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Detecting device and measuring device

Abstract

A detecting device includes: a first light-emitting section configured to emit first light having a green wavelength band; a second light-emitting section configured to emit second light having a wavelength band longer than the green wavelength band; a first light-receiving section configured to receive the first light emitted from the first light-emitting section and passed through a living body; and a second light-receiving section configured to receive the second light emitted from the second light-emitting section and passed through the living body. In the direction intersecting the direction in which the first light-emitting section and the second light-emitting section are aligned, in the second direction, at least a portion of the first light-receiving section is disposed closer to the first light-emitting section than the second light-receiving section. An area of the first light-receiving section is smaller than an area of the second light-receiving section.

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Background/Summary

(1) The present application is based on, and claims priority from JP Application Serial Number 2021-013632, filed Jan. 29, 2021, the disclosure of which is hereby incorporated by reference herein in its entirety.

BACKGROUND

1. Technical Field

(2) The present disclosure relates to a detecting device and a measuring device.

2. Related Art

(3) Various measurement technologies for non-invasively measuring biological information such as pulse waves have been proposed in the past. For example, JP-A-2018-061675 discloses a detecting device that includes a light-emitting section configured to emit light to a living body, and a light-receiving section configured to receive light emitted from the light-emitting section and reflected by the living body to be incident on the light-receiving section. JP-A-2018-061675 discloses a technology whereby the light utilization efficiency of the light-emitting section is increased and a measure against stray light for the light-receiving section is implemented by installing a light-shielding member between the light-emitting section and the light-receiving section in the detecting device.

(4) The above-described detecting device reflects light by an inclined surface formed on the light-shielding member, thereby improving the light utilization efficiency of the light-emitting section. However, there is a problem in that the device configuration cannot be downsized because space is needed for providing the inclined surface on the light-shielding member.

SUMMARY

(5) According to one aspect of the present disclosure, there is provided a detecting device including: a first light-emitting section configured to emit first light having a green wavelength band, a second light-emitting section configured to emit second light having a wavelength band longer than the green wavelength band, a first light-receiving section configured to receive the first light emitted from the first light-emitting section and emitted from a living body, and a second light-receiving section configured to receive the second light emitted from the second light-emitting section and emitted from the living body, when a direction in which the first light-emitting section and the second light-emitting section are aligned is a first direction and a direction intersecting the first direction is a second direction, in the second direction, at least a portion of the first light-receiving section being disposed closer to the first light-emitting section than the second light-receiving section and an area of the first light-receiving section being smaller than an area of the second light-receiving section.

(6) According to one aspect of the present disclosure, there is provided a measuring device including: a detecting device according to the above-described aspect, and an information analysis section configured to identify biological information from a detection signal indicating a detection result by the detecting device.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. **1** is a side view of a measuring device according to a first embodiment.

(2) FIG. **2** is a configuration diagram focused on a function of a measuring device.

(3) FIG. **3** is a plan view of a detecting device.

(4) FIG. **4** is a cross-sectional view taken along the line IV-IV in FIG. **3**.

(5) FIG. **5** is a graph showing a transmission spectrum of a skin.

(6) FIG. **6** is a graph illustrating a relationship between a red light-emitting section and a light-receiving section.

(7) FIG. **7** is a view for explaining an operation of a detecting device.

(8) FIG. **8** is a cross-sectional view of a detecting device according to a second embodiment.

(9) FIG. **9** is a cross-sectional view of a detecting device according to a third embodiment.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

(10) Hereinafter, one embodiment of the present disclosure will be described with reference to the accompanying drawings. Note that in each of the figures below, to illustrate each member at a recognizable size, the scale or angle of each member is changed from the actual scale or angle.

First Embodiment

(11) FIG. **1** is a side view of a measuring device **100** according to a first embodiment. The measuring device **100** according to the present embodiment illustrated in FIG. **1** is a biometric instrument that non-invasively measures biological information of a test subject (e.g., a human), which is an example of a living body. The measuring device **100** is mounted at a site (hereinafter referred to as the "measurement site") M that serves as a measurement target of the body of a test subject. The measuring device **100** according to the present embodiment is a wristwatch-type portable instrument including a housing section **1** and a belt **2**. The measuring device **100** is mountable to a wrist of the test subject by winding a band-shaped belt **2** around a wrist, which is an example of a measurement site (living body) M. In the present embodiment, pulse waves (e.g., pulse peak interval or PPI) and oxygen saturation (SpO2) of the test subject are used as examples of biological information. A pulse wave means temporal change in blood vessel volume linked to the beats of the heart. Oxygen saturation means a percentage (%) of hemoglobin bound to oxygen in total hemoglobin in the blood of the test subject. Oxygen saturation is an indicator for assessing the respiratory function of the test subject.

(12) FIG. **2** is a configuration diagram focused on a function of the measuring device **100**. As illustrated in FIG. **2**, the measuring device **100** according to the present embodiment includes a control device **5**, a storage device **6**, a display device **4**, and a detecting device **3**. The control device **5** and the storage device **6** are installed inside the housing section **1**. As illustrated in FIG. **1**, the display device **4** is installed on a surface of the housing section **1** on a side opposite to the measurement site M. The display device **4** displays various images including measurement results under the control of the control device **5**. The display device **4** is, for example, a liquid crystal display panel.

(13) The detecting device **3** is an optical sensor module that generates a detection signal S in accordance with the state of the measurement site M. As illustrated in FIG. **1**, the detecting device **3** is installed, for example, on a surface (hereinafter referred to as the detection surface) **16** of the housing section **1** that faces the measurement site M. The detection surface **16** is a surface that comes into contact with the measurement site M. As illustrated in FIG. **2**, the detecting device **3** according to the present embodiment includes a light-emitting unit section **11**, a light-receiving unit section **12**, a driving circuit **13**, and an output circuit **14**. Note that one or both of the driving circuit **13** and the output circuit **14** may be installed as an external circuit of the detecting device **3**. That is, the driving circuit **13** and the output circuit **14** can be omitted from the detecting device **3**.

(14) FIG. **3** is a plan view of the detecting device **3**. FIG. **4** is a cross-sectional view taken along the line IV-IV in FIG. **3**. As illustrated in FIG. **3** and FIG. **4**, the detecting device **3** according to the present embodiment further includes, in addition to the light-emitting unit section **11** and the light-receiving unit section **12**, a case **40**, a light-shielding wall **41**, and a sealing layer **42**. Note that in FIG. **3** and FIG. **4**, illustrations of the driving circuit **13** and the output circuit **14** are omitted.

(15) Hereinafter, a configuration of the detecting device **3** will be described using an XYZ coordinate system. The X-axis corresponds to an axis along a long side (one side) of the case **40** having a rectangular outer shape. The Y-axis is orthogonal to the X-axis and corresponds to an axis along the short side (the other side) of the case **40**. The Z-axis is orthogonal to each of the X-axis and the Y-axis and corresponds to an axis along the normal line of the detection surface **16** that comes into contact with the measurement site M.

(16) As illustrated in FIG. **3** and FIG. **4**, the case **40** is a member that houses each constituent (the light-emitting unit section **11** and the light-receiving unit section **12**) constituting the detecting device **3**. The case **40** has a box shape including a rectangular flat plate-shaped bottom surface portion **40***a* and a rectangular frame-shaped side plate portion **40***b* protruding from the periphery of

