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(54) **MEASUREMENT APPARATUS AND MEASUREMENT METHOD**

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(57) **ABSTRACT**

A measurement apparatus includes contact interfaces disposed in a housing so as to allow contact with test sites of a subject; biological sensors configured to acquire respective biological measurement outputs of the test sites contacting the contact interfaces; temperature detectors configured to detect respective temperatures of the contact interfaces; and a controller configured to measure biological information based on the temperatures obtained from the temperature detectors, and the biological measurement outputs obtained from the biological sensors.

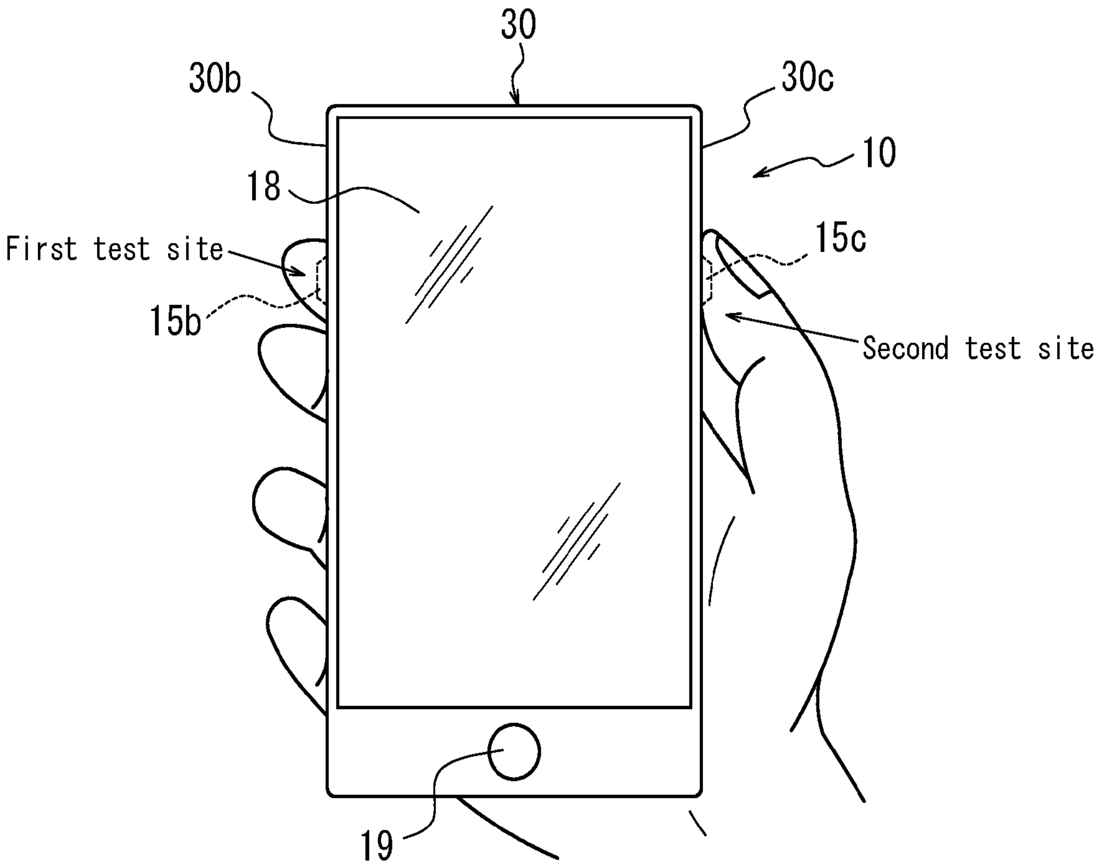


FIG. 1

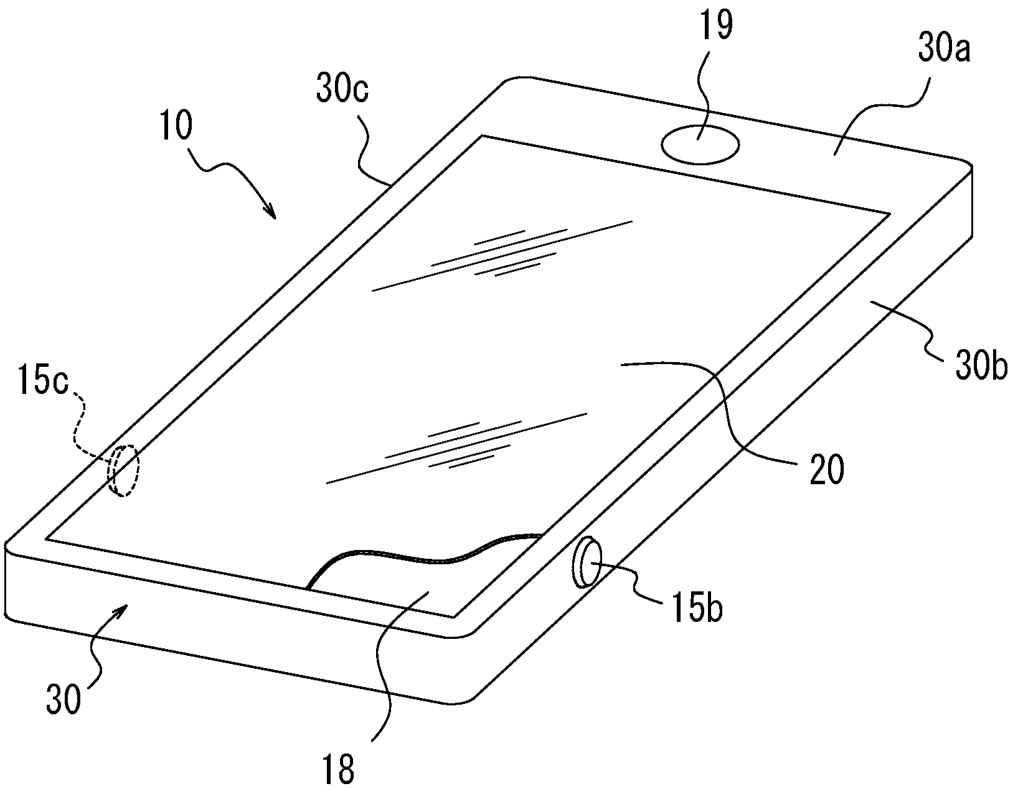
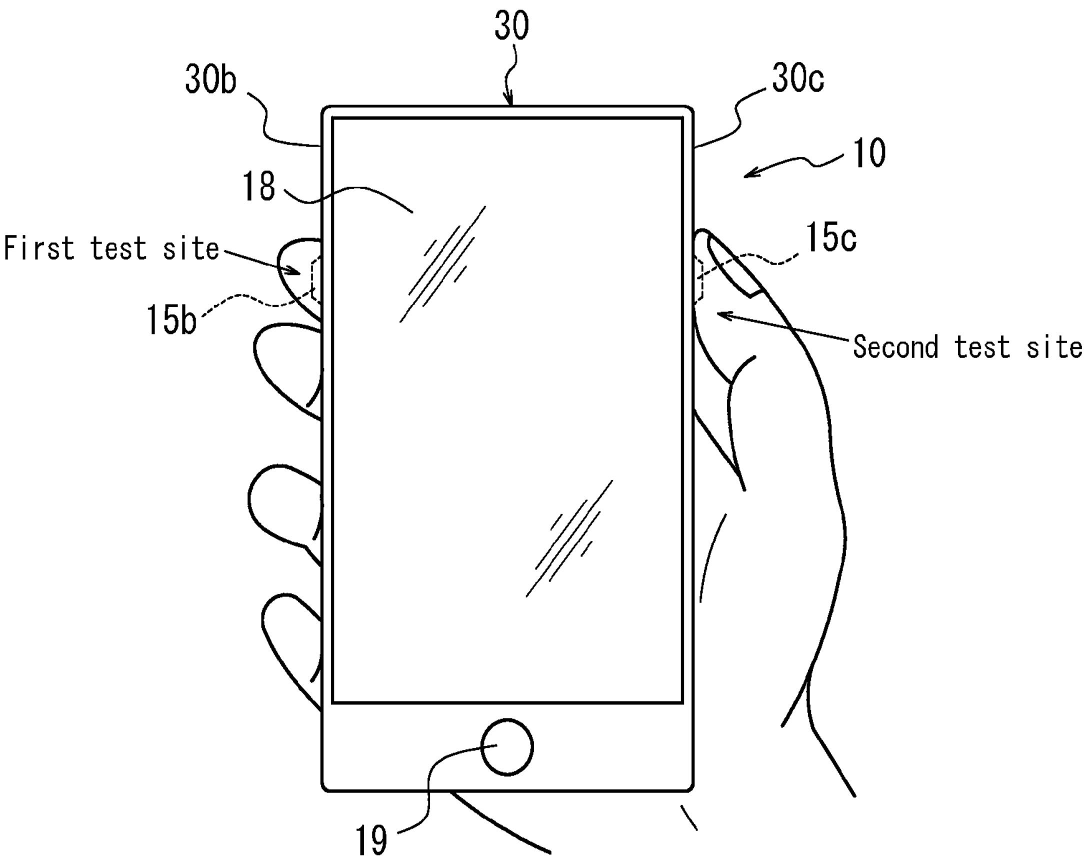


