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(54) **BIOLOGICAL OPTICAL MEASURING INSTRUMENT**

BIOLOGISCHES OPTISCHES MESSINSTRUMENT

INSTRUMENT DE MESURE OPTIQUE BIOLOGIQUE

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a biological optical measuring instrument and, in particular, relates to a signal processing therefor.

BACKGROUND OF THE INVENTION

[0002] The biological optical measuring instrument is an instrument for obtaining information such as blood circulation, blood circulation dynamics and hemoglobin variation inside a living body by irradiating light having predetermined wavelengths into the living body and by measuring the amount of variation in light transmitted through the living body, in particular, a biological optical measuring instrument which is designed for obtaining blood stream information in a comparatively broad area in a form of a topography has been expected , for example, for a research of brain functions such as local center identification at the time of epilepsy stroke and clinical applications.

[0003] As an example of the clinical applications, a measurement result of hemoglobin variation in a brain at the time of performing motion and language task by utilizing a method called brain blood stream mapping method using near-infrared light is reported in WATANABE Eiju, "Brain Blood Stream Mapping Method Using Near-Infrared light" (CLINICAL NUEROSCIENCE Vol.17, No.11, 1999-11,P1280-1281, Cyugaiigakusya). In this method, in order to capture the hemoglobin variation in the brain, after performing a plurality of tests on respective tasks, averages of the respective values are calculated. This calculation of adding and averaging is performed for enhancing S/N ratio, because the hemoglobin variation in the brain, which is obtained through physiological stimulations such as the motion and language task, is at most about 5%.

[0004] In contrast to the fact that the amount of variation in optical signals due to hemoglobin, which is measured with these biological optical measurements, is in an order of a few %, the amount of variation in optical signals caused for example by body movement reaches more than 50%, which is superposed in a spike like noise on an optical signal to be measured. Such a spike like noise can be separated by visual observation in a case of a single measurement data, which does not require the adding and averaging calculation, because it appears as a steep peak, however, in a case where the variation in the amount of hemoglobin is determined by the above referred to adding and averaging calculation, since the peak value due to the noise is averaged and is superposed on the measured data, it was difficult to separate the noise from the actual measured data, which has prevented accurate diagnosis.

[0005] In conventional biological optical measurements, in order to process measured data in which noises are contained, there were no methods other than a method in which the noises are recognized from the measured data through visual observation and a portion corresponding to the noises is removed from the result of the averaged hemoglobin amount variation, and of which method has been extremely impeded real-time data display property.

[0006] US 5820550 A discloses an oximeter apparatus with the features of the preamble of present claim 1. Other conventional optical measuring instruments and methods are described in JP-A-5172582, JP 2001 095766 A, and US 6128517 A.

[0007] Accordingly, an object of the present invention is to provide an improved biological optical measuring instrument and a method thereof which permits to detect measured data containing noise components.

[0008] Further, it is desired to provide a biological optical measuring instrument and a method thereof which permits to quickly acquire highly reliable measurement result and thereby to provide valuable information for research and diagnosis.

DISCLOSURE OF THE INVENTION

[0009] By utilizing a characteristic of the noise components which appear in steep peaks and to automatically remove through computation the optical signal portion containing the noise components from the measured result to be determined as defined in the present claims, this object is met without relying upon the visual observation.

[0010] The invention is defined by the subject-matter of the independent claims. The biological optical measuring instrument comprises a light generating unit which irradiates light having a predetermined wavelength to a subject, a light detecting unit which detects light which is irradiated from the light generating unit and is transmitted through the subject and a signal processing unit which analyzes optical signals detected by the light detecting unit and prepares biological information including blood stream in the subject, wherein the signal processing unit includes means for detecting noise components contained in the detected optical signals and means for removing an optical signal portion containing the detected noise components from the optical signals.

[0011] Therefore, through the provision of the means for detecting existence and absence of noise components in the detected optical signals as well as the means for removing the optical signal portion containing the noise components

from the detected optical signals, the removing work of the optical signal portion containing the noise components, which was performed conventionally through visual observation, is automated which permits to display quickly an accurate measurement result.

[0012] Still further, the detection of the noise components in the optical signals is performed in such a manner that differential values of the optical signals obtained in time-course are determined and the existence of noises is judged when the differential values exceed a predetermined threshold value. Through the judgment of using the differential values, the spike shaped noise being contained such as due body movement of the subject can be effectively detected and the influence due to the spike shaped noise can be eliminated.

[0013] Moreover, the signal processing unit includes means for extracting optical signals in a plurality of sections having a predetermined time interval from optical signals obtained along the time axis and for preparing section data from the respective extracted optical signals, means for detecting and removing section data containing noise components among the extracted and prepared section data and means for performing adding and averaging processing using the not removed section data among the plurality of the section data and for preparing averaged section data having a predetermined time interval.

[0014] With regard to the measured data obtained by the addition and averaging processing, in which the noise components tend to be buried, the noise components are detected in advance and the section data containing the noise components are removed from the object for the addition and averaging processing. Thereby, the reliability of the addition and averaging processing is enhanced and accurate measurement data can be obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig.1 is a block diagram showing an entire constitution of an instrument for displaying variation of hemoglobin amount in an image and representing an example of biological optical measuring instruments ;
Fig.2 is a processing flow; which is executed in a signal process unit as shown in Fig.1;
Fig.3 is a diagram for explaining addition and averaging processing executed in the signal process unit as shown in Fig.1;
Fig.4A is a diagram showing a variation in hemoglobin signals along time axis at the time when tasks are executed and no tasks (rest) are executed, which were measured with the instrument as shown in Fig.1;
Fig.4B is a diagram for explaining an influence of noises in the addition and averaging processing and showing a result of the addition and averaging of the hemoglobin signals as they are for entire sections each including the task executing section and having a predetermined time interval;
Fig.5 is a diagram for explaining a differential processing in the present invention and showing a variation rate of the hemoglobin signals over the entire measurement period; and
Fig.6 is a diagram showing a result according to the present invention in which the section data containing noise components are removed and the remaining hemoglobin signals are added and averaged.

BEST MODES FOR EMBODYING THE INVENTION

[0016] Hereinbelow, the biological optical measuring instrument of the present invention will be explained based on an embodiment in which the present invention is applied to an instrument for displaying a variation of hemoglobin amount in a predetermined region in an image. The present instrument is provided with a function in which, when tasks such as motion and language causing brain activity are given for a subject, measures a variation of the hemoglobin amount in the brain (concentration variation of oxygenated hemoglobin, concentration variation of deoxygenated hemoglobin and concentration variation of total hemoglobin) and displays the variations at every measurement position.

[0017] Fig.1 is a diagram showing an entire constitution of an instrument to which the present invention is applied. As shown in the drawing, the present instrument is provided with a light irradiating and detecting unit 101 which irradiates light at a predetermined region of a subject 100 and detects light transmitted through the predetermined region at every of a plurality of detection positions and takes out biological information including position information in optical signals, and a signal process unit 108 which processes the detected optical signals and displays variation information of hemoglobin, oxygen saturation degree and cytochrome concentration in such as numerical values and topography.