the bottom surface portion **40***a* to the +Z side. The case **40** is formed of aluminum, for example. An inner circumferential surface **40***b***1** of the side plate portion **40***b* is colored in black and thus has light-shielding properties. As a result, reflection on the inner circumferential surface **40***b***1** of the side plate portion **40***b* is suppressed.
(17) Note that the material and manufacturing method of the case **40** may be selected as desired. For example, the case **40** can be formed by injection molding of a resin material. Furthermore, a configuration in which the case **40** is formed integrally with the housing section **1** is also suitable.
(18) The light-emitting unit section **11** and the light-receiving unit section **12** are installed on the bottom surface portion **40***a* of the case **40** in a state of being mounted on a wiring substrate (not illustrated). The light-shielding wall **41** is disposed between the light-emitting unit section **11** and the light-receiving unit section **12** in the direction along the X-axis. The light-shielding wall **41** is a flat plate-shaped member protruding from the bottom surface portion **40***a* to the +Z side and extending in the Y-axis direction. The light-shielding wall **41** divides the housing space inside the case **40** into two in the X-axis direction. That is, the light-shielding wall **41** is a member that separates the space housing the light-emitting unit section **11** and the light-receiving unit section **12** in the direction along the X-axis. The light-shielding wall **41** is a member having light-shielding properties for shielding light so as to prevent light emitted from the light-emitting unit section **11** from being directly incident on the light-receiving section **12**. Since it is a flat plate-shaped member, the light-shielding wall **41** of the present embodiment does not upsize the device configuration in the direction along the X-axis.
(19) In the present embodiment, the light-shielding wall **41** is provided between the light-emitting unit section **11** including a first light-emitting section **50** and a second light-emitting section **60** and the light-receiving unit section **12** in the direction along the X-axis. It can also be said that the light-shielding wall **41** is a member that blocks a portion of green light LG, red light LR, and near-infrared light LI.
(20) The sealing layer **42** is an optically transparent resin material filled into a gap between the light-emitting unit section **11** and the light-receiving unit section **12** housed within the case **40** and the side plate portion **40***b*. The sealing layer **42** seals (molds) the light-emitting unit section **11** and the light-receiving unit section **12** within the case **40**. The surface of the sealing layer **42** functions as the detection surface **16**.
(21) Note that instead of a configuration in which the sealing layer **42** is used to seal, a configuration may be employed in which the upper surface of the side plate portion **40***b* of the case **40** is covered by a transmissive substrate. In this case, the upper surface of the transmissive substrate functions as the detection surface **16**.
(22) The light-emitting unit section **11** includes the first light-emitting section **50**, the second light-emitting section **60**, and a third light-emitting section **70**. The first light-emitting section **50**, the second light-emitting section **60**, and the third light-emitting section **70** are light sources that each emit light of a different wavelength to the measurement site M.
(23) The first light-emitting section **50** emits green light (first light) LG having a green wavelength band of 520 nm to 550 nm toward the measurement site M. The green light LG of the present embodiment is, for example, light having a peak wavelength of 520 nm.
(24) The second light-emitting section **60** emits red light (second light) LR having a red wavelength band of 600 nm to 800 nm toward the measurement site M, for example. The red light LR of the present embodiment is, for example, light having a peak wavelength of 660 nm.
(25) The third light-emitting section **70** emits near-infrared light (third light) LI having a near-infrared wavelength band of 800 nm to 1300 nm toward the measurement site M, for example. The near-infrared light LI of the present embodiment is, for example, light having a peak wavelength of 905 nm.
(26) As the light-emitting elements constituting the first light-emitting section **50**, the second light-emitting section **60**, and the third light-emitting section **70**, a bare chip-type or a shell-type light-

emitting diode (LED) is suitably utilized, for example. Note that the wavelength of light emitted by each light-emitting section is not limited to the above-described numerical range. Hereinafter, when the first light-emitting section **50**, the second light-emitting section **60**, and the third light-emitting section **70** are not particularly distinguished, they are collectively referred to as the light-emitting sections **50**, **60**, and **70**.
(27) Each of the light-emitting sections **50**, **60**, and **70** is installed in the case **40** so that the light-emitting surface thereof is parallel to the XY plane. That is, each of the light-emitting sections **50**, **60**, and **70** emits light toward the +Z side.
(28) Each of the light-emitting sections **50**, **60**, and **70** emits light by the driving current supplied from the driving circuit **13** illustrated in FIG. **2**. In the case of the present embodiment, the driving circuit **13** causes each of the light-emitting sections **50**, **60**, and **70** to emit light independently in time sequence. Hereinafter, an aspect in which each of the light-emitting sections **50**, **60**, and **70** independently emits light in time sequence is referred to by saying that the light-emitting sections **50**, **60**, and **70** periodically emits light in time division.
(29) Light emitted from each of the light-emitting sections **50**, **60**, and **70** is incident on the measurement site M. After being propagated through repeated reflections and scatterings inside the measurement site M, the light is emitted to the housing section **1** side to reach the light-receiving unit section **12**. That is, the detecting device **3** according to the present embodiment is a reflection-type optical sensor in which the light-emitting unit section **11** and the light-receiving unit section **12** are positioned on one side of the measurement site M.
(30) As illustrated in FIG. **3**, the light-emitting sections **50**, **60**, and **70** are disposed side by side and spaced apart from each other in the direction along the Y-axis (first direction). Specifically, the second light-emitting section **60** is disposed on the +Y side of the first light-emitting section **50**, while the third light-emitting section **70** is disposed on the −Y side of the first light-emitting section **50**. That is, the first light-emitting section **50** is disposed between the second light-emitting section **60** and the third light-emitting section **70** in the direction along the Y-axis. Furthermore, it can also be said that the first light-emitting section **50** is positioned between the second light-emitting section **60** and the third light-emitting section **70**.
(31) Traditionally, detecting devices capable of acquiring both the pulse peak interval (PPI) and oxygen saturation (SpO2) as biological information of a test subject are known. Furthermore, there is a demand for further downsizing of measuring devices that include such a detecting device. In view of such background, the present inventors conducted diligent research on small detecting devices capable of acquiring both the pulse peak interval and oxygen saturation.
(32) First, the present inventors focused on the fact that the transmittance of skin varies by the wavelength band of light.
(33) FIG. **5** is a graph showing a transmission spectrum of a skin. In FIG. **5**, the horizontal axis indicates the wavelength of light, while the vertical axis indicates the transmittance (unit: %). FIG. **5** shows the transmission spectrum when the skin thickness is 0.43 mm as an example.
(34) As illustrated in FIG. **5**, the transmittance of the wavelength band of the green light LG (e.g., 520 nm) when incident on the skin is approximately 30%; the transmittance of the wavelength band of the red light LR (e.g., 660 nm) when incident on the skin is approximately 50% to 60%; and the transmittance of the wavelength band of the near-infrared light LI (e.g., 905 nm) when incident on the skin is approximately 60%.
(35) The graph shown in FIG. **5** shows that the distance that light can propagate in a living body differs per wavelength of light. That is, according to the graph of FIG. **5**, it can be seen that the green light LG can only propagate a short distance in the living body compared to the red light LR or the near-infrared light LI. In other words, it can also be said that the red light LR and the near-infrared light LI can propagate farther in the living body than the green light LG. Note that in FIG. **5**, an example is given in which the skin thickness is 0.43 mm. However, even when the skin thickness is different, the red light LR and the near-infrared light LI can similarly propagate farther

in the living body than the green light LG.
(36) As shown in the graph of FIG. **5**, the present inventors discovered that the green light LG is easily attenuated as it passes through the living body compared to the red light LR and the near-infrared light LI.
(37) Furthermore, the present inventors simulated the state of incidence on the light-receiving section of the green light LG that passed through the living body. In this simulation, a traditionally-used regular-sized light-receiving section was used. As a reference, the results of the simulation are shown in the bottom row of FIG. **3**.
(38) As illustrated in FIG. **3**, a light incident region **7** in which the green light LG was incident in a concentrated manner was formed on a light-receiving surface **9***a* on the first light-emitting section **50** side (the left side of the bottom row of FIG. **3**) of a regular-sized light-receiving section **9**. However, it was confirmed that almost no green light LG was incident on the light-receiving surface **9***a* on the side away from the first light-emitting section **50** (the right side of the bottom row of FIG. **3**). This is because the green light LG is sufficiently attenuated in the living body before it is incident on the light-receiving surface **9***a* away from the first light-emitting section **50**.
(39) The present inventors discovered that, in the vicinity of the light-emitting section, at a light incident region in which the green light LG transmitted through the living body is concentrated, disposing a light-receiving section for green light having a size corresponding to the light incident region can make the device configuration small.
(40) Furthermore, the present inventors focused on the fact that the noise component contained in red light and near-infrared light that propagate in the living body and that are incident on a light-receiving section changes in accordance with the distance from a light-emitting section to the light-receiving section. In the following description, red light is used as an example. However, the same applies to near-infrared light.
(41) FIG. **6** is a graph illustrating a relationship among the distance from a red light-emitting section that emits red light to a light-receiving section, the noise component of red light, and the current consumption of the red light-emitting section. In FIG. **6**, the horizontal axis indicates the distance from the red light-emitting section to the light-receiving section; the vertical axis on the left side indicates the noise component of the red light LR; and the vertical axis on the right side indicates the current consumption of the light-emitting section.
(42) As illustrated in FIG. **6**, the closer the distance between the light-receiving section and the light-emitting section is, the more the noise component of the red light LR received at the light-receiving section increases. In other words, the farther away the light-receiving section is disposed from the light-emitting section, the more the noise component of the red light LR decreases, which improves the detection accuracy for the red light LR. This is because on a light-receiving section disposed close to the light-emitting section, a red light component that is reflected at the surface layer portion of the living body and thus does not pass through the blood is incident. Such red light LR that does not pass through the blood is a noise component in identifying blood oxygen concentration at the light-receiving section.
(43) Accordingly, disposing the light-receiving section away from the red light-emitting section can reduce the noise component contained in the red light LR and improve the detection accuracy for the red light LR. On the other hand, when the light-receiving section is disposed away from the red light-emitting section, the distance to be propagated in the living body increases. Therefore, the input current to the red light-emitting section needs to be increased to increase the luminance of the red light. In this case, since current consumption of the red light-emitting section increases, the distance between the red light-emitting section and the light-receiving section may be determined taking into account the balance between the noise component and current consumption.
(44) Note that, for the near-infrared light LI as well, similar to the red light LR, disposing the near-infrared light-emitting section that emits the near-infrared light LI and the light-receiving section away from each other can improve the detection accuracy for the near-infrared light LI.

