optical characteristic values of the subject on the basis of at least of the first relative position information and the second relative position information and a change between at least the first sound pressure and the second sound pressure of the acoustic wave generated from the light absorber at at least the irradiation at the first irradiation area and the irradiation at the second irradiation area.

3. The information obtaining apparatus according to claim 1, wherein said light source includes a first light source and a second light source, and said signal processor is configured to obtain the information representing the distribution of the optical characteristic values of the subject using the first distance relevant to irradiation with light from the first light source and the second distance relevant to irradiation with light from the second light source, the first and second light sources being provided at mutually different positions.

4. The information obtaining apparatus according to claim 1, further comprising an optical-path converter configured to convert an optical path of the light from said light source, wherein said signal processor is configured to obtain the information representing the distribution of the optical characteristic values of the subject using the first distance relevant to irradiation with light from a first position and the second distance relevant to irradiation with light from a second position, the second position being varied from the first position by said optical-path converter.

5. The information obtaining apparatus according to claim 1, said signal processor is configured to obtain the information representing the distribution of the optical characteristic values using differences between sound pressures obtained by simultaneous irradiation with light from n light sources and second pressures obtained by simultaneous irradiation with light from n - 1 light sources.

6. The information obtaining apparatus according to claim 1, wherein said signal processor is configured to obtain an average effective attenuation coefficient of the subject using a straight line identified on the basis of coordinate values represented by the respective pieces of relative position information and logarithms of the respective sound pressures of the acoustic waves generated from the light absorber when the living body is irradiated at the respective irradiation regions.

7. The information obtaining apparatus according to claim 6, wherein said signal processor is configured to identify the straight line using the least square method on the basis of the coordinate values.

8. The information obtaining apparatus according to claim 6 or 7, wherein said signal processor is configured to obtain information representing a distribution of an absorption coefficient in the subject as the information representing the distribution of the optical characteristic values.

9. The information obtaining apparatus according to claim 8, wherein said signal processor is configured to perform time-resolved measurements of change in sound pressure (P) at multiple points to estimate a distribution of optical-energy absorption densities ($\mu_a \Phi_0$) and configured to obtain a light amount (Φ_0) with which the light absorber (12) is irradiated using the average effective attenuation coefficient and therefrom said distribution of an absorption coefficient (μ_a) in the subject.

10. The information obtaining apparatus according to claim 8 or 9, wherein said information representing the distribution of the optical characteristic values comprises information representing a distribution of density of a constituent of the subject.

11. The information obtaining apparatus according to claim 10, wherein said information representing the distribution of the density of the constituent comprises information representing a distribution of density of oxidized or reduced hemoglobin.

12. The information obtaining apparatus according to any one of claims 1 to 11, wherein said acoustic detector includes a plurality of transducers.

13. An information obtaining method comprising:

    irradiating a surface of a subject with light from a light source at a first irradiation region and a second irradiation region different from the first irradiation region;
    detecting a respective acoustic wave generated from a light absorber in the subject when any of the first irradiation region and the second irradiation region is irradiated with the light in the irradiating step;
    obtaining, by a signal processor, a first distance from the first irradiation region to the light absorber, a second distance from the second irradiation region to the light absorber, a first sound pressure of said respective acoustic wave when the light is irradiated at the first irradiation region, and a second sound pressure of said respective acoustic wave when the light is irradiated at the second irradiation region by analyzing time-resolved electric signals corresponding to the respective acoustic wave detected by said acoustic-wave detector when said respective irradiation region is irradiated with the light;
    obtaining, by said signal processor, information representing a distribution of optical characteristic values using the first sound pressure, the second sound pressure, a first relative position information based on the first distance (d_1), and a second relative position information based on the second distance (d_2).

Patentansprüche

1. Intravital-Informationsabbildungsvorrichtung, die ein Abbilden unter Verwendung einer akustischen Welle, die durch Bestrahlen eines lebenden Körpers mit Licht erzeugt wird, durchführt, wobei die Intravital-Informationsabbildungsvorrichtung aufweist:

    eine Lichtquelle, die eine oder mehrere Lichtquellen (10, 20, 30) aufweist, die konfiguriert sind, eine Oberfläche des lebenden Körpers mit Licht in einem ersten Bestrahlungsgebiet und in einem zweiten Bestrahlungsgebiet, das verschieden von dem ersten Bestrahlungsgebiet ist, zu bestrahlen;
    einen Akustischewellendetektor (15, 25), der konfiguriert ist, eine jeweilige akustische Welle, die von einem Lichtabsorber, der einen Teil einer Energie des Lichts, mit dem eine der ersten und zweiten Bestrahlungsgebiete bestrahlt wurde, absorbiert hat, zu erfassen, wobei der Lichtabsorber innerhalb des lebenden Körpers existiert; und
    einen Signalprozessor (16, 26), der konfiguriert ist, eine Information, die eine Verteilung von optischen charakteristischen Werten repräsentiert, unter Verwendung eines ersten Schalldrucks der jeweiligen akustischen Welle, wenn das Licht auf das erste Bestrahlungsgebiet bestrahlt wird, eines zweiten Schalldrucks der jeweiligen akustischen Welle, wenn das Licht auf das zweite Bestrahlungsgebiet bestrahlt wird, einer ersten relativen Positionsinformation basierend auf einem ersten Abstand (d_1) von dem ersten Bestrahlungsgebiet zu dem Lichtabsorber, und einer zweiten relativen Positionsinformation basierend auf einem zweiten Abstand d_2) von dem zweiten Bestrahlungsgebiet zu dem Lichtabsorber zu erhalten, wobei die ersten und zweiten Abstände und die ersten und zweiten Schalldrücke durch Analysieren von zeitaufgelösten elektrischen Signalen, die den jeweiligen akustischen Wellen, die durch den Akustischewellendetektor erfasst werden, wenn das jeweilige Bestrahlungsgebiet mit dem Licht bestrahlt wird, entsprechen, erhalten werden.

2. Informationserhaltevorrichtung nach Anspruch 1, wobei der Signalprozessor konfiguriert ist, die Information, die die Verteilung der optischen charakteristischen Werte des Gegenstands repräsentiert, auf der Basis von zumindest der ersten relativen Positionsinformation und der zweiten relativen Positionsinformation und einer Änderung zwischen zumindest dem ersten Schalldruck und dem zweiten Schalldruck der akustischen Welle, die von dem Lichtabsorber erzeugt wird bei zumindest der Bestrahlung auf dem ersten Bestrahlungsgebiet und der Bestrahlung auf dem zweiten Bestrahlungsgebiet zu erhalten.

3. Informationserhaltevorrichtung nach Anspruch 1, wobei die Lichtquelle eine erste Lichtquelle und eine zweite Lichtquelle enthält, und der Signalprozessor konfiguriert ist, die Information, die die Verteilung der optischen charakteristischen Werte des Subjekts repräsentiert, unter Verwendung des ersten Abstands, der relevant für eine Bestrahlung mit Licht von der ersten Lichtquelle ist, und des zweiten Abstands, der relevant für die Bestrahlung mit Licht von der zweiten Lichtquelle ist, zu erhalten, wobei die ersten und zweiten Lichtquellen an unterschiedlichen Positionen bereitgestellt sind.

4. Informationserhaltevorrichtung nach Anspruch 1, ferner mit einem Optischerpfadumwandler, der konfiguriert ist, einen optischen Pfad des Lichts von der Lichtquelle zu konvertieren, wobei der Signalprozessor konfiguriert ist, die Information, die die Verteilung der optischen charakteristischen Werte des Subjekts repräsentiert, unter Verwendung des ersten Abstands, der relevant für eine Bestrahlung mit Licht von einer ersten Position ist, und des zweiten Abstands, der relevant für eine Bestrahlung mit Licht von einer zweiten Position ist, zu erhalten, wobei die zweite Position gegenüber der ersten Position durch den Optischerpfadumwandler verändert wird.

5. Informationserhaltevorrichtung nach Anspruch 1, wobei der Signalprozessor konfiguriert ist, die Information, die die Verteilung der optischen charakteristischen Werte repräsentiert, unter Verwendung von Differenzen zwischen Schalldrücken, die durch gleichzeitige Bestrahlung mit Licht von n Lichtquellen erhalten werden, und zweite Drücke, die durch gleichzeitige Bestrahlung mit Licht von n-1 Lichtquellen erhalten werden, zu erhalten.

6. Informationserhaltevorrichtung nach Anspruch 1, wobei der Signalprozessor konfiguriert ist, einen durchschnittlichen effektiven Abschwächungskoeffizienten des Subjekts unter Verwendung einer geraden Linie, die auf der Basis von Koordinatenwerten, die durch jeweilige relative Positionsinformationen und Logarithmen der jeweiligen Schalldrücke der akustischen Wellen, die durch den Lichtabsorber erzeugt werden, wenn der lebende Körper an den jeweiligen Bestrahlungsgebieten bestrahlt wird, erzeugt werden, identifiziert wird, zu erhalten.

7. Informationserhaltevorrichtung nach Anspruch 6, wobei der Signalprozessor konfiguriert ist, die gerade Linie unter Verwendung eines Kleinste-Quadrate-Verfahrens auf der Basis der Koordinatenwerte zu identifizieren.

8. Informationserhaltevorrichtung nach Anspruch 6 oder 7, wobei der Signalprozessor konfiguriert ist, eine Information, die eine Verteilung eines Absorptionskoeffizienten in dem Subjekt als die Information, die die Verteilung der optischen charakteristischen Werte repräsentiert, zu erhalten.