FIG. 2



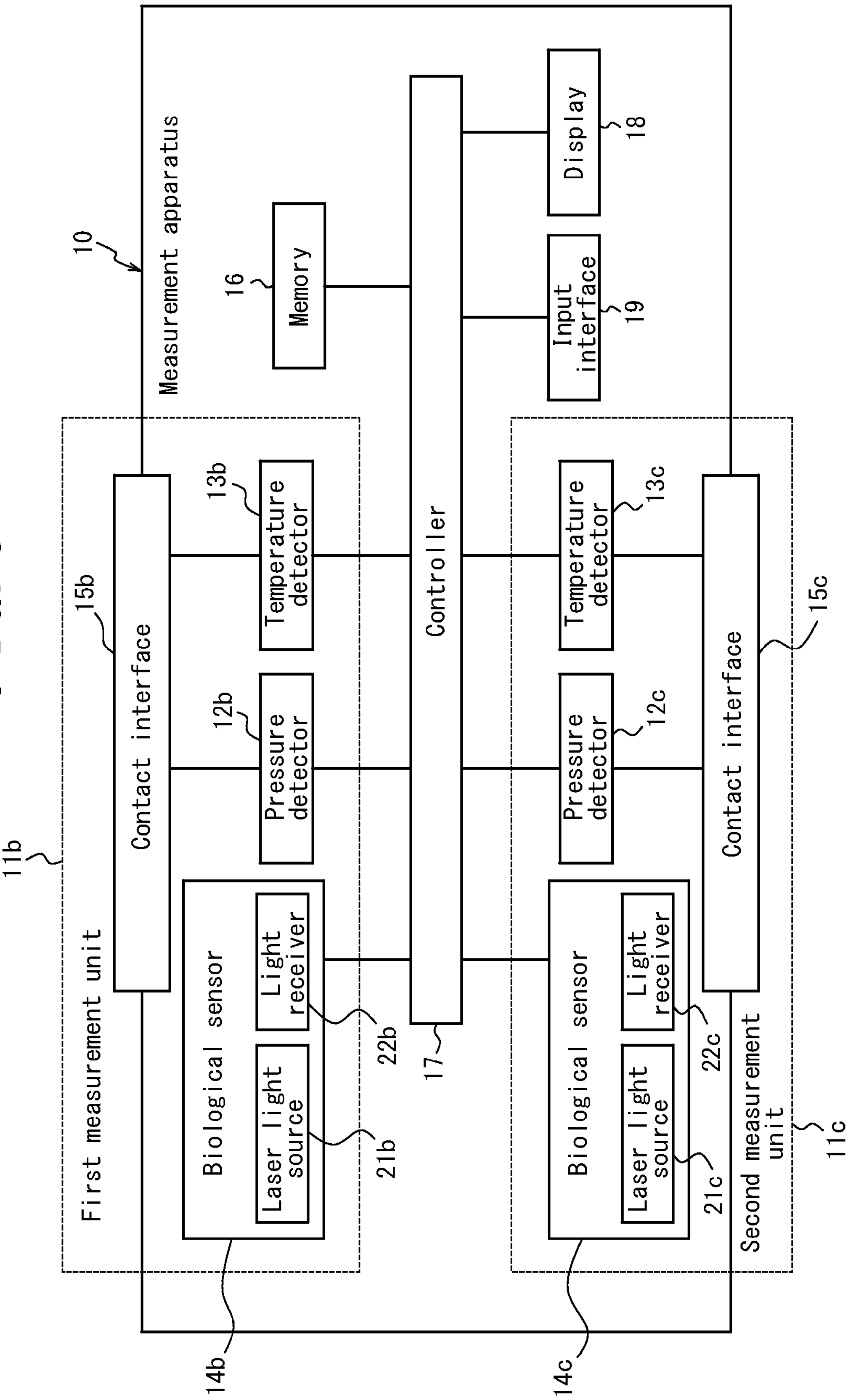

10
Measurement apparatus
16
Memory
17
Controller
18
Display
19
Input interface
11b
First measurement unit
15b
Contact interface
13b
Temperature detector
12b
Pressure detector
14b
Biological sensor
21b
Laser light source
22b
Light receiver
11c
Second measurement unit
15c
Contact interface
13c
Temperature detector
12c
Pressure detector
14c
Biological sensor
21c
Laser light source
22c
Light receiver