Furthermore, the distance between the near-infrared light-emitting section and the light-receiving section may be determined taking into account the balance between the noise component and the current consumption.
(45) The present inventors discovered that disposing a light-receiving section that receives the red light LR or the near-infrared light LI away from the light-emitting section improves the detection accuracy for the red light LR or the near-infrared light LI.
(46) Based on the above-described discoveries, the present inventors completed the detecting device **3** and the measuring device **100** according to the present embodiment. Hereinafter, a configuration of the detecting device **3** and the measuring device **100** according to the present embodiment will be specifically described.
(47) The light-receiving unit section **12** receives light caused by the light emission of the light-emitting unit section **11** and coming from the measurement site M. The light-receiving unit section **12** of the present embodiment includes a first light-receiving section **51** and a second light-receiving section **61**. The light-receiving section **51** and the light-receiving section **61** generate a detection signal in accordance with the intensity of received light. Hereinafter, when the light-receiving section **51** and the light-receiving section **61** are not particularly distinguished, they are collectively referred to as the “light-receiving sections **51** and **61**”.
(48) The light-receiving unit section **12** is installed in the case **40** so that the light-receiving surface of each of the light-receiving sections **51** and **61** is parallel to the XY plane. That is, each of the light-receiving sections **51** and **61** is configured to receive light incident from the Z direction.
(49) As illustrated in FIG. **3**, the light-receiving sections **51** and **61** are disposed side by side and spaced apart from each other in the direction along the X-axis (second direction) that intersects (is orthogonal to) the Y-axis. Specifically, the first light-receiving section **51** is positioned on the +X side of the light-emitting unit section **11**, while the second light-receiving section **61** is positioned on the +X side of the first light-receiving section **51**. The second light-receiving section **61** is disposed on a side opposite to the light-emitting unit section **11** with the first light-receiving section **51** interposed therebetween. In the case of the present embodiment, the second light-receiving section **61** is provided at a position farther away from the first light-emitting section **50** than the first light-receiving section **51**. Specifically, the first light-receiving section **51** is positioned more on the first light-emitting section **50** side than the second light-receiving section **61** in the direction along the X-axis.
(50) Here, the distance from the first light-emitting section **50** to the first light-receiving section **51** is D**1**; the distance from the second light-emitting section **60** to the second light-receiving section **61** is D**2**; and the distance from the third light-emitting section **70** to the second light-receiving section **61** is D**3**. The distance D**1** corresponds to the distance between the center portions of the first light-emitting section **50** and the first light-receiving section **51** when viewed in plan view from the Z-axis direction. Furthermore, the distance D**2** corresponds to the distance between the center portions of the second light-emitting section **60** and the second light-receiving section **61** when viewed in plan view from the Z-axis direction. Furthermore, the distance D**3** corresponds to the distance between the center portions of the third light-emitting section **70** and the second light-receiving section **61** when viewed in plan view from the Z-axis direction.
(51) In the detecting device **3** according to the present embodiment, the distance D**1** from the first light-emitting section **50** to the first light-receiving section **51** is shorter than the distance D**2** from the second light-emitting section **60** to the second light-receiving section **61**. Furthermore, the distance D**1** from the first light-emitting section **50** to the first light-receiving section **51** is shorter than the distance D**3** from the third light-emitting section **70** to the second light-receiving section **61**. Note that the distance D**2** and the distance D**3** are equal.
(52) In this way, for the detecting device **3** according to the present embodiment, a configuration is employed in which the first light-receiving section **51** for receiving the green light LG is disposed at the position closest to the first light-emitting section **50** that emits the green light LG. As a result,

the first light-receiving section **51** is capable of receiving the green light LG transmitted through the living body without being attenuated and emitted therefrom.
(53) In the detecting device **3** according to the present embodiment, when receiving the green light LG emitted from the first light-emitting section **50** and propagated inside the measurement site M, the first light-receiving section **51** generates a detection signal in accordance with the received light intensity. The second light-receiving section **61** receives the red light LR emitted from the second light-emitting section **60** and propagated inside the measurement site M or the near-infrared light LI emitted from the third light-emitting section **70** and propagated inside the measurement site M, and generates a detection signal in accordance with the received light intensity.
(54) In the case of the present embodiment, the light-receiving unit section **12** receives each light in synchronization with the light emission timing of the light-emitting sections **50**, **60**, and **70** that are driven in time division, and generates a detection signal in accordance with each light.
(55) The light-receiving unit section **12** sends the detection signal generated at each of the light-receiving sections **51** and **61** to the output circuit **14**. The output circuit **14** includes, for example, an A/D converter that converts the detection signal generated by each of the light-receiving sections **51** and **61** from analog to digital, and an amplification circuit that amplifies the converted detection signal (both not illustrated). The output circuit **14** generates a plurality of detection signals S (S**1**, S**2**, and S**3**) corresponding to different wavelengths.
(56) Here, the detection signal S**1** is a signal that represents the received light intensity of the first light-receiving section **51** when the green light LG emitted from the first light-emitting section **50** is received. The detection signal S**2** is a signal that represents the received light intensity of the second light-receiving section **61** when the red light LR emitted from the second light-emitting section **60** is received. The detection signal S**3** is a signal that represents the received light intensity of the second light-receiving section **61** when the near-infrared light LI emitted from the third light-emitting section **70** is received.
(57) In general, since the absorbance of blood varies between the diastolic phase and the systolic phase of the blood vessel, each of the detection signals S is a pulse wave signal that includes a periodic fluctuation component corresponding to the pulsating component (plethysmogram) of an artery inside the measurement site M.
(58) Note that the driving circuit **13** and the output circuit **14** are mounted on the wiring substrate together with the light-emitting unit section **11** and the light-receiving unit section **12** in the form of an integrated circuit (IC) chip. Note that, as described above, the driving circuit **13** and the output circuit **14** may be installed outside of the detecting device **3**.
(59) The control device **5** is an arithmetic processing device such as a central processing unit (CPU) and a field-programmable gate array (FPGA). The control device **5** controls the entire measuring device **100**. The storage device **6** is constituted, for example, by a non-volatile semiconductor memory. The storage device **6** stores a program executed by the control device **5** and various data used by the control device **5**. Note that a configuration in which the functions of the control device **5** are distributed among a plurality of integrated circuits or a configuration in which some or all of the functions of the control device **5** are realized by a dedicated electronic circuit can also be employed. Note that in FIG. **2**, the control device **5** and the storage device **6** are illustrated as separate constituents. However, it is also possible to realize the control device **5** including the storage device **6** by, for example, an application-specific integrated circuit (ASIC) and the like.
(60) The control device **5** of the present embodiment executes a program stored in the storage device **6**, and thereby identifies biological information of the test subject from the plurality of detection signals S (S**1**, S**2**, and S**3**) generated by the detecting device **3**.
(61) Specifically, the control device (information analysis section) **5** identifies a pulse wave of the test subject from the detection signal S**1** that represents the received light intensity of the green light LG received by the first light-receiving section **51**. The controller **5** can identify a pulse peak