9. Informationserhaltevorrichtung nach Anspruch 8, wobei der Signalprozessor konfiguriert ist, zeitaufgelöste Messungen einer Änderung im Schalldruck (P) an mehreren Punkten durchzuführen, um eine Verteilung von optischer Energieabsorptionsdichten ($\mu_a\phi_0$) zu schätzen, und konfiguriert ist, eine Lichtmenge (ϕ_0), mit der der Lichtabsorber (12) bestrahlt wird, unter Verwendung des durchschnittlichen effektiven Abschwächungskoeffizienten zu erhalten, und daraus die Verteilung eines Absorptionskoeffizienten (μ_a) in dem Subjekt zu erhalten.

10. Informationserhaltevorrichtung nach Anspruch 8 oder 9, wobei die Information, die die Verteilung der optischen charakteristischen Werte repräsentiert, eine Information, die eine Verteilung einer Dichte eines Konstituenten des Subjekts repräsentiert, aufweist.

11. Informationserhaltevorrichtung nach Anspruch 10, wobei die Information, die die Verteilung der Dichte des Konstituenten eine Information, die eine Verteilung einer Dichte von oxidiertem oder reduziertem Hämoglobin repräsentiert, aufweist.

12. Informationserhaltevorrichtung nach einem der Ansprüche 1 bis 11, wobei der Akustischedetektor eine Vielzahl von Transducern enthält.

13. Informationserhalteverfahren mit:

Bestrahlen einer Oberfläche eines Subjekts mit Licht von einer Lichtquelle in einem ersten Bestrahlungsgebiet und einem zweiten Bestrahlungsgebiet, das verschieden von dem ersten Bestrahlungsgebiet ist;
Erfassen einer jeweiligen akustischen Welle, die von einem Lichtabsorber in dem Subjekt erzeugt wird, wenn eines des ersten Bestrahlungsgebiets und des zweiten Bestrahlungsgebiets mit dem Licht in dem Bestrahlungsschritt bestrahlt wird;
Erhalten eines ersten Abstands von dem ersten Bestrahlungsgebiet zu dem Lichtabsorber, eines zweiten Abstands von dem zweiten Bestrahlungsgebiet zu dem Lichtabsorber, eines ersten Schalldrucks der jeweiligen akustischen Welle, wenn das Licht in dem ersten Bestrahlungsgebiet bestrahlt wird, und eines zweiten Schalldrucks der jeweiligen akustischen Welle, wenn das Licht in dem zweiten Bestrahlungsgebiet bestrahlt wird, durch einen Signalprozessor durch Analysieren von zeitaufgelösten elektrischen Signalen, die der jeweiligen akustischen Welle, die durch den Akustischewellendetektor erfasst wird, entspricht, wenn das jeweilige Bestrahlungsgebiet mit dem Licht bestrahlt wird;
Erhalten einer Information, die eine Verteilung von optischen charakteristischen Werten repräsentiert, durch den Signalprozessor unter Verwendung des ersten Schalldrucks, des zweiten Schalldrucks, einer ersten rela-

tiven Positionsinformation basierend auf dem ersten Abstand (d_1) und einer zweiten relativen Positionsinformation basierend auf dem zweiten Abstand (d_2).

Revendications

1. Appareil de formation d'image d'information intravitale qui effectue une formation d'image en utilisant une onde acoustique générée en irradiant un corps vivant avec de la lumière, l'appareil de formation d'image d'information intravitale comprenant :

   une source de lumière comprenant une ou plusieurs sources de lumière (10, 20, 30) configurée pour irradier une surface du corps vivant avec de la lumière au niveau d'une première région d'irradiation et d'une deuxième région d'irradiation différente de la première région d'irradiation ;
   un détecteur d'onde acoustique (15, 25) configuré pour détecter une onde acoustique respective générée à partir d'un absorbeur de lumière ayant absorbé une partie de l'énergie de la lumière irradiée au niveau de l'une des première et deuxième régions d'irradiation, l'absorbeur de lumière existant à l'intérieur du corps vivant ; et
   un processeur de signaux (16, 26) configuré pour obtenir une information représentant une distribution de valeurs de caractéristique optique en utilisant une première pression sonore de ladite onde acoustique respective lorsque la lumière est irradiée au niveau de la première région d'irradiation, une seconde pression sonore de ladite onde acoustique respective lorsque la lumière est irradiée au niveau de la deuxième région d'irradiation, une information de première position relative sur la base d'une première distance (d_1) entre la première région d'irradiation et l'absorbeur de lumière, et une information de seconde position relative sur la base d'une seconde distance (d_2) entre la deuxième région d'irradiation et l'absorbeur de lumière, les première et seconde distances et les première et seconde pressions sonores étant obtenues en analysant des signaux électriques à résolution dans le temps correspondant à l'onde acoustique respective détectée par ledit détecteur d'onde acoustique lorsque ladite région d'irradiation respective est irradiée avec de la lumière.