[0018] The light irradiation and detecting unit 101 is provided with a light irradiation unit 102 which generates light having a predetermined wavelength, specifically, near infrared light, a light detecting unit 105 which detects light transmitted through the subject 100 and converts the detected light into electrical signals, a probe 104 which holds the top ends of optical fibers 103a and 103b connected respectively to the light irradiation unit 102 and the light detecting unit 105 in a predetermined arrangement and causes to contact the optical fibers to the subject 100, a lock-in amplifier 106 which lock-in detects the electrical signals from the light detecting unit 105, a continuous variable amplifier 107 which

amplifies the output from the lock-in amplifier 106 and an A/D converter not shown. As the light detecting unit 105, it is preferable to use a photo diode, in particular, an avalanche photo diode, which can realize light measurement of high sensitivity.

[0019] In the drawings, a single piece of the irradiation optical fiber 103a and detection optical fiber 103b is illustrated, however, each of the optical fibers is constituted by a plurality of optical fibers, for example, they are constituted in 3 x 3 mode or 4 x 4 mode and their top ends are arranged alternatively at the grid points of the probe 104 so that each pair of irradiation and detection optical fibers constitutes one channel. Depending on the number of the irradiation optical fibers, the light irradiation unit 102 generates light modulated by a plurality of frequencies. Further, the lock-in amplifier 106 selectively detects the modulated signals corresponding to irradiation positions and wavelengths using the plurality of modulation frequencies as reference frequencies. Thereby, optical signals at respective measurement positions (positions between top ends of the irradiation optical fibers and of the detection optical fibers) can be detected.

[0020] The continuous variable amplifier 107 is provided for leveling the signals from the respective channels. Further, although not illustrated, the signals being leveled are time integrated for every cannel and held in a sample-hold-circuit and, thereafter, sent out to the A/D converter.

[0021] The signal process unit 108 is provided with a memory 109 which temporarily stores digital signals sent from the light irradiation and detection unit 101, a CPU 110 which performs a variety of computation and analysis such as variation of hemoglobin concentration by using the digital signals, another memory 111 which stores the computation result in the CPU 110, a display unit 112 which displays the computation result, for example, the variation of the hemoglobin amount in a line diagram like a contour and colored image, and an input unit not shown which permits to input in the CPU a variety of information such as conditions necessary for the measurement and information of the subject.

[0022] The signal process unit 108 can be constituted integral with the light irradiation and detection unit 101 in the instrument, however, alternatively can be realized by a general use personal computer.

[0023] Other than the functions of computing light amount variation depending on the variation of hemoglobin amount before and after giving tasks to the subject and of performing the addition and averaging calculation of the measured values obtained in a plurality of measurements, the CPU 110 detects noises contained in a variation curve of the light amount and removes a portion of measured value containing noise components from the variation curve, of which function will be explained later.

[0024] Now, the operation of the instrument with the above constitution and the processing performed by the signal process unit 108 will be explained.

[0025] Under a condition where the probe 104 is attached on the head (for example, the front head) of the subject 100, while giving intermittently tasks to the subject 100, light is irradiated from the light irradiation unit 102 and the light detection unit 105 detects the transmitted irradiation light through the subject 100. A part of the transmitting light is absorbed by specific pigments in the living body, for example, hemoglobin, and shows a light amount reflecting the hemoglobin concentration. Further, since depending on the conditions whether tasks are given or not, the blood stream in the brain changes, the hemoglobin amount varies correspondingly.

[0026] The variation of the light amount depending upon the change in hemoglobin amount is detected for every detection position by the light detection unit 105 and converted into electrical signals which are lock-in detected by the lock-in amplifier 106 and inputted in the signal process unit 108 as the signals at the respective measurement positions. The signals inputted in the signal process unit 108 are stored in the memory 109, and hereafter converted into signals (hemoglobin signals) corresponding to hemoglobin concentration in the CPU 110.

[0027] Now, the processing performed by the CPU 110 will be explained with reference to Fig.2.

[0028] At first, the CPU 110 determines the hemoglobin concentration for every channel based on the detected light amount through computation according to the following equations (1) ~ (3) (refer to, Atsushi MAKI et al "Visualizing human motor activity by using non-invasive optical topography" (Frontiers Med.Biol.Engng.Vol.7, No.4 pp 285-297 (1996)), and the hemoglobin signals are generated (step 201). Namely, detected light amount $R(\lambda)$ of wavelength λ at respective measurement positions is represented approximately by the equation (1). Likewise, detected light amount $R^s(\lambda)$ at the time of task execution is represented by the equation (2);

$$-\ln\frac{R(\lambda)}{R_0(\lambda)} = \varepsilon_{oxy}(\lambda)\, C_{oxy}d + \varepsilon_{deoxy}(\lambda)\, C_{deoxy}d + \alpha(\lambda) + s(\lambda) \quad \cdots (1)$$

$$-\ln\frac{R^s(\lambda)}{R_0(\lambda)} = \varepsilon_{oxy}(\lambda)\, C^s_{oxy}d + \varepsilon_{deoxy}(\lambda)\, C^s_{deoxy}d + \alpha(\lambda) + s(\lambda) \quad \cdots (2)$$

In the equations, $R_0(\lambda)$ is the irradiation light amount, $\varepsilon_{oxy0}(\lambda)$, $\varepsilon_{deoxy}(\lambda)$ are molecular extinction coefficients of oxygenated and deoxygenated hemoglobin at wavelength λ, C_{oxy}, C_{deoxy} are concentrations of oxygenated and deoxygenated hemoglobin, d is an effective light propagation length in an active region of the cerebral cortex, $\alpha(\lambda)$ is an attenuation due to light absorption by pigments other than hemoglobin, and $s(\lambda)$ shows an attenuation due to light scattering by tissue. The superior letter "s" indicates values during the task execution.

[0029] Herein, it is considered that $\alpha(\lambda)$, $s(\lambda)$ do not change both during the task execution and non-task execution, through subtracting equation (1) from equation (2), a variation of the hemoglobin amount can be obtained according to the following equation (3);

$$-\ln\frac{R^s(\lambda)}{R(\lambda)} = \varepsilon_{oxy}(\lambda)\Delta C_{oxy} + \varepsilon_{deoxy}(\lambda)\Delta C_{deoxy} \quad \cdots (3)$$

Wherein,

$$\Delta C_{oxy} = (C^s{}_{oxy} - C_{oxy})d$$

$$\Delta C_{deoxy} = (C^s{}_{deoxy} - C_{deoxy})d$$

$$\Delta C_{total} = \Delta C_{oxy} + C_{deoxy}$$

[0030] Further, when determining ΔC_{oxy}, ΔC_{deoxy}, ΔC_{total} independently, the left-hand member of equation (3) has to determined with regard to at least two wavelengths and by solving the simultaneous equations with regard to the two wavelengths the respective concentration variations can be determined.

[0031] Subsequently, using the hemoglobin signals (for example, hemoglobin signal corresponding to the total hemoglobin amount) which were determined as explained above, the CPU 110 performs the adding and averaging of the data corresponding to a plurality of task execution sections and determines the hemoglobin variation during the task execution (step 205).

[0032] A manner of obtaining the average is illustrated in Fig. 3. As shown in the drawing, the CPU 110 cuts out data having a predetermined interval C, for example 40 sec, containing the task execution section B, for example 10 sec, from the hemoglobin signals 301 representing time course data and obtains data 302 corresponding to number of task times, for example 5 times (hereinbelow referred to as extracted section data). The cutting out process of the extracted section data 302 can be performed based on clocks in the measurement system, which manages the task execution. Namely, in order to cause the subject to perform the tasks in a predetermined interval, clocks are used. Therefore, following the clocks, when the timing of the time course data acquisition and the timing of ending thereof are set, data having a predetermined length including a predetermined interval A, for example 15 sec, before and after the task execution section can be cut out.