interval (PPI) of the test subject based on, for example, the detection signal S**1**. Furthermore, the control device **5** can analyze the detection signal S**2** that represents the received light intensity of the red light LR received by the second light-receiving section **61**, and the detection signal S**3** that represents the received light intensity of the near-infrared light LI received by the second light-receiving section **61**, and thereby identify oxygen saturation (SpO2) of the test subject.
(62) As described above, in the measuring device **100**, the control device **5** functions as an information analysis section that identifies biological information from detection signals S indicating detection results by the detecting device **3**. The control device **5** causes the display device **4** to display biological information identified from detection signals S. Note that it is also possible to notify a user of a measurement result by sound output. A configuration in which a user is notified of a warning (possibility of impairment in a bodily function) when the pulse rate or oxygen saturation fluctuates to a numerical value outside a predetermined range is also suitable.
(63) As illustrated in FIG. **6**, the width of the first light-receiving section **51** in the direction along the X-axis is smaller than the width of the second light-receiving section **61** in the direction along the X-axis. In the case of the detecting device **3** according to the present embodiment, the area of the first light-receiving section **51** is smaller than the area of the second light-receiving section **61**. Here, the areas of the first light-receiving section **51** and the second light-receiving section **61** mean plane areas when viewed in plan view from the +Z side. In the case of the present embodiment, the area of the first light-receiving section **51** is set to a size corresponding to a light incident region **7** in which the green light transmitted through the living body is concentrated as illustrated in the simulation result in FIG. **3**. For the detecting device **3** according to the present embodiment, a configuration is employed in which the size of the first light-receiving section **51** that receives the green light LG is smaller than the size of traditional, commonly used light-receiving sections. In the case of the present embodiment, the size of the first light-receiving section **51** is approximately half the size of traditional, commonly used light-receiving sections. Note that the unit price of a light-receiving section depends on the area. Therefore, in the present embodiment, downsizing the first light-receiving section **51** can reduce cost.
(64) According to the light-receiving unit section **12** of the present embodiment, even when the first light-receiving section **51** is downsized, the green light LG that passed through the living body can be received at a sufficient amount of light. Thus, in the detecting device **3** according to the present embodiment, since there is no need to increase current consumption of the first light-emitting section **50** in order to increase the light emission amount of the green light LG, power consumption of the light-emitting unit section **11** can be reduced.
(65) Furthermore, in the detecting device **3** according to the present embodiment, a portion of the second light-receiving section **61** that receives the red light LR or the near-infrared light LI is provided so as to overlap a portion of the space made by downsizing the first light-receiving section **51** that receives the green light LG. In other words, for the detecting device **3** according to the present embodiment, a configuration is employed in which the second light-receiving section **61** is disposed in a space made by downsizing of the first light-receiving section **51**, whereby the second light-receiving section **61** is disposed closer to the light-emitting unit section **11** side. Thus, in the detecting device **3** according to the present embodiment, since the light-receiving unit section **12** including the first light-receiving section **51** and the second light-receiving section **61** decreases in size, the device configuration can be downsized.
(66) Furthermore, for the detecting device **3** according to the present embodiment, a configuration is employed in which the second light-receiving section **61** that receives the red light LR or the near-infrared light LI is disposed at a position away from the second light-emitting section **60** or the third light-emitting section **70**. In the detecting device **3** according to the present embodiment, the distance between the second light-emitting section **60** or the third light-emitting section **70** and the second light-receiving section **61** (distance D**2** or distance D**3**) is greater than the distance D**1** between the first light-emitting section **50** and the first light-receiving section **51**.

(67) In other words, the distance that the red light LR and the near-infrared light LI propagate in the living body before being incident on the second light-receiving section **61** is greater than the distance that the green light LG propagates in the living body before being incident on the first light-receiving section **51**.
(68) As shown in FIG. **5**, with the red light LR or the near-infrared light LI, the longer the propagation distance in the living body is, the more the component that is reflected at the surface layer portion of the living body and thus does not pass through the blood, that is, a noise component in identifying blood oxygen concentration decreases. With the noise component suppressed from being incident, the second light-receiving section **61** of the present embodiment can obtain a high signal/noise (S/N) ratio. Thus, in the detecting device **3** according to the present embodiment, the red light LR or the near-infrared light LI can be received with high accuracy at the second light-receiving section **61**.
(69) On the other hand, when the propagation distance in the living body of the red light LR or the near-infrared light LI is too long, it becomes necessary to increase the light emission amount of the second light-emitting section **60** or the third light-emitting section **70**. In the case of the present embodiment, the second light-receiving section **61** is installed in the space made by downsizing of the first light-receiving section **51**, and the second light-receiving section **61** is brought to the light-emitting unit section **11** side; whereby the second light-receiving section **61**, the second light-emitting section **60**, and the third light-emitting section **70** are each disposed in a suitable position. As a result, power consumption of the second light-emitting section **60** or the third light-emitting section **70** can be restrained and power consumption of the light-emitting unit section **11** can be suppressed while maintaining the light receiving accuracy for the red light LR and the near-infrared light LI.
(70) As illustrated in FIG. **4**, the first light-receiving section **51** includes a light-receiving element (first sensor section) **120**, an angle-limiting filter (first angle-limiting filter) **121**, and a band-pass filter **122**. The first light-receiving section **51** of the present embodiment includes a single light-receiving element **120**.
(71) The light-receiving element **120** is constituted by, for example, a photodiode (PD). The angle-limiting filter **121** is provided so as to cover the entire light-receiving surface **120***a* of the light-receiving element **120**. The angle-limiting filter **121** is formed, for example, by embedding a plug **1212** formed of a material having light-shielding properties such as tungsten in a silicon oxide layer **1211** having optical transparency.
(72) The silicon oxide layer **1211** forms an optical path that guides light to the light-receiving surface **120***a* of the light-receiving element **120**. The plug **1212** embedded in the silicon oxide layer **1211** limits the incident angle of light passing through the optical path (the silicon oxide layer **1211**). That is, when the light incident into the silicon oxide layer **1211** is tilted relative to the optical path by a predetermined angle or more, the incident light impinges on the plug **1212**, causing a portion of that light to be absorbed by the plug **1212** and the remainder to be reflected. Further, since the intensity of the reflected light grows weak through repeated reflections before passing through the optical path, light that can ultimately pass through the angle-limiting filter **121** is substantially limited to light that is tilted relative to the light path by a predetermined limit angle or less.
(73) The angle-limiting filter **121** has a characteristic of transmitting light incident at an angle smaller than a predetermined incident angle, and cutting, rather than transmitting, light incident at an angle greater than a predetermined incident angle. As a result, the angle-limiting filter **121** is capable of limiting the incident angle of light incident on the light-receiving element **120**. Specifically, the angle-limiting filter **121** transmits light that propagates in the living body and thus is incident at a predetermined incident angle (hereinafter referred to as the permissible incident angle), and cuts light that is incident at an angle greater than the permissible incident angle, including outside light such as sunlight and light that was not incident on the living body.

(74) The band-pass filter **122** has a characteristic of selectively transmitting a wavelength band of the green light LG, and absorbing and thereby cutting the red light LR and the near-infrared light LI, which fall under light in the other wavelength bands. The band-pass filter **122** is formed, for example, by alternately stacking a plurality of low refractive index layers such as silicon oxide and a plurality of high refractive index layers such as titanium oxide on the angle-limiting filter **121**.
(75) Furthermore, the second light-receiving section **61** includes a light-receiving element (second sensor section) **220** that receives the red light LR or the near-infrared light LI, and an angle-limiting filter (second angle-limiting filter) **221** that limits the incident angle of the red light LR or the near-infrared light LI reaching the light-receiving element **220**. That is, in the detecting device **3** according to the present embodiment, the second light-receiving section **61** has a configuration different from that of the first light-receiving section **51** in that the second light-receiving section **61** include no band-pass filter that selectively transmits the red light LR or the near-infrared light LI.
(76) The light-receiving element **220** is constituted, for example, by a photodiode. The angle-limiting filter **221** is provided on the light-receiving surface **220***a* of the light-receiving element **220**. The angle-limiting filter **221** has a configuration similar to that of the angle-limiting filter **121**. The angle-limiting filter **221** is capable of limiting the incident angle of the red light LR or the near-infrared light LI reaching the light-receiving element **220**. For example, the angle-limiting filter **221** transmits the red light LR or the near-infrared light LI that propagates in the living body and is incident at a permissible incident angle, and cuts light that is incident at an angle greater than the permissible incident angle, including outside light such as sunlight and the red light LR or the near-infrared light LI that did not pass through the living body.
(77) Here, a portion of the red light LR and the near-infrared light LI emitted from the second light-emitting section **60** sometimes passes through the living body and is incident on the light-receiving section **51**. In the case of the present embodiment, the first light-receiving section **51** includes a band-pass filter **122** that selectively transmits the green light LG. For this reason, the first light-receiving section **51** can cut the red light LR and the near-infrared light LI, each of which have a wavelength band different from that of the green light LG. Thus, the first light-receiving section **51** can efficiently receive the green light LG emitted from the light-emitting section **50**.
(78) FIG. **7** is a view for explaining an operation of the detecting device **3**.
(79) As illustrated in FIG. **7**, in the detecting device **3** according to the present embodiment, a portion of the green light LG emitted from the first light-emitting section **50** is reflected by the surface of the living body (measurement site M) and thus is sometimes directly incident on the first light-receiving section **51** without passing through the living body. Furthermore, outside light such as sunlight is sometimes directly incident on the first light-receiving section **51** by passing through the gap between the living body and the detection surface **16**. Hereinafter, the green light LG heading to the first light-receiving section **51** without passing through the living body is referred to as the “first stray light component SL**1**”. Outside light directly heading to the first light-receiving section **51** is referred to as the “second stray light component SL**2**”.
(80) Since it has a green wavelength band, the first stray light component SL**1** passes through the band-pass filter **122** and is incident on the angle-limiting filter **121** provided at a lower layer of the band-pass filter **122**. As described above, the angle-limiting filter **121** has a characteristic of transmitting light incident at an angle smaller than the permissible incident angle, and cutting light incident at an angle greater than the permissible incident angle.
(81) Since the first stray light component SL**1** is incident on the first light-receiving section **51** without passing through the living body, the incident angle of the green light LG relative to the first light-receiving section **51** is greater than the permissible incident angle of the angle-limiting filter **121**. In other words, the first stray light component SL**1** is cut by the angle-limiting filter **121**. As a result, the first light-receiving section **51** can suppress the first stray light component SL**1** from being incident on the light-receiving surface **120***a* of the light-receiving element **120** by the angle-