2. Appareil d'obtention d'information selon la revendication 1, dans lequel ledit processeur de signaux est configuré pour obtenir l'information représentant la distribution des valeurs de caractéristique optique du sujet sur la base d'au moins l'information de première position relative et l'information de seconde position relative et un changement entre au moins la première pression sonore et la seconde pression sonore de l'onde acoustique générée à partir de l'absorbeur de lumière au niveau d'au moins l'irradiation dans la première zone d'irradiation et l'irradiation dans la deuxième zone d'irradiation.

3. Appareil d'obtention d'information selon la revendication 1, dans lequel ladite source de lumière comporte une première source de lumière et une deuxième source de lumière, et ledit processeur de signaux est configuré pour obtenir l'information représentant la distribution des valeurs de caractéristique optique du sujet en utilisant la première distance concernant l'irradiation avec de la lumière provenant de la première source de lumière et la seconde distance concernant l'irradiation avec de la lumière provenant de la deuxième source de lumière, les première et deuxième sources de lumière étant disposées à des positions mutuellement différentes.

4. Appareil d'obtention d'informations selon la revendication 1, comprenant en outre un convertisseur de trajet optique configuré pour convertir un trajet optique de la lumière provenant de ladite source de lumière, dans lequel ledit processeur de signaux est configuré pour obtenir l'information représentant la distribution des valeurs de caractéristique optique du sujet en utilisant la première distance concernant l'irradiation avec de la lumière provenant d'une première position et la seconde distance concernant l'irradiation avec de la lumière provenant d'une seconde position, la seconde position étant modifiée par rapport à la première position par ledit convertisseur de trajet optique.

5. Appareil d'obtention d'information selon la revendication 1, ledit processeur de signaux est configuré pour obtenir l'information représentant la distribution des valeurs de caractéristique optique en utilisant des différences entre des pressions sonores obtenues par irradiation simultanée avec de la lumière provenant de n sources de lumière et des secondes pressions obtenues par irradiation simultanée avec de la lumière provenant de n-1 sources de lumière.

6. Appareil d'obtention d'information selon la revendication 1, dans lequel ledit processeur de signaux est configuré pour obtenir un coefficient effectif moyen d'atténuation du sujet en utilisant une ligne droite identifiée sur la base de valeurs de coordonnées représentées par les informations de position relative respectives et des logarithmes des pressions sonores respectives des ondes acoustiques générées par l'absorbeur de lumière lorsque le corps vivant

est irradié au niveau des régions d'irradiation respectives.

7. Appareil d'obtention d'information selon la revendication 6, dans lequel ledit processeur de signaux est configuré pour identifier la ligne droite en utilisant la méthode des moindres carrés sur la base des valeurs de coordonnées.

8. Appareil d'obtention d'information selon la revendication 6 ou 7, dans lequel ledit processeur de signaux est configuré pour obtenir une information représentant une distribution d'un coefficient d'absorption dans le sujet en tant qu'information représentant la distribution des valeurs de caractéristique optique.

9. Appareil d'obtention d'information selon la revendication 8, dans lequel ledit processeur de signaux est configuré pour effectuer des mesures à résolution dans le temps de changement de pression acoustique (P) à plusieurs points pour estimer une distribution de densités d'absorption d'énergie optique ($\mu_a \Phi_0$) et configuré pour obtenir une quantité de lumière (Φ_0) avec laquelle l'absorbeur de lumière (12) est irradié en utilisant le coefficient effectif moyen d'atténuation, et ainsi ladite distribution d'un coefficient d'absorption (μ_a) chez le sujet.

10. Appareil d'obtention d'information selon la revendication 8 ou 9, dans lequel ladite information représentant la distribution des valeurs de caractéristique optique comprend une information représentant une distribution de densité d'un constituant du sujet.

11. Appareil d'obtention d'information selon la revendication 10, dans lequel ladite information représentant la distribution de la densité du constituant comprend une information représentant une distribution de densité de l'hémoglobine oxydée ou réduite.

12. Appareil d'obtention d'information selon l'une quelconque des revendications 1 à 11, dans lequel ledit détecteur acoustique comporte une pluralité de transducteurs.