[0033] The CPU 110 adds the plurality of extracted section data 302 extracted in the above manner and divides the sum by the number of task times, thereby an averaged section data 303 is obtained. However, if a noise of spike shape caused by a body movement is contained in any of the extracted section data, the averaged section data significantly varies due to the influence of the noise, which prevents acquisition of effective data for diagnosis. Therefore, prior to the addition and averaging process, the CPU 110 detects noise components contained in the hemoglobin signals and removes the extracted section data containing noise components so as not to be used in the addition and averaging process (steps 202- 204).

[0034] The above will be explained with reference to Figs.4A and 4B. Fig.4A shows a graph formed by plotting the hemoglobin signals 401 along time axis. As shown in the drawing, the hemoglobin signals 401 show large values in the task executing sections 402-406 as shown in the drawing. However, in the task executing section 406, since a spike shaped noise caused by such as a body movement is superposed, the hemoglobin signals averaged by including data of such task executing section 406 contains the steeply varying noise components as shown by 407 in Fig.4B, therefore, a curve representing correct hemoglobin variation can not be obtained.

[0035] In order not to use such data of task executing sections containing noises for the averaging, the CPU 110 determines differential values for the respective hemoglobin signals and specifies the task executing sections containing hemoglobin signals of which differential values exceed a predetermined value (steps 202,203).

[0036] In the step 202 in which the differential values are determined by using the hemoglobin signals, a difference T between the average value of a plurality of hemoglobin signals Vn-1 which were measured prior to the objective hemoglobin signal Vn and the hemoglobin signal Vn. Namely, a calculation according to the following equation (4) is performed;

$$T = V_n - \frac{1}{i} \sum V_{n-1} \quad \cdots (4)$$

[0037] As shown in Fig.5, the variation of the hemoglobin amount 501 both during task execution and non-task execution is within a few %, however, the spike shaped noise 502 caused by such as body movement exceeds far beyond the range of the normal variation of hemoglobin amount.

[0038] For this reason, it is judged whether or not the difference T between the objective hemoglobin signal value and the average value of the previous hemoglobin signals exceeds the threshold value (step 203). As the threshold value, a proper value, which exceeds a normal variation of hemoglobin amount, can be selected, for example, at 0.5. The threshold value can be set in advance as a constant value for the processing program in the CPU 110 or can be set optionally and occasionally by the user. As the result of the above judgment, when the difference T (absolute value) is larger than the threshold value, it is judged that noises are superposed in the hemoglobin signal, the extracted section data containing the hemoglobin signal is deleted (step 204). Thereby, the extracted section data containing noise components is removed from objects of the adding and averaging process thereafter (step 205).

[0039] Subsequently, as has been explained above, a plurality of extracted section data not deleted are averaged, and data representing hemoglobin variation at the time of task execution is obtained. The result of averaging obtained after the steps 202-205 is shown in Fig.6 as by 503. As will be apparent from the comparison with 407 in Fig.4B, the hemoglobin variation curve 503 correctly reflecting the hemoglobin increase due to the task execution can be obtained.

[0040] Such a hemoglobin variation curve is obtained for every measurement position. The display unit 112 displays these curves for every measurement position in form of a graph as well as a two dimensional image of the hemoglobin variation in a topography. Thereby, diagnostically important information such as specifying varied portions in the brain due to stimulation such as tasks and difference in the variation depending on the kind of the tasks can be obtained correctly. In the present embodiment, since the conventional noise removal by means of visual observation is eliminated. The measured data can be displayed in real time.

[0041] Hereinabove, as an example of the biological optical measuring instruments of the present invention, an embodiment of the instrument, which permits to display hemoglobin amount variation in an image form has been explained. The present invention is not limited to the present embodiment and is defined by the scope of the claims. For example, although in the above embodiment the measured signals are extracted as data for every section having a predetermined time interval and the data are averaged, the present invention can be applied when removing a portion containing noise components for a single measurement signal.

[0042] Further, although in the present embodiment the hemoglobin variation more than the threshold value is detected and the extracted section data containing such hemoglobin signal is removed from the addition and averaging process, the method of removing noises from the addition and averaging process is not limited to the above method.

[0043] According to the invention, when it is judged in step 202 that the differential value (difference from the average value) T of the hemoglobin signal is larger than the threshold value, the hemoglobin signal value is removed as well as the removed hemoglobin signal value is interpolated by the hemoglobin signal values at the nearest both sides of which difference T is less than the threshold value and the interpolated extracted section data can be used for the addition and averaging process. When the number of the extracted section data is small, the above method is advantageous for preventing a deterioration of S/N ratio.

[0044] Further, the hemoglobin signal value can be any amount of oxygenated hemoglobin, deoxygenated hemoglobin and total hemoglobin. Still further, the present invention can be like wise applied to the variation measurement of materials other than hemoglobin, which permit measurement by the biological optical measurement, such as cytochrome a, a3 and myoglobin.

[0045] According to the present invention, since the noise components superposed on the signals to be measured are automatically detected through computation without relying upon visual observation and the section data containing the noise components are removed from the measured data, accurate measurement data can be obtained. In particular, in order to detect noise components in the signals to be measured, because of the use of the differential value of the signal value, the spike shaped noise, which significantly affect to the adding and averaging process of the signal values can be removed effectively.

Claims

1. A biological optical measuring instrument comprising
a light generating unit (102) for irradiating light having a predetermined wavelength to a subject (100),
a light detecting unit (105) for detecting light which has been irradiated from the light generating unit (102) and transmitted through the subject (100), and
a signal processing unit (108, 110) for analyzing optical signals (301; 401) detected by the light detecting unit (105) and preparing biological information relating to the blood stream in the subject (100),
wherein the signal processing unit (108, 110) includes
means for extracting optical signals in a plurality of sections having a predetermined time interval (C) from the optical signals (301; 401) obtained along the time axis and for preparing section data (302) from the respective extracted optical signals,
means for detecting and removing section data containing noise components among the extracted and prepared section data (302) by determining differential values (T) of the optical signals obtained in time course and judging that noise components are contained in a corresponding portion of the optical signals, when any of the differential values (T) is higher than a predetermined threshold value, and
means for performing an adding and averaging process using the not removed section data among the plurality of the section data (302),
characterized in that
said optical signals extracting means is adapted to extract said optical signals such that each said predetermined time interval (C) in the extracted and prepared section data (302) includes a section (B; 402-406) in which a task is being executed by the subject (100) and a section (A) in which the subject (100) is at rest and executes no task; further **characterized by** means to obtain interpolated section data by interpolating the hemoglobin signal values at the nearest both sides of which the differential value (T) is less than the threshold value and in that
said means for performing the adding and averaging process is adapted to prepare averaged section data (303) having said predetermined time interval (C) by adding the not removed section data and the interpolated section data and dividing the sum by the number of task times.