FIG. 3

FIG. 4

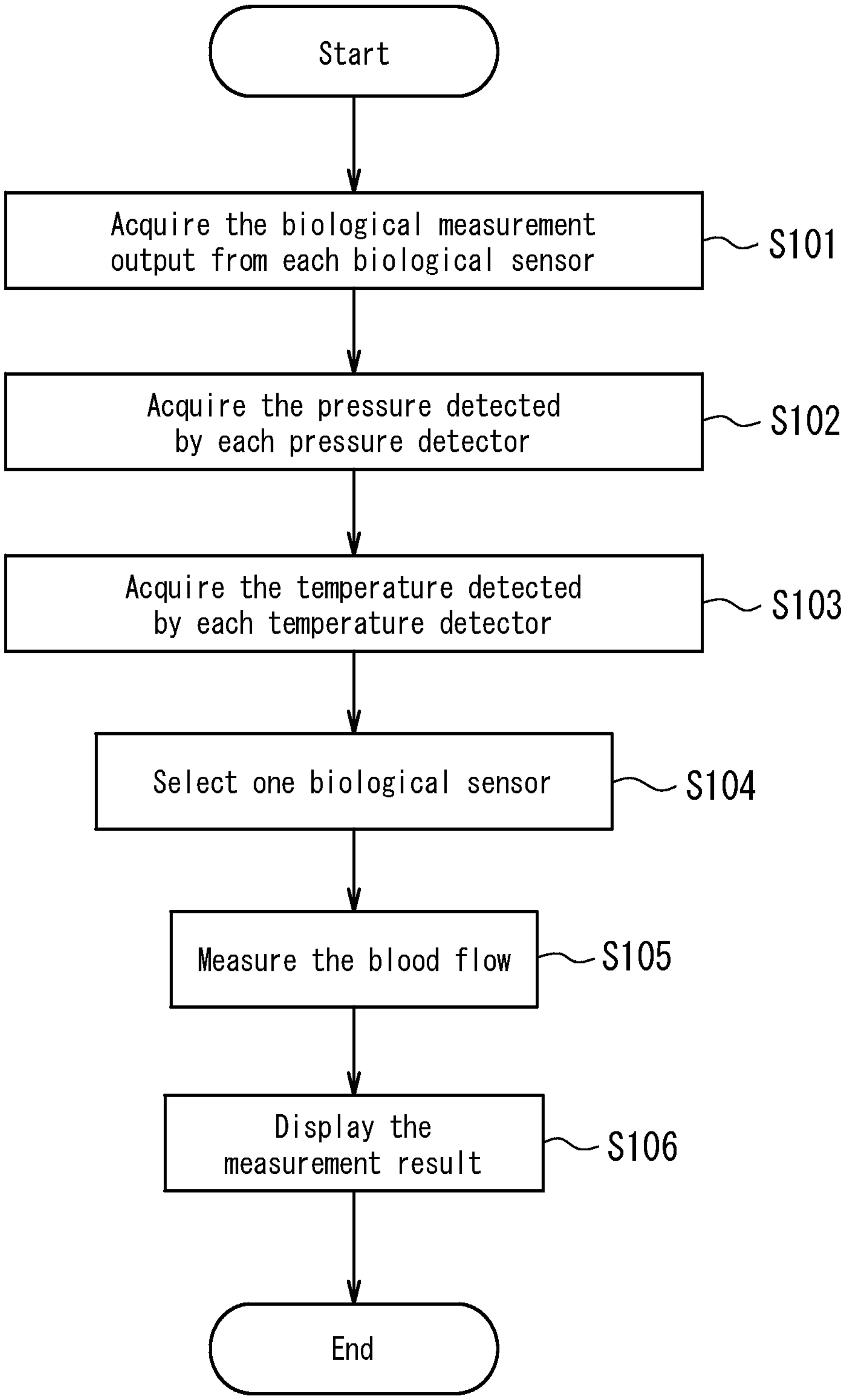

Start
Acquire the biological measurement output from each biological sensor
S101
Acquire the pressure detected by each pressure detector
S102
Acquire the temperature detected by each temperature detector
S103
Select one biological sensor
S104
Measure the blood flow
S105
Display the measurement result
S106
End

FIG. 5A

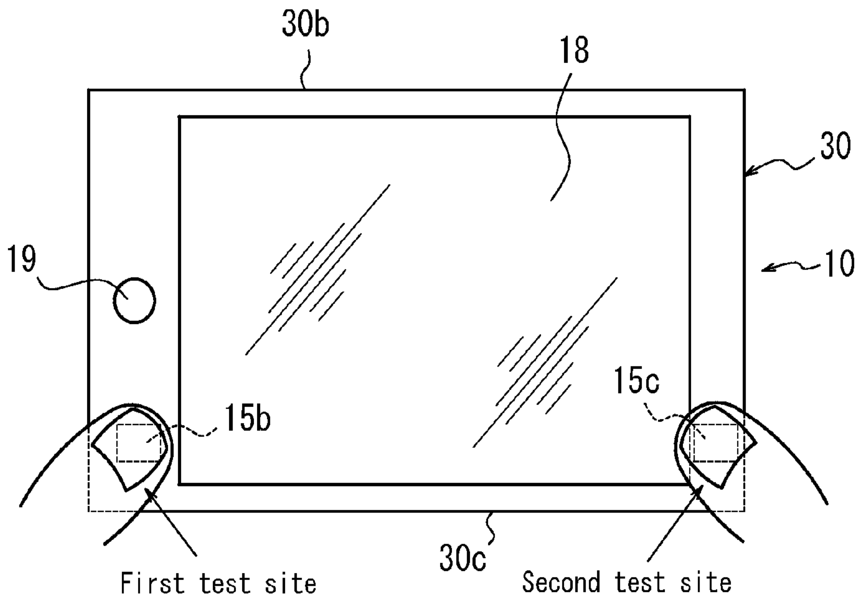
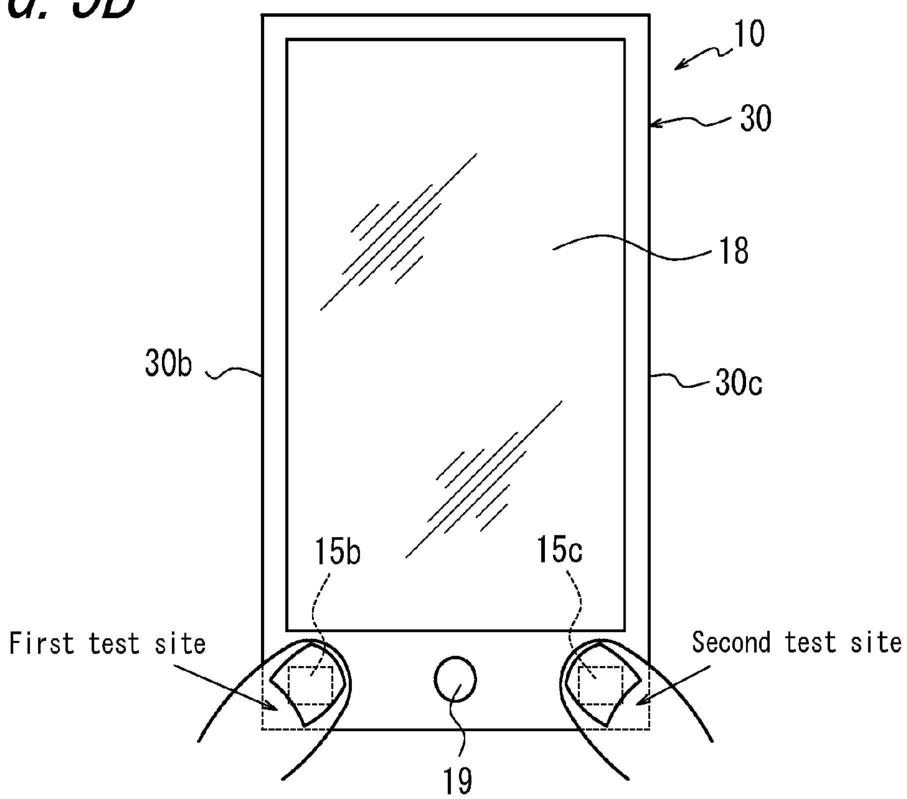