13. Procédé d'obtention d'information consistant à :

irradier une surface d'un sujet avec de la lumière provenant d'une source de lumière au niveau d'une première région d'irradiation et d'une deuxième région d'irradiation différente de la première région d'irradiation ;
détecter une onde acoustique respective générée à partir d'un absorbeur de lumière dans le sujet lorsque l'une de la première région d'irradiation et de la deuxième région d'irradiation est irradiée avec de la lumière dans l'étape d'irradiation ;
obtenir, par un processeur de signaux, une première distance entre la première région d'irradiation et l'absorbeur de lumière, une seconde distance entre la deuxième région d'irradiation et l'absorbeur de lumière, une première pression sonore de ladite onde acoustique respective lorsque la lumière est irradiée au niveau de la première région d'irradiation, et une seconde pression sonore de ladite onde acoustique respective lorsque la lumière est irradiée au niveau de la deuxième région d'irradiation en analysant des signaux électriques à résolution dans le temps correspondant à l'onde acoustique respective détectée par ledit détecteur d'onde acoustique lorsque ladite région d'irradiation respective est irradiée avec de la lumière ;
obtenir, par ledit processeur de signaux, une information représentant une distribution de valeurs de caractéristique optique en utilisant la première pression sonore, la seconde pression sonore, une information de première position relative sur la base de la première distance (d_1), et une information de seconde position relative sur la base de la seconde distance (d_2).