2. The instrument of claim 1, wherein the noise component has a spike shape.

3. The instrument of claim 1 or 2, wherein the light having the predetermined wavelength is near-infrared light.

4. A biological optical measuring method comprising the following steps:

irradiating light having a predetermined wavelength to a subject (100);
detecting optical signals (301; 401) in the irradiated light which has been transmitted through the subject (100);
analyzing the detected optical signals (301; 401) and preparing biological information relating to the blood stream in the subject (100);
extracting optical signals in a plurality of sections having a predetermined time interval(C) from the optical signals (301; 401) obtained along the time axis and preparing section data (302) from the respective extracted optical signals;
detecting and removing section data containing noise components among the extracted and prepared section data (302) by determining differential values (T) of the optical signals obtained in time course and judging that noise components are contained in a corresponding portion of the optical signals, when any of the differential values (T) is higher than a predetermined threshold value; and
performing an adding and averaging process using the not removed section data among the plurality of the section data (302),
characterized in that
each said predetermined time interval (C) in the extracted and prepared section data (302) includes a section (B; 402-406) in which a task is being executed by the subject (100) and a section (A) in which the subject (100) is at rest and executes no task, and by obtaining interpolated section data by interpolating the hemoglobin signal values at the nearest both sides of which the differential value (T) is less than the threshold value, and **in that** said step of performing the adding and averaging process includes preparing averaged section data (303) having said predetermined time interval (C) by adding the not removed section data and interpolated section data and dividing the sum by the number of task times.

5. The method of claim 4, wherein the noise component has a spike shape.

6. The method of claim 4 or 5, wherein the light having the predetermined wavelength is near-infrared light.

7. The instrument of any of claims 1 to 3, or the method of any of claims 4 to 6, wherein the biological information is hemoglobin concentration signal data relating to oxygenated hemoglobin, deoxygenated hemoglobin or total hemoglobin.

Patentansprüche

1. Biologisches optisches Messinstrument mit
einer Lichterzeugungseinheit (102) zum Ausstrahlen von Licht mit einer vorbestimmten Wellenlänge auf ein Subjekt (100),
einer Lichterfassungseinheit (105) zum Erfassen von Licht, das aus der Lichterzeugungseinheit (102) ausgestrahlt und durch das Subjekt (100) transmittiert wurde, und
einer Signalverarbeitungseinheit (108, 110) zum Analysieren von durch die Lichterfassungseinheit (105) erfassten optischen Signalen (301; 401) und Erstellen von biologischer Information bezüglich des Blutstroms in dem Subjekt (100),
wobei die Signalverarbeitungseinheit (108, 110) aufweist:

eine Einrichtung zum Extrahieren optischer Signale in mehreren Abschnitten mit einer vorbestimmten Zeitspanne (C) aus den längs der Zeitachse erhaltenen optischen Signalen (301; 401) und zum Erstellen von Abschnittsdaten (302) aus den zugehörigen extrahierten optischen Signalen,
eine Einrichtung zum Erfassen und Entfernen von Abschnittsdaten mit Rauschkomponenten unter den extrahierten und erstellten Abschnittsdaten (302), indem Differenzwerte (T) der über die Zeit erhaltenen optischen Signale bestimmt werden und festgestellt wird, dass Rauschkomponenten in einem entsprechenden Abschnitt der optischen Signale enthalten sind, wenn ein beliebiger der Differenzwerte (T) größer ist als ein vorbestimmter Schwellenwert, und
eine Einrichtung zum Durchführen eines Additions- und Mittelungsprozesses unter Verwendung der nicht entfernten Abschnittsdaten unter den mehreren Abschnittsdaten (302),
dadurch gekennzeichnet, dass
die Einrichtung zum Extrahieren optischer Signale dazu ausgelegt ist, die optischen Signale so zu extrahieren, dass jede vorbestimmte Zeitspanne (C) in den extrahierten und erstellten Abschnittsdaten (302) einen Abschnitt (B; 402-406) aufweist, in dem eine Aufgabe durch das Subjekt (100) ausgeführt wird, sowie einen Abschnitt (A), in dem das Subjekt (100) im Ruhezustand ist und keine Aufgabe ausführt;
ferner **gekennzeichnet durch** eine Einrichtung zum Erhalten von interpolierten Abschnittsdaten **durch** Interpolieren der Hämoglobinsignalwerte an den nächsten beiden Seiten deren Differenzwert (T) niedriger als der Schwellenwert ist, und **dadurch**, dass
die Einrichtung zum Durchführen des Additions- und Mittelungsprozesses dazu ausgelegt ist, gemittelte Abschnittsdaten (303) mit der vorbestimmten Zeitspanne (C) zu erstellen, indem die nicht entfernten Abschnittsdaten und die interpolierten Abschnittsdaten addiert und die Summe **durch** die Anzahl von Malen der Aufgabenausführung dividiert.

2. Instrument nach Anspruch 1, wobei die Rauschkomponente eine Nadelform aufweist.

3. Instrument nach Anspruch 1 oder 2, wobei das Licht mit der vorbestimmten Wellenlänge nahinfrarotes Licht ist.

4. Biologisches optisches Messverfahren, in dem
Licht mit einer vorbestimmten Wellenlänge auf ein Subjekt (100) ausgestrahlt wird,
optische Signale (301; 401) in dem ausgestrahlten Licht erfasst werden, das durch das Subjekt (100) transmittiert wurde,
die erfassten optischen Signale (301; 401) analysiert und biologische Information bezüglich des Blutstroms in dem Subjekt (100) erstellt wird,
optische Signale in mehreren Abschnitten mit einer vorbestimmten Zeitspanne (C) aus den längs der Zeitachse erhaltenen optischen Signalen (301; 401) extrahiert und Abschnittsdaten (302) aus den entsprechenden extrahierten optischen Signalen erstellt werden,
Abschnittsdaten mit Rauschkomponenten unter den extrahierten und erstellten Abschnittsdaten (302) erfasst und entfernt werden, indem Differenzwerte (T) der über die Zeit erhaltenen optischen Signale bestimmt werden und festgestellt wird, dass Rauschkomponenten in einem entsprechenden Bereich der optischen Signale enthalten sind,

wenn ein beliebiger der Differenzwerte (T) größer ist als ein vorbestimmter Schwellenwert, und
ein Additions- und Mittelungsprozess unter Verwendung der nicht entfernten Abschnittsdaten unter den mehreren Abschnittsdaten (302) durchgeführt wird,
dadurch gekennzeichnet, dass
jede der vorbestimmten Zeitspannen (C) in den extrahierten und erstellten Abschnittdaten (302) einen Abschnitt (B; 402-406) enthält, in dem eine Aufgabe durch das Subjekt (100) ausgeführt wird, sowie einen Abschnitt (A), in dem das Subjekt (100) im Ruhezustand ist und keine Aufgabe ausführt, und indem interpolierte Abschnittdaten durch Interpolieren der Hämoglobinsignalwerte an den nächsten beiden Seiten erhalten werden, deren Differenzwert (T) niedriger ist als der Schwellenwert, und
dadurch, dass beim Durchführen des Additions- und Mittelungsprozesses gemittelte Abschnittsdaten (303) mit der vorbestimmten Zeitspanne (C) erstellt werden, indem die nicht entfernten Abschnittsdaten und die interpolierten Abschnittsdaten addiert und die Summe durch die Anzahl von Malen der Aufgabenausführung dividiert wird.