limiting filter **121**.

(82) The second stray light component SL**2** is generally cut by the band-pass filter **122**. However, the component having a green wavelength band contained in the second stray light component SL**2** is transmitted through the band-pass filter **122**. Here, as described above, since the second stray light component SL**2** is incident by passing through the gap between the living body and the detection surface **16**, the incident angle of the second stray light component SL**2** relative to the first light-receiving section **51** is greater than the permissible incident angle of the angle-limiting filter **121**. Therefore, a portion of the second stray light component SL**2** transmitted through the band-pass filter **122** (the component having a green wavelength band) is cut by the angle-limiting filter **121**. As a result, the first light-receiving section **51** can suppress the second stray light component SL**2** from being incident on the light-receiving surface **120***a* of the light-receiving element **120** by the angle-limiting filter **121**.

(83) In this way, in the detecting device **3** according to the present embodiment, it is possible to cause the green light LG emitted from the light-emitting unit section **11** and passed through the living body to be efficiently incident on the light-receiving surface **120***a* of the light-receiving element **120**. Furthermore, in the detecting device **3** according to the present embodiment, it can be made difficult for the first stray light component SL**1** and the second stray light component SL**2** to be incident on the light-receiving surface **120***a* of the light-receiving element **120**.

(84) Thus, with the first stray light component SL**1** and the second stray light component SL**2** that represent noise components suppressed from being incident, the first light-receiving section **51** can obtain a high S/N ratio. Therefore, in the detecting device **3** according to the present embodiment, since the green light LG can be received with high accuracy at the first light-receiving section **51**, the light emission amount of the green light LG at the first light-emitting section **50** can be restrained to suppress power consumption of the light-emitting unit section **11**.

(85) Furthermore, a portion of the red light LR emitted from the second light-emitting section **60** or a portion of the near-infrared light LI emitted from the third light-emitting section **70** is sometimes directly incident on the second light-receiving section **61** without passing through the living body.

(86) Furthermore, outside light such as sunlight is sometimes directly incident on the second light-receiving section **61** by passing through the gap between the living body and the detection surface **16**. Hereinafter, the red light LR or the near-infrared light LI heading directly to the second light-receiving section **61** without passing through the living body is collectively referred to as the "third stray light component SL**3**". Outside light heading directly to the second light-receiving section **61** is referred to as the "fourth stray light component SL**4**".

(87) Since the third stray light component SL**3** is incident on the angle-limiting filter **221** without passing through the living body, the incident angle of the third stray light component SL**3** relative to the second light-receiving section **61** is greater than the permissible incident angle of the angle-limiting filter **221**. Furthermore, since the fourth stray light component SL**4** is incident by passing through the gap between the living body and the detection surface **16**, the incident angle of the fourth stray light component SL**4** relative to the second light-receiving section **61** is greater than the permissible incident angle of the angle-limiting filter **221**.

(88) Therefore, the third stray light component SL**3** and the fourth stray light component SL**4** are successfully cut by the angle-limiting filter **221**. As a result, the second light-receiving section **61** can suppress the third stray light component SL**3** and the fourth stray light component SL**4** from being incident on the light-receiving surface **220***a* of the light-receiving element **120** by the angle-limiting filter **221**.

(89) In this way, in the detecting device **3** according to the present embodiment, it is possible to cause the red light LR or the near-infrared light LI emitted from the light-emitting unit section **11** and passed through the living body to be efficiently incident on the light-receiving surface **220***a* of the light-receiving element **220**. Furthermore, in the detecting device **3** according to the present embodiment, it can be made difficult for the third stray light component SL**3** and the fourth stray

light component SL**4** to be incident on the light-receiving surface **220***a* of the light-receiving element **220**.
(90) Thus, with the third stray light component SL**3** and the fourth stray light component SL**4** that represent noise components suppressed from being incident, the second light-receiving section **61** can obtain a high S/N ratio. According to the detecting device **3** according to the present embodiment, since the red light LR and the near-infrared light LI are efficiently received at the second light-receiving section **61**, the light emission amount of each of the second light-emitting section **60** and the third light-emitting section **70** can be restrained to suppress power consumption of the light-emitting unit section **11**.
(91) Furthermore, in the case of the present embodiment, only the red light LR and the near-infrared light LI are incident on the second light-receiving section **61**. Therefore, no band-pass filter that selectively transmits the red light LR and the near-infrared light LI and cuts the green light LG is provided at the second light-receiving section **61**. That is, for the detecting device **3** according to the present embodiment, a configuration may be employed in which only the first light-receiving section **51** includes the band-pass filter **122** and the second light-receiving section **61** includes no band-pass filter. Thus, in the detecting device **3** according to the present embodiment, the band-pass filter for the second light-receiving section **61** can be omitted to reduce cost.
(92) According to the detecting device **3** according to the present embodiment, even when the light emission amount of each of the light-emitting sections **50**, **60**, and **70** is restrained to reduce power consumption, light passed through the living body can be received with high accuracy at the light-receiving unit section **12**. Furthermore, in the detecting device **3** according to the present embodiment, the band-pass filter in the second light-receiving section **61** can be omitted to reduce cost.
(93) As described above, the detecting device **3** according to the present embodiment includes: the first light-emitting section **50** configured to emit the green light LG; the second light-emitting section **60** configured to emit the red light LR having a wavelength band higher than that of the green light LG; the third light-emitting section **70** configured to emit the near-infrared light LI having a wavelength band higher than that of the green light LG; the first light-receiving section **51** configured to receive the green light LG emitted from the first light-emitting section **50** and emitted from the measurement site M; and the second light-receiving section **61** configured to receive the red light LR or the near-infrared light LI emitted from the second light-emitting section **60** or the third light-emitting section **70** and emitted from the measurement site M. In the direction along the X-axis, the first light-receiving section **51** is disposed closer to the first light-emitting section **50** than the second light-receiving section **61**. The area of the first light-receiving section **51** is smaller than the area of the second light-receiving section **61**. The first light-receiving section **51** includes a single light-receiving element **120**. The width of the first light-receiving section **51** in the direction along the X-axis is smaller than the width of the second light-receiving section **61** in the direction along the X-axis.
(94) The detecting device **3** according to the present embodiment includes the first light-receiving section **51** having a size corresponding to the light incident region **7** on which the green light LG transmitted through the living body is incident in a concentrated manner. The size of the first light-receiving section **51** is smaller than the size of traditional, commonly used light-receiving sections. The second light-receiving section **61** is disposed so that a portion thereof overlaps a portion of the space made by downsizing the first light-receiving section **51**. Therefore, the second light-receiving section **61** and the light-emitting unit section **11** are disposed closer to each other. Thus, according to the detecting device **3** according to the present embodiment, since the light-receiving unit section **12** including the first light-receiving section **51** and the second light-receiving section **61** can be decreased in size, the device configuration can be downsized. Thus, a small detecting device **3** capable of acquiring both the pulse peak interval and oxygen saturation is provided. Furthermore,