FIG. 1A

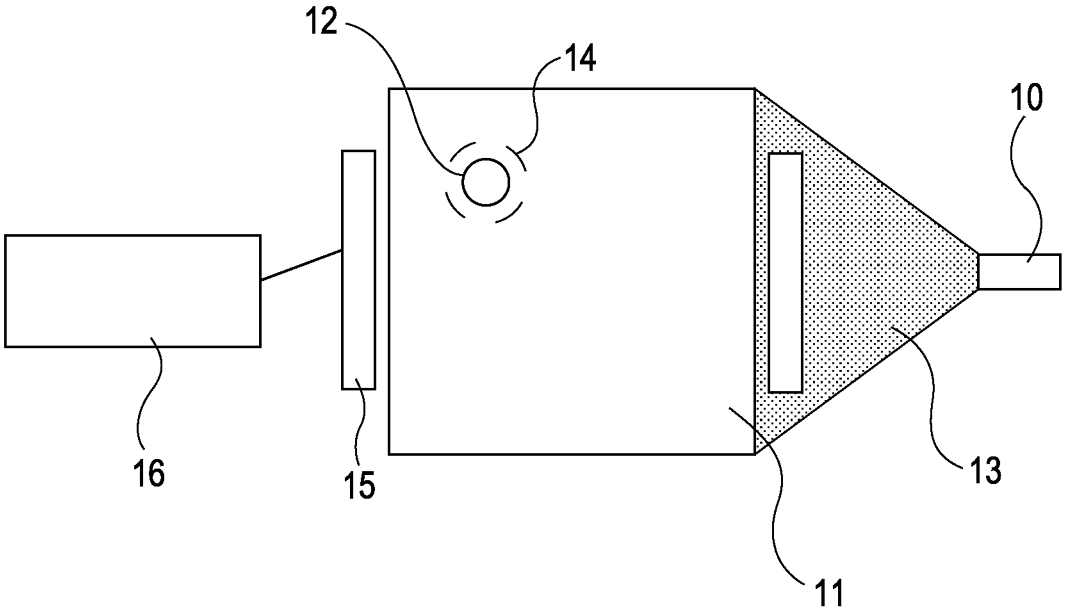


FIG. 1B

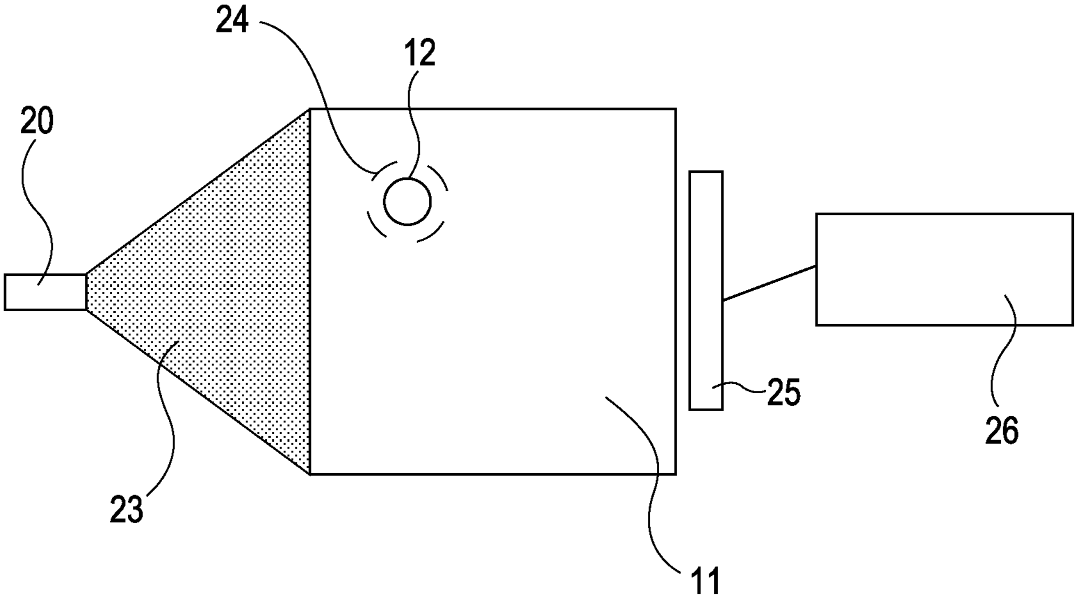


FIG. 2

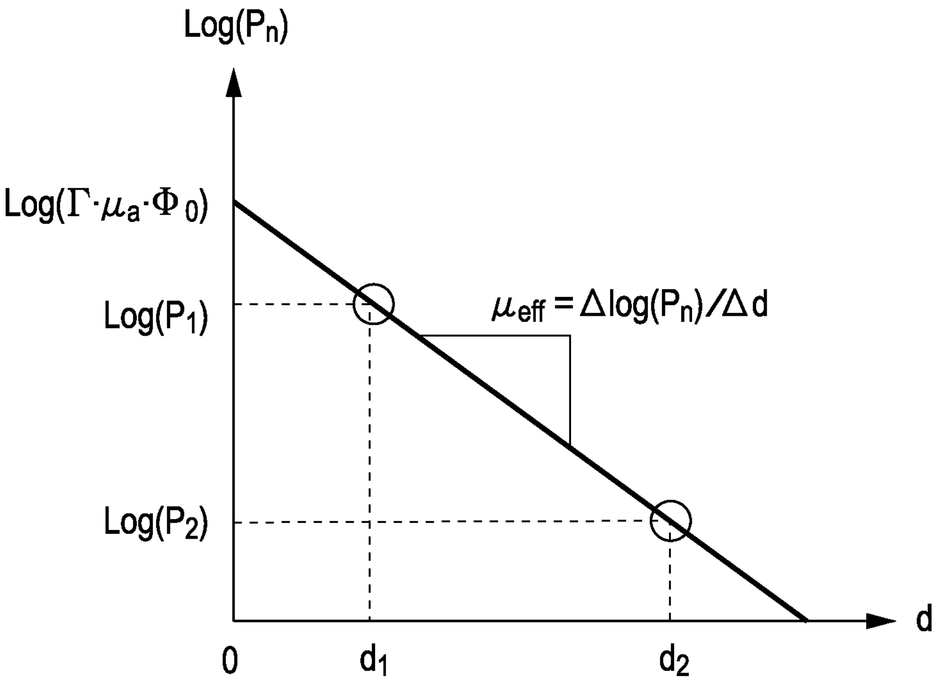