30b
18
30
19
10
15c
15b
30c
First test site
Second test site

FIG. 5B


10
30
18
30b
30c
15b
15c
First test site
Second test site
19

MEASUREMENT APPARATUS AND MEASUREMENT METHOD

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to and the benefit of Japanese Patent Application No. 2014-124413 filed Jun. 17, 2014, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] This disclosure relates to a measurement apparatus and a measurement method.

BACKGROUND

[0003] An example of an existing measurement apparatus measures biological information by acquiring biological output information from a test site, such as a fingertip of a subject.

SUMMARY

[0004] A measurement apparatus according to this disclosure includes:

[0005] a plurality of contact interfaces disposed in a housing so as to allow contact with a plurality of test sites of a subject;

[0006] a plurality of biological sensors configured to acquire respective biological measurement outputs of the test sites contacting the contact interfaces;

[0007] a plurality of temperature detectors configured to detect respective temperatures of the contact interfaces; and

[0008] a controller configured to measure biological information based on the temperatures obtained from the temperature detectors, and the biological measurement outputs obtained from the biological sensors.

[0009] While the solution to the problem in this disclosure has been described in terms of apparatuses, this disclosure may also be implemented as methods substantially corresponding to these apparatuses, and such methods are to be understood as included in the scope of this disclosure.

[0010] For example, a measurement method comprises:

[0011] acquiring a plurality of biological measurement outputs with a plurality of biological sensors from a plurality of test sites contacting a plurality of contact interfaces;

[0012] detecting temperatures of the plurality of the contact interfaces; and

[0013] measuring biological information based on the detected temperatures and on the acquired biological measurement outputs.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] In the accompanying drawings:

[0015] FIG. **1** is an external perspective view schematically illustrating the structure of a measurement apparatus according to one of the embodiments of this disclosure;

[0016] FIG. **2** illustrates a subject holding the measurement apparatus of FIG. **1**;

[0017] FIG. **3** is a functional block diagram schematically illustrating the structure of the measurement apparatus in FIG. **1**;

[0018] FIG. **4** is a flowchart illustrating an example of processing executed by the controller in FIG. **1**; and

[0019] FIGS. **5**A and **5**B illustrate examples of arrangement of the contact interfaces in the measurement apparatus.

DETAILED DESCRIPTION

[0020] For example, a known blood flow measurement apparatus that measures blood flow as the biological information irradiates a fingertip with laser light and measures the blood flow based on scattered light from the blood flow in a capillary at the fingertip.

[0021] The measurement result of biological information, however, tends to change based on the pressure on the measurement apparatus from the test site. When the error in the measurement result of the biological information exceeds the allowable range, the subject needs to measure the biological information again, which the subject may find troublesome.

[0022] It would therefore be helpful to provide an improved measurement apparatus and measurement method.

[0023] The following describes one of the disclosed embodiments in detail with reference to the drawings.

[0024] FIG. **1** is an external perspective view schematically illustrating the structure of a measurement apparatus according to one of the embodiments of this disclosure. This measurement apparatus **10** may be a measurement apparatus exclusively for measuring a subject's biological information, or an electronic device, such as a mobile phone, may be used as the measurement apparatus **10** according to this embodiment. The measurement apparatus **10** is not limited to a mobile phone and may be implemented in any type of electronic device, such as a portable music player, a laptop computer, a wristwatch, a tablet, a game device, or the like.

[0025] The measurement apparatus **10** according to this embodiment includes a housing **30** having an approximately rectangular external shape. In the housing **30**, an input interface **19** and a panel **20** are provided at the front face **30***a*, and as illustrated by the partial cutout of the panel **20** in FIG. **1**, a display **18** is held below the panel **20**.

[0026] The panel **20** is configured using a touch panel that detects contact, a cover panel that protects the display **18**, or the like and is, for example, made from glass or a synthetic resin such as acrylic or the like. The panel **20** is, for example, rectangular. The panel **20** may be a flat plate or may be a curved panel, the front face **30***a* of which is smoothly inclined. When the panel **20** is a touch panel, the panel **20** detects contact by the subject's finger, a pen, a stylus pen, or the like. Any detection system may be used in the touch panel, such as a capacitive system, a resistive film system, a surface acoustic wave system (or an ultrasonic wave system), an infrared system, an electromagnetic induction system, a load detection system, or the like. In the present embodiment, for the sake of explanation, the panel **20** is assumed to be a touch panel.

[0027] The measurement apparatus **10** according to this embodiment includes a contact interface **15***b* on a side face **30***b*, which is one of the long sides of the housing **30**. The contact interface **15***b* is a portion of the below-described first measurement unit. The measurement apparatus **10** also includes a contact interface **15***c* on a side face **30***c*, which is the other long side of the housing **30**, at a position symmetrical to the contact interface **15***b* when the measurement apparatus **10** is viewed from the front face **30***a*. The contact interface **15***c* is a portion of the second measurement unit. The contact interfaces **15***b* and **15***c* are portions that contact the test site, such as a finger, in order for the subject to measure biological information.

[0028] The input interface **19** receives operation input from the subject and may be configured, for example, using operation buttons (operation keys). The panel **20** can also receive operation input from the subject by detecting contact by the subject on a soft key or the like displayed on the display **18**.