5. Verfahren nach Anspruch 4, wobei die Rauschkomponente eine Nadelform aufweist.

6. Verfahren nach Anspruch 4 oder 5, wobei das Licht mit der vorbestimmten Wellenlänge nahinfrarotes Licht ist.

7. Instrument nach einem der Ansprüche 1 bis 3, oder Verfahren nach einem der Ansprüche 4 bis 6, wobei die biologische Information in Hämoglobinkonzentrationssignaldaten bezogen auf sauerstoffangereichertes Hämoglobin, sauerstoffverarmtes Hämoglobin oder Gesamthämoglobin besteht.

Revendications

1. Instrument de mesure optique biologique comprenant :

une unité de génération de lumière (102) pour projeter une lumière ayant une longueur d'onde prédéterminée vers un sujet (100),
une unité de détection de lumière (105) pour détecter la lumière qui a été projetée par l'unité de génération de lumière (102) et transmise à travers le sujet (100), et
une unité de traitement de signaux (108, 110) pour analyser des signaux optiques (301 ; 401) détectés par l'unité de détection de lumière (105) et préparer une information biologique se rapportant au courant sanguin dans le sujet (100),
dans lequel l'unité de traitement de signaux (108, 110) comprend :

un moyen pour extraire des signaux optiques dans une pluralité de sections ayant un intervalle de temps prédéterminé (C) à partir de signaux optiques (301 ; 401) obtenus le long de l'axe de temps et pour préparer des données de section (302) à partir des signaux optiques extraits respectifs,
un moyen pour détecter et supprimer des données de section contenant des composantes de bruit parmi les données de section extraites et préparées (302) en déterminant des valeurs différentielles (T) des signaux optiques obtenus au cours du temps et en évaluant que des composantes de bruit sont contenues dans une partie correspondante des signaux optiques, quand l'une quelconque des valeurs différentielles (T) est supérieure à une valeur de seuil prédéterminée, et
un moyen pour réaliser un processus d'addition et de calcul de moyenne en utilisant les données de section non supprimées parmi la pluralité de données de section (302),
caractérisé en ce que :

ledit moyen d'extraction de signaux optiques est adapté pour extraire lesdits signaux optiques de telle manière que chacun desdits intervalles de temps prédéterminés (C) dans les données de section extraites et préparées (302) comprend une section (B ; 402-406) dans laquelle une tâche est en train d'être exécutée par le sujet (100) et une section (A) dans laquelle le sujet (100) est au repos et n'exécute pas de tâche ; **caractérisé en outre par** un moyen pour obtenir des données de section interpolées en interpolant les valeurs de signal d'hémoglobine aux deux côtés les plus proches desquelles la valeur différentielle (T) est inférieure à la valeur de seuil, et en ce que
ledit moyen pour réaliser le processus d'addition et de calcul de moyenne est adapté pour préparer une moyenne de données de section (303) ayant ledit intervalle de temps prédéterminé (C) en additionnant les données de section non supprimées et les données de section interpolées et en divisant la somme par le nombre de temps de tâches.

2. Instrument selon la revendication 1, dans lequel la composante de bruit a une forme de pointe.

3. Instrument selon la revendication 1 ou 2, dans lequel la lumière ayant la longueur d'onde prédéterminée est de la lumière proche infrarouge.

4. Procédé de mesure optique biologique comprenant les étapes suivantes :

projeter une lumière ayant une longueur d'onde prédéterminée vers un sujet (100) ;
détecter des signaux optiques (301 ; 401) dans la lumière projetée qui a été transmise à travers le sujet (100) ;
analyser les signaux optiques détectés (301 ; 401) et préparer une information biologique se rapportant au courant sanguin dans le sujet (100) ;
extraire des signaux optiques dans une pluralité de sections ayant un intervalle de temps prédéterminé (C) à partir des signaux optiques (301 ; 401) obtenus le long de l'axe de temps et préparer des données de section (302) à partir des signaux optiques extraits respectifs ;
détecter et supprimer des données de section contenant des composantes de bruit parmi les données de section extraites et préparées (302) en déterminant des valeurs différentielles (T) des signaux optiques obtenus au cours du temps et en évaluant que des composantes de bruit sont contenues dans une partie correspondante des signaux optiques, quand l'une quelconque des valeurs différentielles (T) est supérieure à une valeur de seuil prédéterminée ;
et
réaliser un processus d'addition et de calcul de moyenne en utilisant les données de section non supprimées parmi la pluralité de données de section (302),
caractérisé en ce que :

chacun desdits intervalles de temps prédéterminés (C) dans les données de section extraites et préparées (302) comprend une section (B ; 402-406) dans laquelle une tâche est en train d'être exécutée par le sujet (100) et une section (A) dans laquelle le sujet (100) est au repos et n'exécute pas de tâche ; et par l'obtention de données de section interpolées en interpolant les valeurs de signal d'hémoglobine aux deux côtés les plus proches desquelles la valeur différentielle (T) est inférieure à la valeur de seuil, et **en ce que** ladite étape de réalisation du processus d'addition et de calcul de moyenne comprend la préparation d'une moyenne de données de section (303) ayant ledit intervalle de temps prédéterminé (C) en additionnant les données de section non supprimées et les données de section interpolées et en divisant la somme par le nombre de temps de tâches.

5. Procédé selon la revendication 4, dans lequel la composante de bruit a une forme de pointe.

6. Procédé selon la revendication 4 ou 5, dans lequel la lumière ayant la longueur d'onde prédéterminée est de la lumière proche infrarouge.

7. Instrument selon l'une quelconque des revendications 1 à 3, ou procédé selon l'une quelconque des revendications 4 à 6, dans lequel l'information biologique est une donnée de signal de concentration d'hémoglobine concernant l'hémoglobine oxygénée, l'hémoglobine désoxygénée ou l'hémoglobine totale.