downsizing the first light-receiving section **51** can reduce cost.
(95) The detecting device **3** according to the present embodiment further includes the flat plate-shaped light-shielding wall **41** provided between the first light-emitting section **50** and the first light-receiving section **51** and configured to block at least a portion of the green light LG.
(96) According to the detecting device **3** according to the present embodiment, since the flat plate-shaped light-shielding wall **41** is included, the device configuration can be downsized in the width direction of the light-shielding wall **41**, that is, in the direction along the X-axis.
Second Embodiment
(97) Next, a second embodiment will be described. For the first embodiment, an example is given of a case in which the first light-receiving section **51** is constituted by a single light-receiving element. However, a detecting device according to the present embodiment differs from that of the first embodiment in that the first light-receiving section is constituted by two light-receiving elements.
(98) FIG. **8** is a cross-sectional view of a detecting device according to the present embodiment. FIG. **8** is a view illustrating a configuration corresponding to FIG. **3** in the first embodiment. Note that configurations and members common to the first embodiment will be given an identical reference numeral and detailed description thereof will be omitted. Note that in FIG. **8**, for convenience of explanation, light incident regions **7***a* and **7***b* in which the green light LG transmitted through the living body is concentrated are illustrated on the −Z side of a detecting device **103**.
(99) As illustrated in FIG. **8**, a light-receiving unit **112** in the detecting device **103** according to the present embodiment includes a first light-receiving section **151** and the second light-receiving section **61**. The first light-receiving section **151** of the present embodiment includes a first light-receiving portion **1511** and a second light-receiving portion **1512**. The first light-receiving portion **1511** and the second light-receiving portion **1512** are disposed sandwiching the first light-emitting section **50** in the direction along the X-axis.
(100) In the case of the present embodiment, the first light-receiving portion **1511** is provided on the +X side of the first light-emitting section **50**, while the second light-receiving portion **1512** is provided on the −X side of the first light-emitting section **50**. The first light-receiving portion **1511** and the second light-receiving portion **1512** each have a configuration similar to that of the first light-receiving section **51** of the first embodiment, and differ only in size. The first light-receiving portion **1511** and the second light-receiving portion **1512** have the same area. The first light-receiving portion **1511** and the second light-receiving portion **1512** each have an area obtained by dividing the first light-receiving section **51** of the first embodiment in half. Therefore, in the present embodiment, the total area of the first light-receiving portion **1511** and the second light-receiving portion **1512** is smaller than the area of the second light-receiving section **61**.
(101) Here, since the first light-receiving portion **1511** and the second light-receiving portion **1512** each have a half area of the first light-receiving section **51**, the unit prices of the first light-receiving portion **1511** and the second light-receiving portion **1512** are lower than that of the first light-receiving section **51**. Therefore, according to the present embodiment, the first light-receiving section **151** can be configured using the first light-receiving portion **1511** and the second light-receiving portion **1512** that have low unit prices to suppress the cost of the detecting device **103**.
(102) The detecting device **103** according to the present embodiment further includes a first light-shielding wall **141** and a second light-shielding wall **142**.
(103) The first light-shielding wall **141** is disposed between the light-emitting unit section **11** and the first light-receiving portion **1511** in the direction along the X-axis. The first light-shielding wall **141** is a flat plate-shaped member protruding from the bottom surface portion **40***a* to the +Z side and extending in the Y-axis direction. The first light-shielding wall **141** is a member having light-shielding properties for shielding light so as to prevent light emitted from the light-emitting unit section **11** from being directly incident on the first light-receiving portion **1511** or the second light-

receiving section **61**.

(104) The second light-shielding wall **142** is disposed between the light-emitting unit section **11** and the second light-receiving portion **1512** in the direction along the X-axis. The second light-shielding wall **142** is a flat plate-shaped member protruding from the bottom surface portion **40***a* to the +Z side and extending in the Y-axis direction. The second light-shielding wall **142** is a member having light-shielding properties for shielding light so as to prevent light emitted from the light-emitting unit section **11** from being directly incident on the second light-receiving portion **1512**.

(105) The detecting device **103** according to the present embodiment includes the first light-shielding wall **141** and the second light-shielding wall **142**, thereby dividing the housing space inside the case **40** into three in the X-axis direction.

(106) The first light-receiving portion **1511** is provided at a position corresponding to the light incident region **7***a* formed on the +X side of the first light-emitting section **50** by the green light LG emitted from the first light-emitting section **50** and transmitted through the living body. The first light-receiving portion **1511** has a half area of the light-receiving section **51** of the first embodiment. In other words, the first light-receiving portion **1511** is capable of receiving substantially half of the amount of light incident on the light incident region **7***a* on the +X side of the first light-emitting section **50**.

(107) In the case of the present embodiment, the second light-receiving section **61** is moved to the −X side by as much as the first light-receiving portion **1511** is shrunk in width in the X direction, whereby increase in dimension in the X direction is restrained.

(108) Here, the green light LG is emitted from the first light-emitting section **50** radially in various directions. Therefore, the green light LG transmitted through the living body is also concentrated on the −X side of the first light-emitting section **50** to form another light incident region **7***b*.

(109) The second light-receiving portion **1512** is provided at a position corresponding to the light incident region **7***b* formed on the −X side of the first light-emitting section **50** by the green light LG emitted from the first light-emitting section **50** and transmitted through the living body. Similar to the first light-receiving portion **1511**, the second light-receiving portion **1512** has a half area of the light-receiving section **51** of the first embodiment. In other words, the second light-receiving portion **1512** is capable of receiving substantially half of the amount of light incident on the light incident region **7***b* on the −X side of the first light-emitting section **50**.

(110) The total amount of light received at the first light-receiving portion **1511** and the second light-receiving portion **1512** is equal to the amount of light received at the light-receiving section **51** of the first embodiment. Therefore, according to the detecting device **103** according to the present embodiment, similar to the first embodiment, the green light LG can be efficiently received, and the device configuration can be downsized while cost is reduced.

Third Embodiment

(111) Next, a third embodiment will be described. The detecting device according to the present embodiment differs from that of the other embodiments in that the first light-receiving section is constituted by four light-receiving elements.

(112) FIG. **9** is a cross-sectional view of a detecting device according to the present embodiment. FIG. **9** is a view illustrating a configuration corresponding to FIG. **3** in the first embodiment. Note that configurations and members common to the first embodiment will be given an identical reference numeral and detailed description thereof will be omitted.

(113) As illustrated in FIG. **9**, a light-receiving unit **212** in the detecting device **203** according to the present embodiment includes a first light-receiving section **251** and the second light-receiving section **61**. The first light-receiving section **251** of the present embodiment includes a first light-receiving portion **2511**, a second light-receiving portion **2512**, a third light-receiving portion **2513**, and a fourth light-receiving portion **2514**.

(114) The first light-receiving portion **2511** and the second light-receiving portion **2512** are disposed sandwiching the first light-emitting section **50** in the direction along the X-axis, while the