[0029] The measurement apparatus **10** measures biological information while being held by the subject. FIG. **2** illustrates the subject holding the measurement apparatus **10** of FIG. **1** in the right hand. In this case, for example as illustrated in FIG. **2**, the pad of the right index finger contacts the contact interface **15***b* of the side face **30***b*, and the pad of the right thumb contacts the contact interface **15***c* of the side face **30***c*. The measurement apparatus **10** measures biological information while two fingers are being pressed against different contact interfaces **15***b* and **15***c*, as in FIG. **2**. The biological information may be any biological information that can be measured using a biological sensor provided in the measurement apparatus **10**. In this embodiment, as one example, the measurement apparatus **10** is described as measuring the subject's amount of blood flow, which is information related to blood flow.

[0030] FIG. **3** is a functional block diagram schematically illustrating the structure of the measurement apparatus **10** in FIG. **1**. As illustrated in FIG. **3**, the measurement apparatus **10** includes a first measurement unit **11***b*, a second measurement unit **11***c*, a memory **16**, a controller **17**, the display **18**, and the input interface **19**. The first measurement unit **11***b* includes a pressure detector **12***b*, a temperature detector **13***b*, a biological sensor **14***b*, and the contact interface **15***b*. The second measurement unit **11***c* includes a pressure detector **12***c*, a temperature detector **13***c*, a biological sensor **14***c*, and the contact interface **15***c*. The pressure detectors **12***b* and **12***c*, the temperature detectors **13***b* and **13***c*, the biological sensors **14***b* and **14***c*, and the contact interfaces **15***b* and **15***c* respectively have the same functions. The biological sensor **14***b* includes a laser light source **21***b* and a light receiver **22***b*, and the biological sensor **14***c* includes a laser light source **21***c* and a light receiver **22***c*. The biological sensors **14***b* and **14***c* may, for example, be biological sensors of the same type. The contact interface **15***b* of the first measurement unit **11***b* is disposed on the side face **30***b* of the housing **30**, and the contact interface **15***c* of the second measurement unit **11***c* is disposed on the side face **30***c* of the housing **30**. Hereinafter, when not distinguishing whether each functional unit is included in the first measurement unit **11***b* or the second measurement unit **11***c*, the functional units are simply referred to as the pressure detector **12**, temperature detector **13**, biological sensor **14**, contact interface **15**, laser light source **21**, and light receiver **22**.

[0031] Each pressure detector **12** detects contact pressure, by the test site, acting on the corresponding contact interface **15**. The pressure detector **12** may, for example, be configured by a piezoelectric element. The pressure detector **12** is connected to the controller **17** and transmits the detected contact pressure to the controller **17** as a pressure signal. Accordingly, when the test site is in contact with the contact interface **15**, the pressure detector **12** detects the contact pressure, from the test site, acting on the contact interface **15** and transmits the detected contact pressure to the controller **17** as a pressure signal. When the subject holds the measurement apparatus **10** as illustrated in FIG. **2**, the pressure detector **12***b* of the first measurement unit **11***b* detects the contact pressure acting on the contact interface **15***b* from the right index finger, and the pressure detector **12***c* of the second measurement unit **11***c* detects the contact pressure acting on the contact interface **15***c* from the right thumb.

[0032] Each temperature detector **13** detects the temperature of the corresponding contact interface **15**. The temperature detector **13** may be configured by a known temperature sensor, such as a thermocouple, a thermistor, bimetal, or the like. The temperature detector **13** is connected to the controller **17** and transmits the detected temperature to the controller **17** as a temperature signal. Accordingly, when the test site is in contact with the contact interface **15**, the temperature detector **13** detects the temperature of the contact interface **15** based on contact by the test site and transmits the detected signal to the controller **17** as a temperature signal. When the subject holds the measurement apparatus **10** as illustrated in FIG. **2**, the temperature detector **13***b* of the first measurement unit **11***b* detects the temperature of the contact interface **15***b* based on contact by the right index finger, and the temperature detector **13***c* of the second measurement unit **11***c* detects the temperature of the contact interface **15***c* based on contact by the right thumb.

[0033] The biological sensor **14** acquires biological measurement output from the test site in contact with the contact interface **15**. When the subject holds the measurement apparatus **10** as illustrated in FIG. **2**, the biological sensor **14***b* of the first measurement unit **11***b* acquires biological measurement output from the right index finger, and the biological sensor **14***c* of the second measurement unit **11***c* acquires biological measurement output from the right thumb.

[0034] The laser light source **21** emits laser light based on control by the controller **17**. The laser light source **21** may, for example, be configured to irradiate the test site with laser light, as measurement light, that has a wavelength capable of detecting a predetermined component included in blood. An example of such a laser light source **21** is a Laser Diode (LD).

[0035] The light receiver **22** receives scattered measurement light from the test site as biological measurement output. The light receiver **22** may, for example, be configured using a photodiode (PD). The biological sensor **14** transmits a photoelectric conversion signal of the scattered light received by the light receiver **22** to the controller **17**.

[0036] As described above, the contact interface **15** is a portion that contacts the test site, such as a finger, in order for the subject to measure biological information. The contact interface **15** may, for example, be configured by a plate-shaped member. The contact interface **15** may also be configured by a member that is transparent at least with respect to the measurement light and the scattered light from the test site that is in contact.

[0037] The memory **16** may be configured with a semiconductor memory, a magnetic memory, or the like. The memory **16** stores a variety of information, programs for causing the measurement apparatus **10** to operate, and the like and also functions as a working memory. The memory **16** may, for example, store the amount of blood flow measured by the measurement apparatus **10** as history.

[0038] The controller **17** is a processor that, starting with the functional blocks of the measurement apparatus **10**, controls and manages the measurement apparatus **10** overall. The controller **17** is configured using a processor such as a

Central Processing Unit (CPU) that executes a program prescribing control procedures. Such a program may, for example, be stored in the memory **16**, in an external storage medium, or the like.

[0039] The controller **17** causes laser light to be irradiated onto first and second test sites from the laser light sources **21***b* and **21***c*. The light receivers **22***b* and **22***c* acquire biological measurement outputs by receiving scattered light from the first and second test sites. The controller **17** determines whether the acquisition of the biological measurement output by the biological sensor **14** is complete. The controller **17** may, for example, judge that acquisition of the biological measurement output is complete once a predetermined length of time elapses after the biological sensor **14** starts to acquire the biological measurement output. The controller **17** may also, for example, judge that acquisition of the biological measurement output is complete once the biological sensor **14** has acquired sufficient biological measurement output to measure the biological information.

[0040] Based on outputs (biological information outputs) from the pressure detectors **12***b* and **12***c*, the temperature detectors **13***b* and **13***c*, and the light receiver **22**, the controller **17** measures biological information. For example, the controller **17** selects one of the biological sensors **14***b* and **14***c* based on the contact pressures obtained from the pressure detectors **12***b* and **12***c* and the temperatures obtained from the temperature detectors **13***b* and **13***c*.