Fig. 1

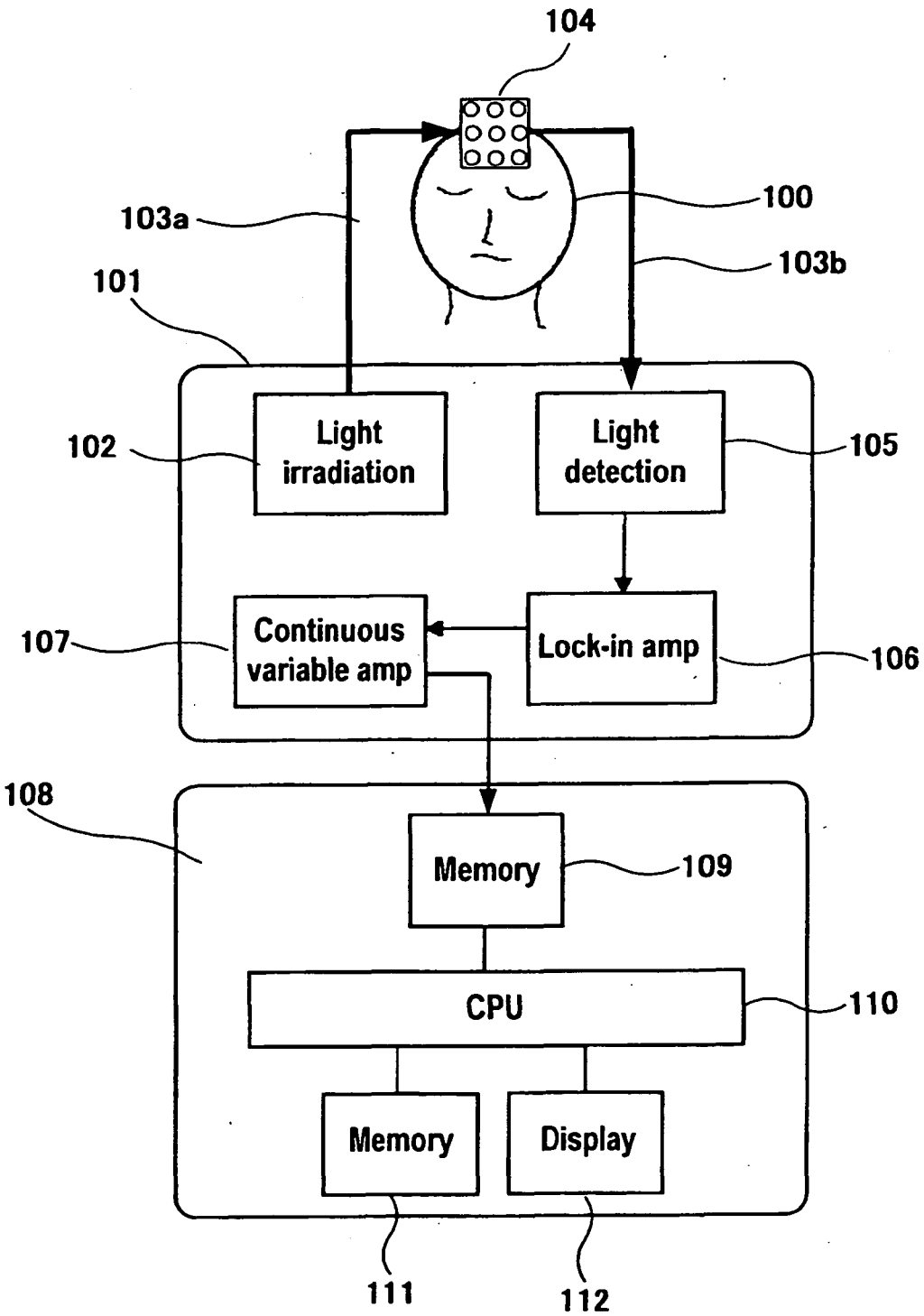

104
100
103a
103b
101
102
Light irradiation
Light detection
105
107
Continuous variable amp
Lock-in amp
106
108
Memory
109
CPU
110
Memory
Display
111
112

Fig. 2

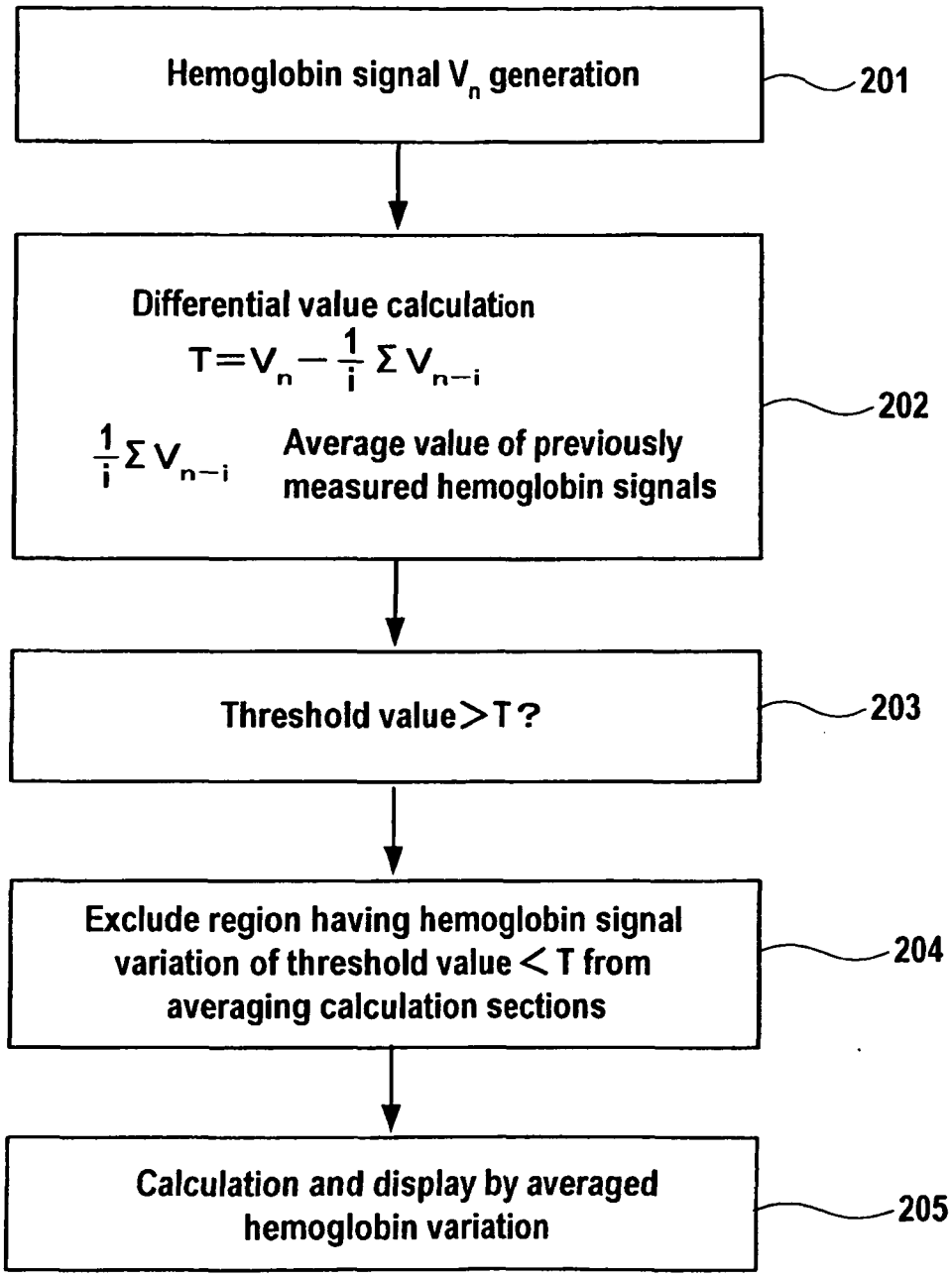

Hemoglobin signal V_n generation
201
Differential value calculation
$T = V_n - \frac{1}{i}\Sigma V_{n-i}$
$\frac{1}{i}\Sigma V_{n-i}$ Average value of previously measured hemoglobin signals
202
Threshold value > T ?
203
Exclude region having hemoglobin signal variation of threshold value < T from averaging calculation sections
204
Calculation and display by averaged hemoglobin variation
205