FIG. 3

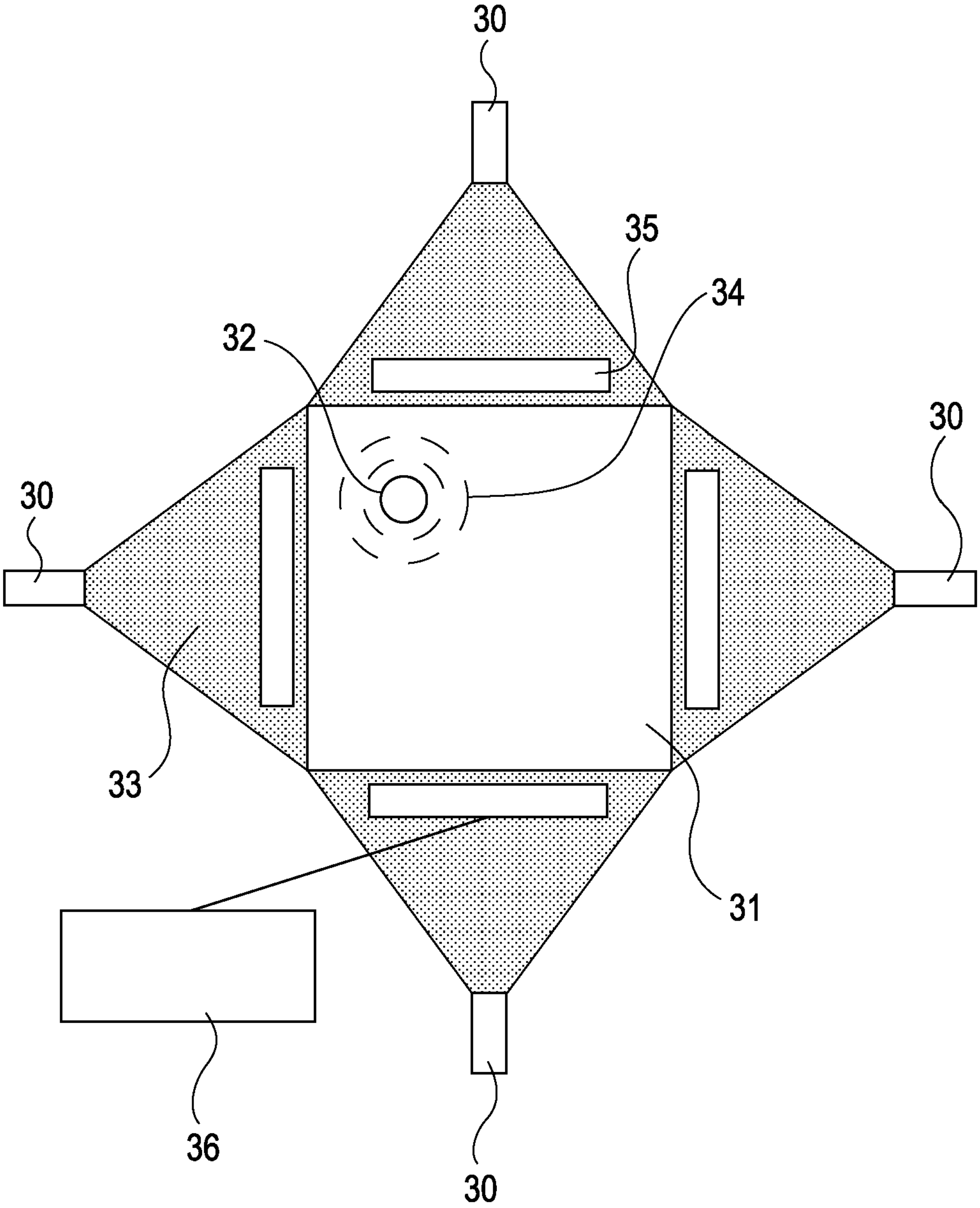


FIG. 4

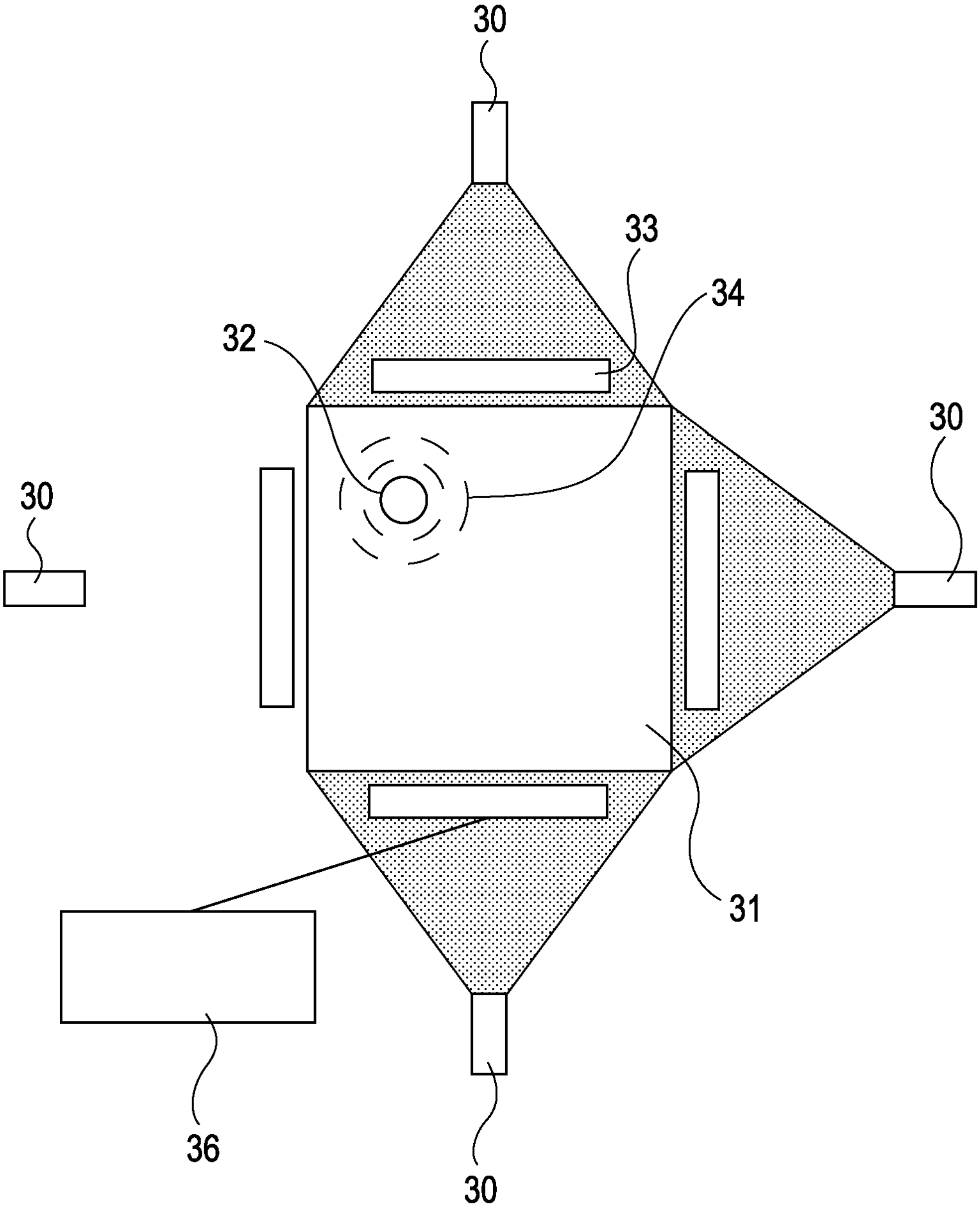
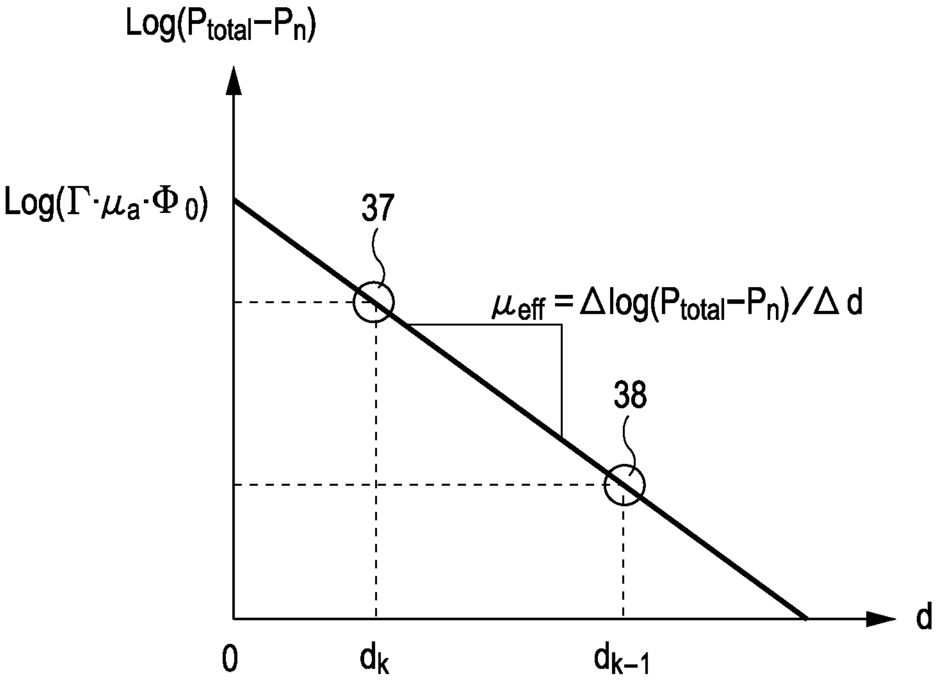