[0041] The selection of a biological sensor **14** based on the contact pressure obtained from the pressure detectors **12***b* and **12***c* is now described. For example, when the contact pressures by the subject on the contact interfaces **15***b* and **15***c* differ, i.e. when the contact pressures obtained from the pressure detectors **12***b* and **12***c* differ, it is envisioned that the measurement accuracy of the biological information measured based on the biological measurement outputs will also differ. The controller **17** judges whether the contact pressure obtained from the pressure detectors **12***b* and **12***c* is within a range (allowable range) such that the error in the measurement result of the amount of blood flow falls within a predetermined range.

[0042] Between the contact pressures obtained from the pressure detectors **12***b* and **12***c*, when one is within the allowable range, and the other is outside of the allowable range, the controller **17** selects the biological sensor **14***b* or **14***c* that corresponds to the pressure detector **12***b* or **12***c* that detected the contact pressure within the allowable range. When both of the contact pressures obtained from the pressure detectors **12***b* and **12***c* are within the allowable range, the controller **17** determines the pressure detector **12***b* or **12***c* indicating the contact pressure with the smaller measurement error in the biological information and selects the biological sensor **14***b* or **14***c* that corresponds to the determined pressure detector **12***b* or **12***c*. When both of the contact pressures obtained from the pressure detectors **12***b* and **12***c* are outside of the allowable range, the controller **17** determines the pressure detector **12***b* or **12***c* indicating the contact pressure that is closer to the allowable range and selects the biological sensor **14***b* or **14***c* that corresponds to the determined pressure detector **12***b* or **12***c*. The controller **17** then measures the biological information based on the biological measurement output obtained from the selected biological sensor **14***b* or **14***c*.

[0043] In this way, the measurement apparatus **10** detects contact pressures from a plurality of test sites, and when any of the contact pressures is within an allowable range, the controller **17** measures biological information based on the biological sensor **14***b* or **14***c* that corresponds to the pressure detector **12***b* or **12***c* indicating the contact pressure within the allowable range. When all of the contact pressures are within the allowable range or when all are outside of the allowable range, the controller **17** measures the biological information based on the biological sensor **14***b* or **14***c* that corresponds to the pressure detector **12***b* or **12***c* indicating the contact pressure that minimizes the measurement error in the biological information. Therefore, the measurement apparatus **10** can more easily obtain a highly accurate measurement result as compared to when biological information is measured based on one biological sensor. Furthermore, since the measurement apparatus **10** is provided with a plurality of biological sensors (two in this embodiment), it is more likely that at least one of the contact pressures will be included in the allowable range as compared to when biological information is measured based on one biological sensor.

[0044] The controller **17** can also select the biological sensor **14** based on the temperatures obtained from the temperature detectors **13***b* and **13***c*. Depending on the temperature of the test site, it may become difficult to output a highly accurate measurement result. Therefore, in addition to the above-described contact pressure, the controller **17** may select the biological sensor **14***b* or **14***c* based on the temperature detected by the temperature detectors **13***b* and **13***c*.

[0045] The controller **17** selects one of the biological sensors **14***b* and **14***c* based both on the above-described contact pressures obtained from the pressure detectors **12***b* and **12***c* and the temperatures obtained from the temperature detectors **13***b* and **13***c*. By having the controller **17** measure the biological information based on the biological measurement output obtained from the biological sensor **14***b* or **14***c* selected in this way, more accurate biological information can be expected to be output from the measurement apparatus **10** as a measurement result.

[0046] A technique for the controller **17** to measure the amount of blood flow using the Doppler shift is now described. When measuring the amount of blood flow, the controller **17** causes laser light to be irradiated from the laser light source **21** onto body tissue (the test site) and receives scattered light that is scattered from the body tissue with the light receiver **22**. The controller **17** then calculates the amount of blood flow based on output related to the scattered light that was received.

[0047] In the body tissue, scattered light that is scattered from moving blood cells undergoes a frequency shift (Doppler shift), due to the Doppler effect, relative to the speed of travel of the blood cells within the blood. The controller **17** detects the beat signal due to interference between scattered light from still tissue and the scattered light from moving blood cells. This beat signal represents strength as a function of time. The controller **17** then turns the beat signal into a power spectrum that represents power as a function of frequency. In this power spectrum of the beat signal, the Doppler shift frequency is proportional to the speed of blood cells, and the power corresponds to the amount of blood cells. The controller **17** calculates the amount of blood flow by multiplying the power spectrum of the beat signal by the frequency and integrating.

[0048] The controller **17** then displays the biological information measured based on the biological measurement output obtained from the selected biological sensor **14***b* or **14***c* on the display **18**. The subject can learn the amount of blood flow by confirming the display on the display **18**.

[0049] At this time, the controller **17** may display whether the biological information is based on biological measurement output obtained from the biological sensor **14***b* or **14***c,* i.e. whether the biological information is based on biological measurement output of the index finger (first test site) or thumb (second test site) in contact with the contact interfaces **15***b* and **15***c*. By confirming such a display, a subject who is continuously measuring biological information can find out the test site for which biological measurement output is more easily selected, i.e. which test site more easily yields highly accurate biological measurement output.

[0050] In addition to the biological information measured based on biological measurement output obtained from the selected biological sensor **14***b* or **14***c*, the controller **17** may also measure the biological information based on the biological measurement output obtained from the biological sensor **14***b* or **14***c* that was not selected. Along with the biological information measured based on biological measurement output obtained from the selected biological sensor **14***b* or **14***c,* the controller **17** may also display, on the display **18**, the biological information measured based on the biological measurement output obtained from the biological sensor **14***b* or **14***c* that was not selected. In this case, the controller **17** may display the selected biological sensor **14***b* or **14***c*.

[0051] The display **18** is a display device configured by a well-known display such as a liquid crystal display, an organic EL display, an inorganic EL display, or the like. For example, under control by the controller **17**, the display **18** displays the measured biological information.

[0052] Next, with reference to the flowchart in FIG. **4**, an example of processing executed by the controller **17** in FIG. **1** is described. The flowchart in FIG. **4** for example begins when the subject holds the measurement apparatus **10** so as to contact test sites to the contact interfaces **15** and performs an operation on the measurement apparatus **10** to place the measurement apparatus **10** in a state capable of measuring the amount of blood flow. In the flowchart in FIG. **4**, as one example, the controller **17** is described as selecting one of the biological sensors **14***b* or **14***c* and displaying, on the display **18**, the biological information measured based on the biological measurement output obtained from the selected biological sensor **14***b* or **14***c*.

[0053] The controller **17** causes the test sites to be irradiated with laser light from the laser light sources **21***b* and **21***c* and acquires biological measurement output from the biological sensors **14***b* and **14***c* (step S**101**).

[0054] The controller **17** acquires the contact pressure on the contact interfaces **15***b* and **15***c* as detected by the pressure detectors **12***b* and **12***c* (step S**102**).