third light-receiving portion **2513** and the fourth light-receiving portion **2514** are disposed sandwiching the first light-emitting section **50** in the direction along the Y-axis.
(115) In the case of the present embodiment, the first light-receiving portion **2511** is provided on the +X side of the first light-emitting section **50**, while the second light-receiving portion **2512** is provided on the −X side of the first light-emitting section **50**. The third light-receiving portion **2513** is provided on the +Y side of the first light-emitting section **50**, while the fourth light-receiving portion **2514** is provided on the −Y side of the first light-emitting section **50**.
(116) The first light-receiving portion **2511**, the second light-receiving portion **2512**, the third light-receiving portion **2513**, and the fourth light-receiving portion **2514** each have a configuration similar to that of the light-receiving section **51** of the first embodiment, and differ only in size. Each of the light-receiving portions **2511** to **2514** has the same area. Each of the light-receiving portions **2511** to **2514** has an area obtained by dividing the first light-receiving section **51** of the first embodiment into four. Therefore, in the present embodiment, the total area of each of the light-receiving portions **2511** to **2514** is smaller than the area of the second light-receiving section **61**. With the detecting device **203** according to the present embodiment, the first light-receiving section **251** is constituted using the light-receiving portions **2511** to **2514** that have low unit prices to reduce cost.
(117) The detecting device **203** according to the present embodiment further includes a first light-shielding wall **241**, a second light-shielding wall **242**, a third light-shielding wall **243**, and a fourth light-shielding wall **244**.
(118) The first light-shielding wall **241** is disposed between the light-emitting unit section **11** and the first light-receiving portion **2511** in the direction along the X-axis. The first light-shielding wall **241** is a flat plate-shaped member protruding from the bottom surface portion **40***a* to the +Z side and extending in the Y-axis direction. The first light-shielding wall **241** is a member having light-shielding properties for shielding light so as to prevent light emitted from the light-emitting unit section **11** from being directly incident on the first light-receiving portion **2511** or the second light-receiving section **61**.
(119) The second light-shielding wall **242** is disposed between the light-emitting unit section **11** and the second light-receiving portion **2512** in the direction along the X-axis. The second light-shielding wall **242** is a flat plate-shaped member protruding from the bottom surface portion **40***a* to the +Z side and extending in the Y-axis direction. The second light-shielding wall **242** is a member having light-shielding properties for shielding light so as to prevent light emitted from the light-emitting unit section **11** from being directly incident on the second light-receiving portion **2512**.
(120) The third light-shielding wall **243** is disposed between the first light-emitting section **50** and the third light-receiving portion **2513** in the direction along the Y-axis. The third light-shielding wall **243** is a flat plate-shaped member protruding from the bottom surface portion **40***a* to the +Z side and extending in the X-axis direction. The third light-shielding wall **243** is provided so as to couple the first light-shielding wall **241** and the second light-shielding wall **242**. The third light-shielding wall **243** is a member having light-shielding properties for shielding light so as to prevent light emitted from the first light-emitting section **50** from being directly incident on the third light-receiving portion **2513**.
(121) In the case of the present embodiment, the third light-receiving portion **2513** is provided between the third light-shielding wall **243** and the second light-emitting section **60** in the direction along the Y-axis.
(122) The fourth light-shielding wall **244** is disposed between the first light-emitting section **50** and the fourth light-receiving portion **2514** in the direction along the Y-axis. The fourth light-shielding wall **244** is a flat plate-shaped member protruding from the bottom surface portion **40***a* to the +Z side and extending in the X-axis direction. The fourth light-shielding wall **244** is provided so as to couple the first light-shielding wall **241** and the second light-shielding wall **242**. The fourth light-shielding wall **244** is a member having light-shielding properties for shielding light so as to prevent

light emitted from the first light-emitting section **50** from being directly incident on the fourth light-receiving portion **2514**.

(123) In the case of the present embodiment, the fourth light-receiving portion **2514** is provided between the fourth light-shielding wall **244** and the third light-emitting section **70** in the direction along the Y-axis.

(124) The detecting device **203** according to the present embodiment includes the first light-shielding wall **241**, the second light-shielding wall **242**, the third light-shielding wall **243**, and the fourth light-shielding wall **244**, thereby dividing the housing space inside the case **40** into five.

(125) The first light-receiving portion **2511** is provided to correspond to a light incident region on the +X side of the first light-emitting section **50** in which the green light LG emitted from the first light-emitting section **50** and transmitted through the living body is concentrated. The first light-receiving portion **2511** has one fourth of the area of the light-receiving section **51** of the first embodiment. In other words, the first light-receiving portion **2511** is capable of receiving substantially one fourth of the amount of light incident on the light incident region on the +X side of the first light-emitting section **50**.

(126) In the case of the present embodiment, the second light-receiving section **61** is moved to the −X side by as much as the first light-receiving portion **2511** is shrunk in width in the X direction, whereby increase in dimension in the X direction is restrained.

(127) Note that the green light LG transmitted through the living body is also similarly concentrated on the −X side, the +Y side, and the −Y side of the first light-emitting section **50** to form respective light incident regions.

(128) The second light-receiving portion **2512** is provided to correspond to a light incident region on the −X side of the first light-emitting section **50** formed by the green light LG emitted from the first light-emitting section **50** and transmitted through the living body. Similar to the first light-receiving portion **2511**, the second light-receiving portion **2512** has one fourth of the area of the light-receiving section **51** of the first embodiment. In other words, the second light-receiving portion **2512** is capable of receiving substantially one fourth of the amount of light incident on the light incident region on the −X side of the first light-emitting section **50**.

(129) The third light-receiving portion **2513** is provided to correspond to a light incident region on the +Y side of the first light-emitting section **50** formed by the green light LG emitted from the first light-emitting section **50** and transmitted through the living body. The third light-receiving portion **2513** is capable of receiving substantially one fourth of the amount of light incident on the light incident region on the +Y side of the first light-emitting section **50**.

(130) The fourth light-receiving portion **2514** is provided to correspond to a light incident region on the −Y side of the first light-emitting section **50** formed by the green light LG emitted from the first light-emitting section **50** and transmitted through the living body. The fourth light-receiving portion **2514** is capable of receiving substantially one fourth of the amount of light incident on the light incident region on the −Y side of the first light-emitting section **50**.

(131) The total amount of light received at each of the light-receiving portions **2511** to **2514** is equal to the amount of light received by the light-receiving section **51** of the first embodiment. Therefore, according to the detecting device **203** according to the present embodiment, similar to the first embodiment, the green light LG can be efficiently received, and the device configuration can be downsized while cost is reduced.

(132) Thus far, the present disclosure has been described based on the embodiments described above. However, the present disclosure is not limited to the above-described embodiments, and can be carried out in various aspects without departing from the spirit and scope of the present disclosure.

(133) For example, in the above-described embodiments, a human is used as an example of a living body. However, the present disclosure is also applicable to measurement of biological information (e.g., pulse) of other animals.

(134) Furthermore, for the above-described embodiments, an example is given of a case in which the first light-receiving section is constituted by two or four light-receiving elements. However, the number of light-receiving elements constituting the first light-receiving section is not limited to these. For example, the first light-receiving section may be constituted by three, five, or more light-receiving elements.
(135) Furthermore, for the measuring device **100** according to the above-described embodiments, an example is given of a case in which the detecting device **3** is provided in the housing section **1**. However, the installation location of the detecting device **3** is not limited to this. For example, the detecting device **3** may be embedded in the belt **2**.
(136) Furthermore, for the measuring device **100** according to the above-described embodiments, a wristwatch-type configuration is given as an example. However, the present disclosure is also applicable, for example, to a configuration in which a necklace-type measuring device **100** is mounted around the neck of the test subject, a configuration in which a seal-type measuring device **100** is attached to the body of the test subject, or a configuration in which a head-mounted display-type measuring device **100** is mounted on the head of the test subject.
(137) Furthermore, for the above-described embodiments, an example is given of a case in which the band-pass filter **122** is provided only for the first light-receiving section **51**. However, a band-pass filter that selectively transmits the red light LR or the near-infrared light LI may also be provided for the second light-receiving section **61**.
(138) Furthermore, for the detecting devices **3** and **103** according to the above-described embodiments, an example is given of a case in which each of the light-emitting sections **50**, **60**, and **70** is caused to emit light in time division. However, since the detecting devices **3** and **103** separately include the first light-receiving sections **51** and **151** corresponding to the green light LG of the light-emitting section **50**, respectively, the light-emitting section **50** may be turned on constantly rather than in time division.
(139) A detecting device according to one aspect of the present disclosure may have the following configuration.
(140) A detecting device according to one aspect of the present disclosure includes: a first light-emitting section configured to emit first light having a green wavelength band; a second light-emitting section configured to emit second light having a wavelength band longer than the green wavelength band; a first light-receiving section configured to receive the first light emitted from the first light-emitting section and emitted from a living body; and a second light-receiving section configured to receive the second light emitted from the second light-emitting section and emitted from the living body; when a direction in which the first light-emitting section and the second light-emitting section are aligned is a first direction and a direction intersecting the first direction is a second direction, in the second direction, at least a portion of the first light-receiving section being disposed closer to the first light-emitting section than the second light-receiving section and an area of the first light-receiving section being smaller than an area of the second light-receiving section.
(141) The detecting device according to one aspect of the present disclosure may have a configuration in which the first light-receiving section includes a band-pass filter configured to selectively transmit the first light.
(142) The detecting device according to one aspect of the present disclosure may have a configuration in which the first light-receiving section includes a first sensor section configured to receive the first light and a first angle-limiting filter configured to limit an incident angle of the first light reaching the first sensor section and the second light-receiving section includes a second sensor section configured to receive the second light and a second angle-limiting filter configured to limit an incident angle of the second light reaching the second sensor section.
(143) The detecting device according to one aspect of the present disclosure may have a configuration in which the detecting device further includes a flat plate-shaped light-shielding wall

provided between the first light-emitting section and the first light-receiving section and configured to block at least a portion of the first light.