FIG. 5


$\mathrm{Log}(P_{total}-P_n)$
$\mathrm{Log}(\Gamma\cdot\mu_a\cdot\Phi_0)$
37
$\mu_{eff}=\Delta\log(P_{total}-P_n)/\Delta d$
38
d
0
d_k
d_{k-1}

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

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专利名称(译)	活体信息成像设备		
公开(公告)号	EP2002784B1	公开(公告)日	2018-07-11
申请号	EP2008157078	申请日	2008-05-28
[标]申请(专利权)人(译)	佳能株式会社		
申请(专利权)人(译)	佳能株式会社		
当前申请(专利权)人(译)	佳能株式会社		
[标]发明人	FUKUTANI KAZUHIKO NAKAJIMA TAKAO NAGAE KENICHI SOMEDA YASUHIRO ASAO YASUFUMI		
发明人	FUKUTANI, KAZUHIKO NAKAJIMA, TAKAO NAGAE, KENICHI SOMEDA, YASUHIRO ASAO, YASUFUMI		
IPC分类号	A61B5/00 A61B8/08 G01N21/49 G01T1/29 G01N29/06 G01N21/17 G01N21/47		
CPC分类号	A61B5/0059 A61B5/0095 A61B8/08 G01N21/1702		
代理机构(译)	TBK		
优先权	2007153587 2007-06-11 JP 2008115739 2008-04-25 JP		
其他公开文献	EP2002784A1		
外部链接	Espacenet		

摘要(译)

一种活体信息成像设备包括用于用光照射活体的光源（10,20），以及检测从吸收光的一部分能量的光吸收体产生的声波的声波检测器（15,25）。光源，存在于生物体内的光吸收体。此外，活体信息成像设备包括信号处理器（16,26），其使用从光吸收体产生的声波的声压来计算表示活体的光学特征值的分布的信息。