[0055] The controller **17** acquires the temperature of the contact interfaces **15***b* and **15***c* as detected by the temperature detectors **13***b* and **13***c* (step S**103**).

[0056] Next, based on the acquired pressures and temperatures, the controller **17** selects one of the biological sensors **14***b* and **14***c* (step S**104**).

[0057] The controller **17** then measures the amount of blood flow as biological information based on the biological measurement output, between the biological measurement outputs acquired in step S**101**, that was obtained from the selected biological sensor **14***b* or **14***c* (step S**105**).

[0058] The controller **17** displays the amount of blood flow on the display **18** as the measurement result measured in step S**105** (step S**106**).

[0059] In this way, the measurement apparatus **10** according to this embodiment acquires biological measurement outputs of a plurality of test sites from a plurality of biological sensors **14***b* and **14***c*. Based on the acquired pressures and temperatures, the controller **17** of the measurement apparatus **10** selects one biological sensor **14***b* or **14***c* that can measure the biological information with higher accuracy and measures the biological information based on the biological measurement output obtained from the selected biological sensor **14***b* or **14***c*. Therefore, with the measurement apparatus **10**, the measurement accuracy of biological information improves. Even when the contact pressure on the contact interface **15***b* or **15***c* is outside of the allowable range, the measurement apparatus **10** can output highly accurate biological information without making the subject measure the biological information again.

[0060] This disclosure is not limited to the above embodiments, and a variety of modifications and changes are possible. For example, the functions and the like included in the various components and steps may be reordered in any logically consistent way. Furthermore, components or steps may be combined into one or divided.

[0061] For example, in the flowchart in FIG. **4**, the controller **17** is described as acquiring the biological measurement output from the biological sensors **14***b* and **14***c* (step S101) and then selecting one of the biological sensors **14***b* and **14***c* based on the pressures and temperatures of the contact interfaces **15***b* and **15***c* (step **104**), but the control by the controller **17** is not limited to this order. For example, the controller **17** may first select one of the biological sensors **14***b* and **14***c* based on the pressures and temperatures of the contact interfaces **15***b* and **15***c* and then acquire the biological measurement output of the selected biological sensor **14***b* or **14***c*. In this case, the controller **17** only causes laser light to be emitted from one of the laser light sources **21***b* and **21***c*. Hence, the power consumption can be suppressed as compared to when laser light is emitted from the laser light sources **21***b* and **21***c*.

[0062] In the above embodiment, the controller **17** has been described as selecting one of the biological sensors **14***b* and **14***c* based both on the contact pressures obtained from the pressure detectors **12***b* and **12***c* and the temperatures obtained from the temperature detectors **13***b* and **13***c,* but selection of a biological sensor is not limited to this method. For example, the measurement apparatus **10** may be configured so that the controller **17** selects one of the biological sensors **14***b* and **14***c* based only on the contact pressure detected by the pressure detectors **12***b* and **12***c*. In this case, the measurement apparatus **10** need not be provided with the temperature detectors **13** and can therefore have a simpler structure. The measurement apparatus **10** may be provided with another detector that detects information for selecting one biological sensor in order to improve the measurement accuracy of the biological information, and the controller **17** may select one biological sensor based on the information detected by this detector.

[0063] In the above embodiment, the measurement apparatus **10** has been described as being provided with first and second measurement units **11***b* and **11***c,* but the number of measurement units provided in the measurement apparatus **10** is not limited to two. The measurement apparatus **10** may include three or more measurement units **11**. The controller **17** may, for example, select one biological sensor based on contact pressures on contact interfaces **15** in a plurality of measurement units **11** and measure the biological information based on the biological measurement output acquired by the selected biological sensor. As the number of measurement units **11** increases, the probability that the contact pressure on one of the contact interfaces will be included in the allowable range can be expected to increase.

[0064] In the above embodiment, the measurement apparatus **10** may notify the subject of information related to the strength of the contact pressures detected by the pressure detectors **12***b* and **12***c*. The information related to the contact pressures may, for example, be information related to whether the contact pressures are within the allowable range. The information related to the strength of the contact pressures may, for example, be information related to whether the contact pressures are stronger or weaker than the allowable range.

[0065] The measurement apparatus **10** can provide notification of information related to the strength of the contact pressures for example by a visual method using an image, characters, light emission, or the like; an auditory method using audio or the like; or a combination of these methods. The measurement apparatus **10** for example can provide notification of information related to the strength of the contact pressures via the display **18**. The measurement apparatus **10** may, for example, include a separate notification interface that provides notification of information related to the strength of the contact pressures and may provide notification via the notification interface. Notification by the notification interface is not limited to a visual or auditory method. Any method recognizable by the user may be adopted. By the measurement apparatus **10** providing notification of information related to the strength of the contact pressures, the subject can find out what the contact pressures are when holding the measurement apparatus **10**, making it easier to adjust the contact pressures to be within the allowable range.

[0066] In the above embodiment, the contact interfaces **15***b* and **15***c* have been described as being disposed respectively on the side faces **30***b* and **30***c*, but the arrangement of the contact interfaces **15***b* and **15***c* is not limited to this example. The contact interfaces **15***b* and **15***c* can, for example, be disposed separately at positions contacted by different fingers of the subject when the subject holds the housing **30** in one hand.

[0067] The contact interfaces **15***b* and **15***c* need not be disposed at positions that are determined assuming that the measurement apparatus **10** is held in one hand and may, for example, be disposed separately at positions contacted by different fingers of the subject when the subject holds the housing **30** in both hands.

[0068] FIGS. **5**A and **5**B illustrate examples of arrangement of the contact interfaces **15** in the measurement apparatus **10**. The contact interfaces **15***b* and **15***c* may, for example, be disposed on the front face **30***a* near one side face **30***c* at the top and bottom of the housing **30**, as illustrated in FIG. **5**A. In this case, the subject can measure biological information by contacting the pad of the left thumb as the first test site to the contact interface **15***b* and contacting the pad of the right thumb as the second test site to the contact interface **15***c*.

[0069] In another arrangement example, the contact interfaces **15***b* and **15***c* are disposed on the front face **30***a* respectively near the side faces **30***b* and **30***c* at the bottom left and right, as illustrated in FIG. **5**B. In this case, the subject can measure biological information by contacting the pad of the left thumb as the first test site to the contact interface **15***b* and contacting the pad of the right thumb as the second test site to the contact interface **15***c*. Having the subject hold the measurement apparatus **10** in both hands in this way is useful when the measurement apparatus **10** is implemented in an electronic device that is difficult to hold in one hand, such as a tablet.

[0070] In the above embodiment, the controller **17** has been described as measuring the biological information based on the biological measurement output obtained from the selected biological sensor **14***b* or **14***c*, but the controller **17** is not limited to measuring the biological information with this method. The controller **17** may, for example, measure (calculate) the biological information using a predetermined algorithm that combines the biological measurement outputs from the biological sensors **14***b* and **14***c* by performing weighting determined based on the pressures obtained from the pressure detectors **12***b* and **12***c* and the temperatures obtained based on the temperature detectors **13***b* and **13***c*.