Fig. 3

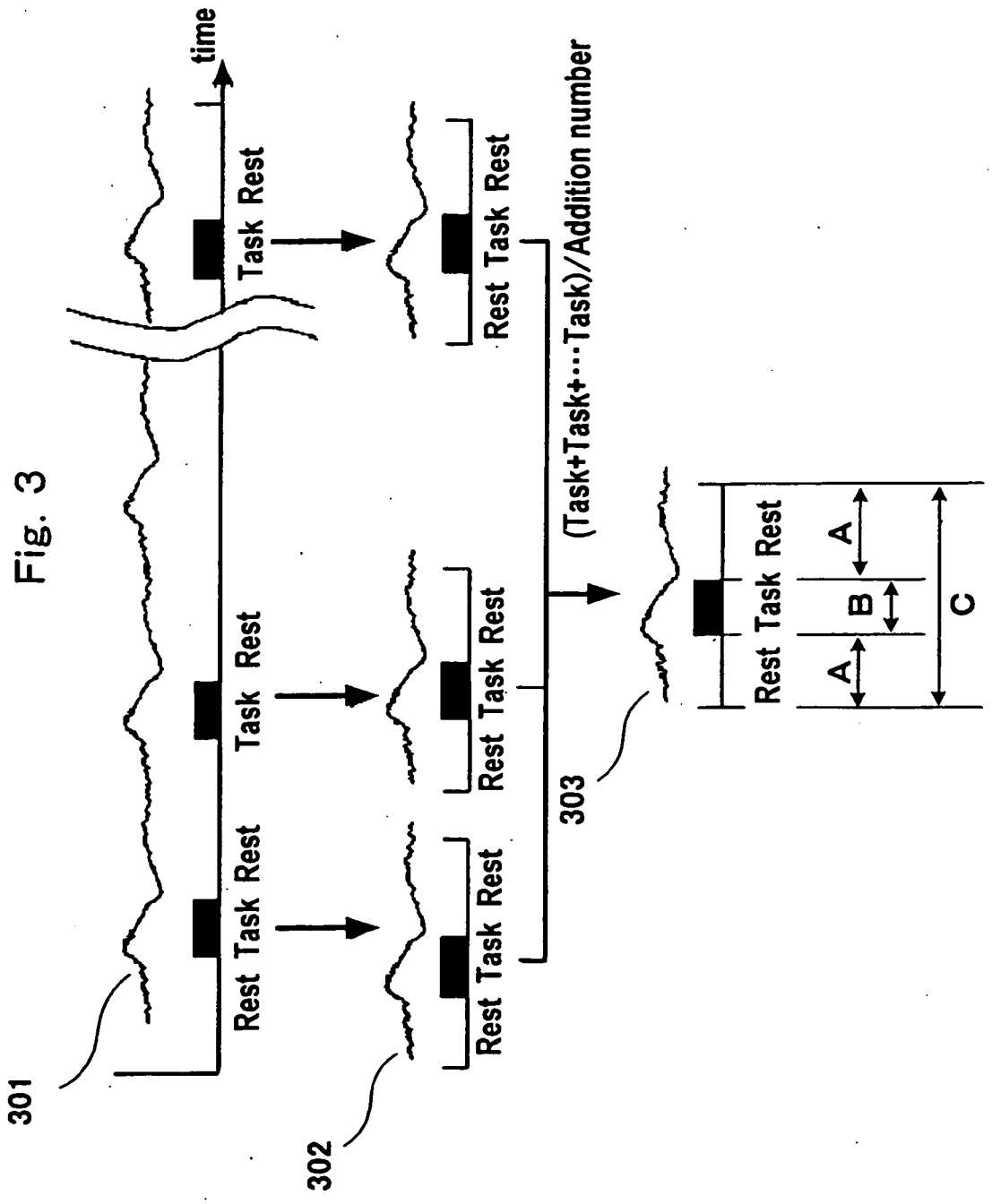

time
Rest Task Rest
Rest Task Rest
Rest Task Rest
Rest Task Rest
Rest Task Rest
Rest Task Rest
(Task+Task+···Task)/Addition number
A
B
A
C
301
302
303

Fig. 4A

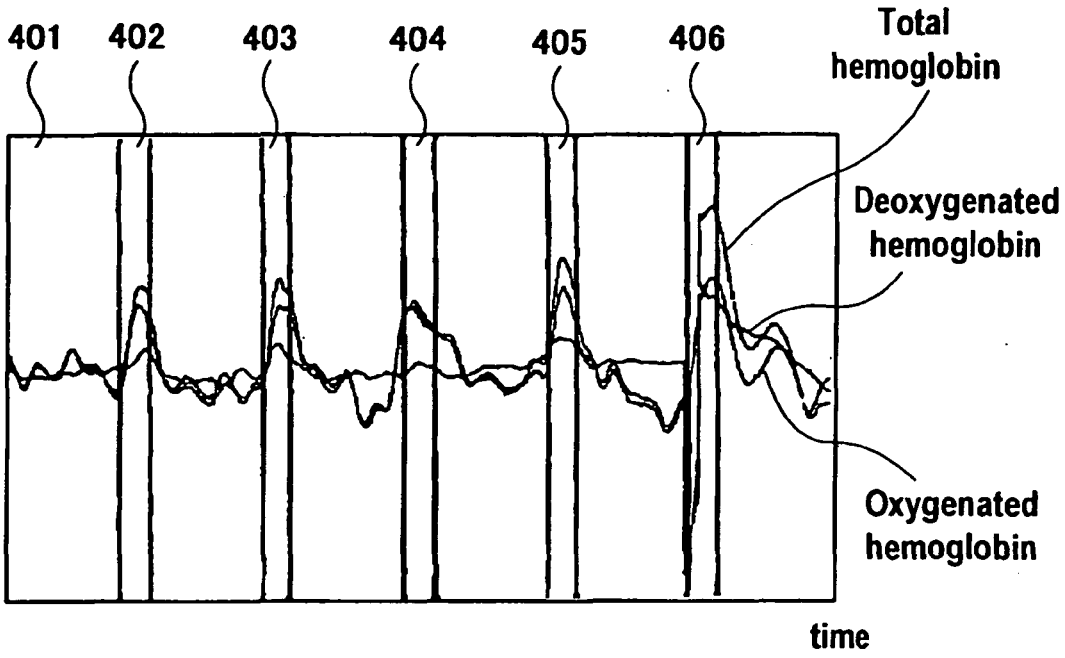

401
402
403
404
405
406
Total hemoglobin
Deoxygenated hemoglobin
Oxygenated hemoglobin
time