(144) The detecting device according to one aspect of the present disclosure may have a configuration in which the first light-receiving section includes a single light-receiving element and a width of the first light-receiving section in the second direction is smaller than a width of the second light-receiving section in the second direction.

(145) The detecting device according to one aspect of the present disclosure may have a configuration in which the first light-receiving section includes a first light-receiving portion and a second light-receiving portion and the first light-receiving portion and the second light-receiving portion are disposed sandwiching the first light-emitting section in the second direction.

(146) The detecting device according to one aspect of the present disclosure may have a configuration in which a total area of the first light-receiving portion and the second light-receiving portion is smaller than an area of the second light-receiving section.

(147) The detecting device according to one aspect of the present disclosure may have a configuration in which the first light-receiving section includes a first light-receiving portion, a second light-receiving portion, a third light-receiving portion, and a fourth light-receiving portion, the first light-receiving portion and the second light-receiving portion are disposed sandwiching the first light-emitting section in the second direction, the third light-receiving portion and the fourth light-receiving portion are disposed sandwiching the first light-emitting section in the first direction, a flat plate-shaped first light-shielding wall is provided between the first light-emitting section and the first light-receiving portion, the flat plate-shaped first light-shielding wall being configured to block at least a portion of the first light, a flat plate-shaped second light-shielding wall is provided between the first light-emitting section and the second light-receiving portion, the flat plate-shaped second light-shielding wall being configured to block at least a portion of the first light, a flat plate-shaped third light-shielding wall is provided between the first light-emitting section and the third light-receiving portion, the flat plate-shaped third light-shielding wall being configured to block at least a portion of the first light, and a flat plate-shaped fourth light-shielding wall is provided between the first light-emitting section and the fourth light-receiving portion, the flat plate-shaped fourth light-shielding wall being configured to block at least a portion of the first light.

(148) The detecting device according to one aspect of the present disclosure may have a configuration in which a total area of the first light-receiving portion, the second light-receiving portion, the third light-receiving portion, and the fourth light-receiving portion is smaller than an area of the second light-receiving section.

(149) The detecting device according to one aspect of the present disclosure may have a configuration in which the detecting device further includes: a third light-emitting section configured to emit third light; wherein the third light emitted from the third light-emitting section and emitted from the living body is received by the second light-receiving section, the third light-receiving portion is provided between the third light-shielding wall and the second light-emitting section in the first direction, and the fourth light-receiving portion is provided between the fourth light-shielding wall and the third light-emitting section in the first direction.

(150) A measuring device according to one aspect of the present disclosure may have the following configuration.

(151) A measuring device according to one aspect of the present disclosure includes a detecting device according to any one of the above-described aspects; and an information analysis section configured to identify biological information from a detection signal indicating a detection result by the detecting device.

Claims

1. A detecting device comprising: a first light-emitting section configured to emit first light having a green wavelength band; a second light-emitting section configured to emit second light having a wavelength band longer than the green wavelength band; a first light-receiving section configured to receive the first light emitted from the first light-emitting section and emitted from a living body; and a second light-receiving section configured to receive the second light emitted from the second light-emitting section and emitted from the living body, wherein when a direction in which the first light-emitting section and the second light-emitting section are aligned is a first direction and a direction intersecting the first direction is a second direction, in the second direction, at least a portion of the first light-receiving section is disposed closer to the first light-emitting section than the second light-receiving section, a width of the first light-receiving section in the second direction is smaller than a width of the second light-receiving section in the second direction, a length of the first light-receiving section in the first direction is same as a length of the second light-receiving section in the first direction, and an area of the first light-receiving section is smaller than an area of the second light-receiving section.
2. The detecting device according to claim 1, wherein the first light-receiving section includes a band-pass filter configured to selectively transmit the first light.
3. The detecting device according to claim 1, wherein the first light-receiving section includes a first sensor section configured to receive the first light and a first angle-limiting filter configured to limit an incident angle of the first light reaching the first sensor section, and the second light-receiving section includes a second sensor section configured to receive the second light and a second angle-limiting filter configured to limit an incident angle of the second light reaching the second sensor section.
4. The detecting device according to claim 1, further comprising a flat plate-shaped light-shielding wall provided between the first light-emitting section and the first light-receiving section and configured to block at least a portion of the first light.
5. The detecting device according to claim 1, wherein the first light-receiving section includes a single light-receiving element, and the area of the first light-receiving section is substantially half of the area of the second light-receiving section.
6. The detecting device according to claim 1, wherein the first light-receiving section includes a first light-receiving portion and a second light-receiving portion, the first light-receiving portion and the second light-receiving portion are disposed sandwiching the first light-emitting section in the second direction, a sum of a width of the first light-receiving portion and a width of the second light-receiving portion in the second direction is the width of the first light-receiving section in the second direction, and a length of the first light-receiving portion in the first direction, a length of the second light-receiving portion in the first direction are the same as the length of the second light-receiving section in the first direction.
7. A detecting device comprising: a first light-emitting section configured to emit first light having a green wavelength band; a second light-emitting section configured to emit second light having a wavelength band longer than the green wavelength band; a first light-receiving section configured to receive the first light emitted from the first light-emitting section and emitted from a living body; and a second light-receiving section configured to receive the second light emitted from the second light-emitting section and emitted from the living body, wherein when a direction in which the first light-emitting section and the second light-emitting section are aligned is a first direction and a direction intersecting the first direction is a second direction, in the second direction, at least a portion of the first light-receiving section is disposed closer to the first light-emitting section than the second light-receiving section, an area of the first light-receiving section is smaller than an area of the second light-receiving section, and the first light-receiving section includes a first light-receiving portion and a second light-receiving portion, and the first light-receiving portion and the second light-receiving portion are disposed sandwiching the first light-emitting section in the

second direction, wherein a total area of the first light-receiving portion and the second light-receiving portion is smaller than an area of the second light-receiving section.

8. A detecting device comprising: a first light-emitting section configured to emit first light having a green wavelength band; a second light-emitting section configured to emit second light having a wavelength band longer than the green wavelength band; a first light-receiving section configured to receive the first light emitted from the first light-emitting section and emitted from a living body; and a second light-receiving section configured to receive the second light emitted from the second light-emitting section and emitted from the living body, wherein when a direction in which the first light-emitting section and the second light-emitting section are aligned is a first direction and a direction intersecting the first direction is a second direction, in the second direction, at least a portion of the first light-receiving section is disposed closer to the first light-emitting section than the second light-receiving section, an area of the first light-receiving section is smaller than an area of the second light-receiving section, the first light-receiving section includes a first light-receiving portion, a second light-receiving portion, a third light-receiving portion, and a fourth light-receiving portion, wherein the first light-receiving portion and the second light-receiving portion are disposed sandwiching the first light-emitting section in the second direction, the third light-receiving portion and the fourth light-receiving portion are disposed sandwiching the first light-emitting section in the first direction, a flat plate-shaped first light-shielding wall is provided between the first light-emitting section and the first light-receiving portion, the flat plate-shaped first light-shielding wall being configured to block at least a portion of the first light, a flat plate-shaped second light-shielding wall is provided between the first light-emitting section and the second light-receiving portion, the flat plate-shaped second light-shielding wall being configured to block at least a portion of the first light, a flat plate-shaped third light-shielding wall is provided between the first light-emitting section and the third light-receiving portion, the flat plate-shaped third light-shielding wall being configured to block at least a portion of the first light, a flat plate-shaped fourth light-shielding wall is provided between the first light-emitting section and the fourth light-receiving portion, the flat plate-shaped fourth light-shielding wall being configured to block at least a portion of the first light, and a total area of the first light-receiving portion, the second light-receiving portion, the third light-receiving portion, and the fourth light-receiving portion is smaller than an area of the second light-receiving section.

9. The detecting device according to claim 8, further comprising: a third light-emitting section configured to emit third light, wherein the third light emitted from the third light-emitting section and emitted from the living body is received by the second light-receiving section, the third light-receiving portion is provided between the third light-shielding wall and the second light-emitting section in the first direction, and the fourth light-receiving portion is provided between the fourth light-shielding wall and the third light-emitting section in the first direction.

10. A measuring device, comprising: a detecting device according to claim 1; and an information analysis section configured to identify biological information from a detection signal indicating a detection result by the detecting device.