[0071] Furthermore, along with measuring a plurality of pieces of biological information based on the biological measurement outputs obtained from the biological sensors **14***b* and **14***c*, the controller **17** may also display, on the display **18**, the result of comparing the measured pieces of biological information. The result of comparison is, for example, the difference in the amount of blood flow for each of the test sites.

[0072] Along with measuring a plurality of pieces of biological information based on the biological measurement outputs obtained from the biological sensors **14***b* and **14***c*, the controller **17** may also display the measured pieces of biological information on the display **18**. At this time, among the measured pieces of biological information, the controller **17** may display biological information judged to have high measurement accuracy on the display **18**. The biological information judged to have high measurement accuracy is biological information considered to be a more plausible representation of the user's biological information and for example is determined based on the contact pressure detected by the pressure detectors **12** and the temperatures detected by the temperature detectors **13**. The controller **17** may display information related to whether each of the contact pressures detected by the pressure detectors **12***b* and **12***c* associated with the biological sensors **14***b* and **14***c* that measured the pieces of biological information is within the allowable range.

[0073] When judging that only one of the contact interfaces **15***b* and **15***c* among the contact interfaces **15** is being contacted based on the pressure obtained from the pressure detector **12***b* or **12***c* or the temperature obtained from the temperature detector **13***b* or **13***c*, the controller **17** may measure the biological information based on the biological measurement output from the biological sensor **14***b* or **14***c* corresponding to the contact interface **15***b* or **15***c* judged to be contacted.

[0074] The measurement apparatus **10** may further be provided with contact detection sensors near the contact interfaces **15***b* and **15***c*. The contact detection sensors are sensors that detect contact by the test site of the subject, such as a touch sensor, a pressor sensor, or a temperature sensor. When the controller **17** is configured to receive operation input from the subject by detecting contact from the subject on a soft key or the like displayed on the display **18**, the controller **17** displays an image on the display **18** based on the positions of the contact interfaces **15***b* and **15***c* positioned near the contact detection sensors and on the output from the contact detection sensors. For example, suppose that the contact interfaces **15***b* and **15***c* are disposed at the positions indicated in FIG. **5**B, and that the subject is pressing the contact interface **15***c* with the right thumb. At this time, upon the contact detection sensor disposed near the contact interface **15***c* detecting contact, the controller **17** judges that the subject is holding the measurement apparatus **10** with the right hand. The controller **17** then disposes soft key(s) displayed on the display **18** so as to be easily operable with the right hand, for example on the right side of the display **18**. The right side of the display **18** refers, for example, to the right side relative to the center of the display **18** when the user is holding the measurement apparatus **10**. Similarly, for example upon the contact detection sensor disposed near the contact interface **15***b* detecting contact, the controller **17** judges that the subject is holding the measurement apparatus **10** with the left hand and disposes soft key(s) displayed on the display **18** on the left side, for example, of the display **18**. The left side of the display **18** refers, for example, to the left side relative to the center of the display **18** when the user is holding the measurement apparatus **10**. As a result, when the subject measures biological information using the measurement apparatus **10** and then performs other operations using the measurement apparatus **10** while continuing to hold the measurement apparatus **10**, the soft key(s) displayed on the display **18** are disposed near the finger performing the operations, thereby improving operability. The pressure detectors **12** or temperature detectors **13** may be used as the contact detection sensors.

[0075] In the above embodiment, the controller **17** of the measurement apparatus **10** has been described as measuring biological information, but measurement of biological information is not limited to being performed by the controller **17** of the measurement apparatus **10**. For example, a measurement terminal provided with the measurement units **11** may transmit the biological measurement outputs acquired by the biological sensors **14** to a server that is connected to the measurement terminal by a network that is wired, wireless, or a combination of both. The server is provided with a server controller that executes similar control to that of the controller **17** in the above embodiment, and the server controller measures the biological information based on the biological measurement outputs. The measurement results are transmitted from the server to the measurement terminal and are displayed, for example, on a display of the measurement terminal.

1. (canceled)

2. (canceled)

3. A measurement apparatus comprising:

a plurality of contact interfaces disposed in a housing so as to allow contact with a plurality of test sites of a subject;

a plurality of biological sensors configured to acquire respective biological measurement outputs of the test sites contacting the contact interfaces;

a plurality of temperature detectors configured to detect respective temperatures of the contact interfaces; and

a controller configured to measure biological information based on the temperatures obtained from the temperature detectors, and the biological measurement outputs obtained from the biological sensors.

4. The measurement apparatus of claim **3**, wherein the controller selects one of the biological sensors based on the temperatures obtained from the temperature detectors and measures the biological information based on the biological measurement output obtained from the selected biological sensor.

5. The measurement apparatus of claim **3**, further comprising:

a display; wherein

the controller displays the measured biological information on the display.

6. The measurement apparatus of claim **3**, further comprising:

a display; wherein

the controller measures a plurality of pieces of biological information based on the biological measurement outputs obtained from the biological sensors and displays the pieces of biological information on the display.

7. The measurement apparatus of claim **3**, wherein the contact interfaces are disposed separately at positions contacted by a plurality of different fingers of the subject when the subject holds the housing in one hand.

8. The measurement apparatus of claim **3**, wherein the contact interfaces are disposed separately at positions contacted by a plurality of fingers of different hands of the subject when the subject holds the housing in both hands.

9. The measurement apparatus of claim **3**, further comprising:

a display; wherein

the controller measures a plurality of pieces of biological information based on the biological measurement outputs obtained from the biological sensors and displays a result of comparing the pieces of biological information on the display.

10. The measurement apparatus of claim **3**, further comprising:

a display; and

a plurality of contact detection sensors disposed near the contact interfaces and configured to detect contact by the test sites of the subject; wherein

the controller displays an image on the display based on positions where the contact interfaces are disposed and on output from the contact detection sensors.

11. The measurement apparatus of claim **3**, wherein the biological information includes information related to blood flow.

12. A measurement method comprising:

acquiring a plurality of biological measurement outputs with a plurality of biological sensors from a plurality of test sites contacting a plurality of contact interfaces;

detecting temperatures of the plurality of the contact interfaces; and measuring biological information based on the detected temperatures and on the acquired biological measurement outputs.

* * * * *

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摘要(译)

测量装置包括设置在壳体中的接触界面，以允许与受试者的测试部位接触;生物传感器，被配置为获取与接触界面接触的测试部位的各个生物测量输出;温度检测器，被配置为检测接触界面的相应温度;控制器，被配置为基于从温度检测器获得的温度测量生物信息，以及从生物传感器获得的生物测量输出。