Fig. 4B

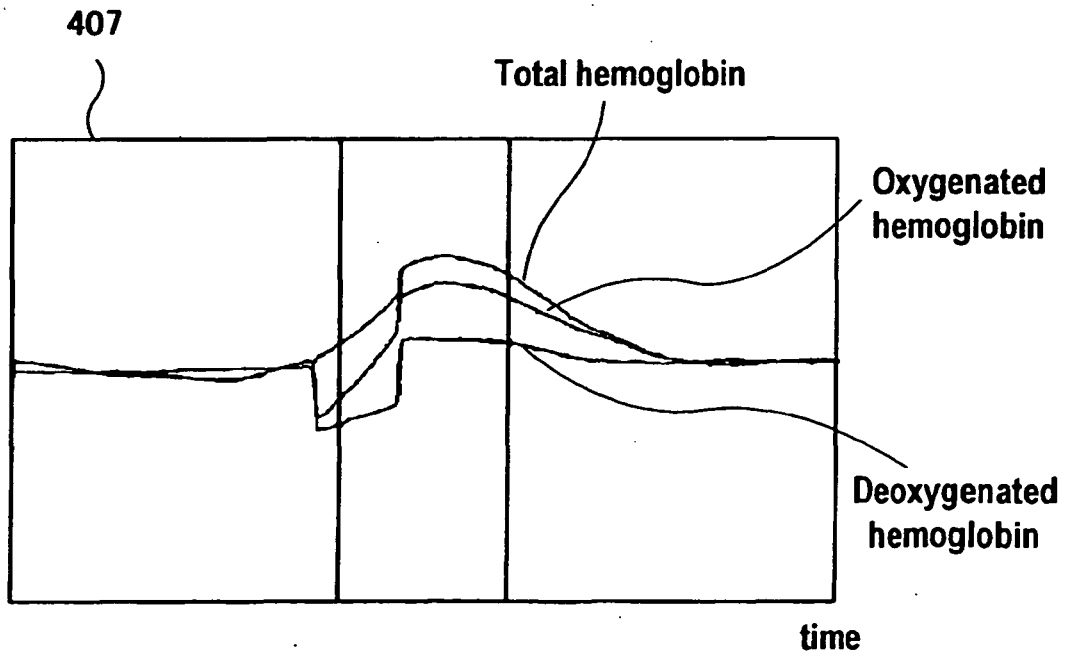

407
Total hemoglobin
Oxygenated hemoglobin
Deoxygenated hemoglobin
time

Fig. 5

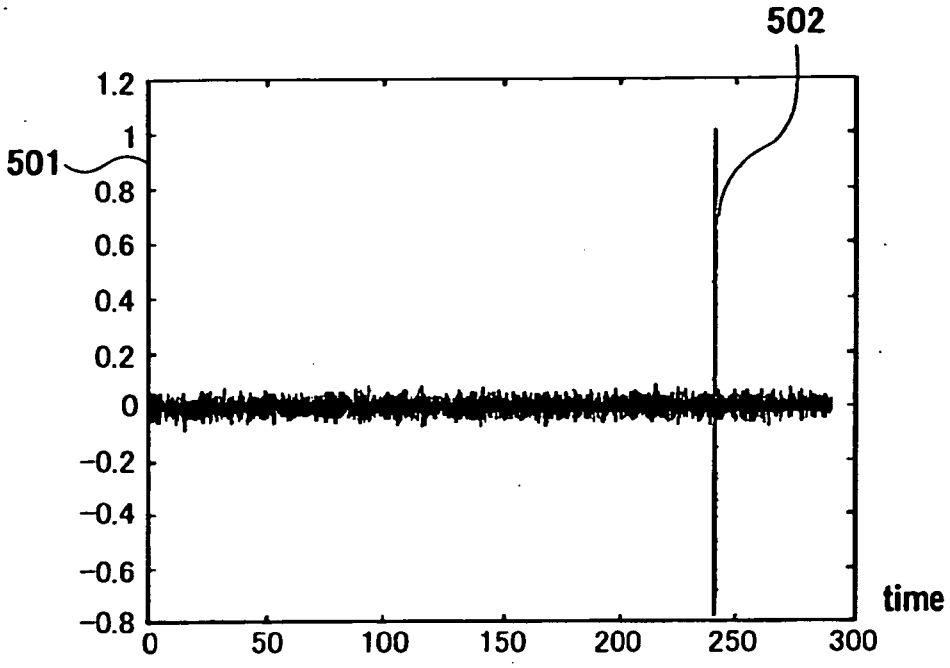
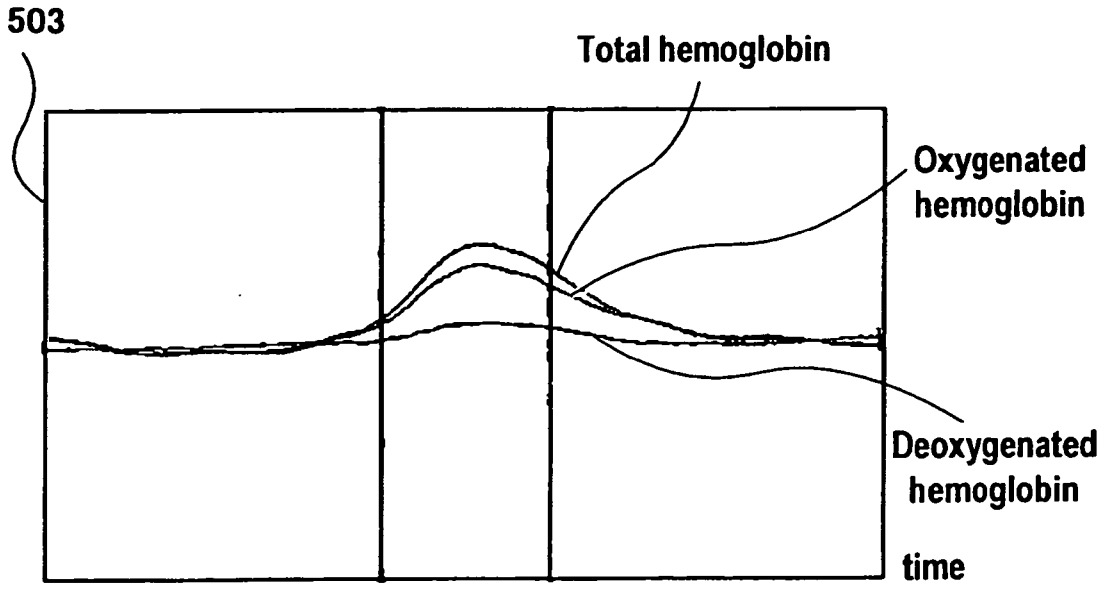

502
501
1.2
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
0
50
100
150
200
250
300
time

Fig. 6


503
Total hemoglobin
Oxygenated hemoglobin
Deoxygenated hemoglobin
time

REFERENCES CITED IN THE DESCRIPTION

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- **ATSUSHI MAKI et al.** Visualizing human motor activity by using non-invasive optical topography. *Frontiers Med.Biol.Engng.,* 1996, vol. 7 (4), 285-297 **[0028]**

专利名称(译)	生物光学测量仪器		
公开(公告)号	EP1402820B1	公开(公告)日	2012-11-28
申请号	EP2002743762	申请日	2002-06-28
[标]申请(专利权)人(译)	株式会社日立医药		
申请(专利权)人(译)	日立医疗器械股份有限公司		
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IPC分类号	A61B10/00 A61B5/00 A61B5/145 A61B5/1455 G01N21/35 G01N21/3577 G01N21/359		
CPC分类号	A61B5/14553 A61B5/1455 A61B2562/0219		
优先权	2001195891 2001-06-28 JP		
其他公开文献	EP1402820A1 EP1402820A4		
外部链接	Espacenet		

摘要(译)

在生物光学测量仪器中，当通过向对象照射光并在处理通过检测透射光获得的光信号来在对象的预定区域中显示生物变化时，具有预定时间间隔的多个部分的光信号是从各个提取的光信号中提取截面数据，对多个准备的截面数据进行相加和平均，在准备预定时间间隔的平均截面数据之前，从包含噪声分量的差分值指定包含噪声分量的光信号部分。从平均操作中排除提取的光信号和包含噪声分量的光信号的截面数据，从而提供一种生物光学测量仪器，其允许通过计算自动去除包含噪声分量的截面数据，而不依赖于视觉天文台，快速获得高度可靠的测量结果并显示相同的结果。