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Electronic device including multiple optical sensors and method for controlling the same

Abstract

An electronic device and a method for controlling the electronic device are provided. The electronic device includes a motion sensor and optical sensors. Each of the optical sensors includes a light emitter and a light receiver. The optical sensors are separately driven to determine a respective signal characteristic of each of the optical sensors. A current state of an object to be measured is determined, based on at least one signal received through the motion sensor or the optical sensors. A light emitter of at least one of the optical sensors is driven, based on the respective signal characteristics of the optical sensors according to the current state of the object to be measured. Based on the respective signal characteristics of the optical sensors, a light signal sensed through a light receiver of at least one of the optical sensors is selected and received.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application is a Continuation application of U.S. patent application Ser. No. 17/573,046, filed in the U.S. Patent and Trademark Office on Jan. 11, 2022, which is a bypass continuation application, claiming priority under § 365(c) to International Application No. PCT/KR2022/000160, filed on Jan. 5, 2022, which is based on and claims priority to Korean Patent Application Serial No. 10-2021-0001595, filed on Jan. 6, 2021 in the Korean Intellectual Property Office, the disclosures of each of which are incorporated herein by reference in its entirety.

BACKGROUND
1. Field
(1) The disclosure is generally related to an electronic device including multiple optical sensors, and more particularly, to an electronic device including multiple optical sensors which may be worn on a user's body so as to acquire the user's biometric information.
2. Description of Related Art
(2) Electronic devices have evolved to have smaller sizes and to be able to perform various functions in various manners according to user needs. Such electronic devices may include, for example, various types of wearable devices that can be directly attached to a part of the user's body.
(3) Such wearable devices are used to acquire various pieces of information from the user's body, and various services are provided based thereon.
(4) A wearable electronic device, such as, for example, a ring-type wearable electronic device worn

on a finger, may be equipped with a photoplethysmography (PPG) sensor so as to acquire information from the user's body, to calculate information such as heart rate, stress, blood oxygen saturation (SpO2), and blood pressure based thereon, and to provide the same to the user.

(5) A wearable electronic device, such as, for example, a ring-type wearable electronic device, may easily spin when worn on the user such that, even if multiple optical sensors are employed, the position of each optical sensor may frequently change, thereby making accurate measurement difficult.

SUMMARY

(6) Embodiments described herein may provide a method in which, in connection with an electronic device including multiple optical sensors, each optical sensor is controlled based on signal characteristics of each of the multiple optical sensors, and the electronic device.

(7) According to an aspect, an electronic device is provided that includes a housing, a motion sensor, and optical sensors disposed on one surface of the housing so as to be brought into contact with an object to be measured when the electronic device is worn. Each of the optical sensors comprises a respective light emitter and a respective light receiver. The electronic device also includes a sensor controller configured to control the optical sensors, and a processor operatively connected to the motion sensor and the sensor controller. The processor is configured to separately drive the optical sensors through the sensor controller to determine a respective signal characteristic of each of the optical sensors, and determine a current state of the object to be measured, based on at least one signal received through the motion sensor or the optical sensors. The processor is also configured to drive a light emitter of at least one of the optical sensors through the sensor controller, based on the respective signal characteristics of the optical sensors according to the current state of the object to be measured, and select and receive, based on the respective signal characteristics of the optical sensors, a light signal sensed through a light receiver of at least one of the optical sensors.

(8) According to an aspect, a method is provided for controlling an electronic device including a motion sensor and optical sensors. Each of the optical sensors includes a light emitter and a light receiver. The optical sensors are separately driven to determine a respective signal characteristic of each of the optical sensors. A current state of an object to be measured is determined, based on at least one signal received through the motion sensor or the optical sensors. A light emitter of at least one of the optical sensors is driven, based on the respective signal characteristics of the optical sensors according to the current state of the object to be measured. Based on the respective signal characteristics of the optical sensors, a light signal sensed through a light receiver of at least one of the optical sensors is selected and received.

(9) Signal characteristics of multiple optical sensors which may change according to a wearing state of an electronic device are identified, and the multiple optical sensors may be individually controlled based thereon, thereby acquiring more accurate measurement values.

(10) Multiple optical sensors may be individually controlled based on signal characteristics of the multiple optical sensors according to a usage state of an electronic device, thereby acquiring more accurate measurement values.

(11) Multiple optical sensors may be controlled in view of signal characteristics of the multiple optical sensors based on an event type when a designated event occurs according to a usage state of an electronic device, thereby acquiring more accurate measurement values.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) The above and other aspects, features, and advantages of certain embodiments of the disclosure will be more apparent from the following description taken in conjunction with the accompanying

drawings, in which:

(2) FIG. **1** is a block diagram illustrating an electronic device in a network environment; according to an embodiment;

(3) FIGS. **2**A and **2**B are diagrams illustrating exterior shapes of an electronic device having multiple optical sensors, according to an embodiment;

(4) FIG. **3** is a diagram illustrating a principle of an optical sensor, according to an embodiment;

(5) FIG. **4** is a block diagram illustrating an electronic device having multiple optical sensors, according to an embodiment;

(6) FIG. **5** is a block diagram illustrating an optical sensor module of an electronic device having multiple optical sensors, according to an embodiment;

(7) FIG. **6** is a diagram illustrating a state in which an electronic device having multiple optical sensors is worn, according to an embodiment;

(8) FIG. **7** is a diagram illustrating signal characteristics of multiple optical sensors of an electronic device, according to an embodiment;

(9) FIG. **8** is a flowchart illustrating a method for determining signal characteristics of multiple optical sensors of an electronic device, according to an embodiment;

(10) FIG. **9** is a flowchart illustrating a method for controlling multiple optical sensors of an electronic device based on signal characteristics of the multiple optical sensors, according to an embodiment;

(11) FIGS. **10**A, **10**B, and **10**C are diagrams illustrating operations for controlling multiple optical sensors based on signal characteristics of the multiple optical sensors, according to an embodiment;

(12) FIG. **11** is a flowchart illustrating operations for controlling multiple optical sensors of an electronic device based on designated event occurrence, according to an embodiment; and

(13) FIGS. **12**A and **12**B are diagrams illustrating operations for controlling multiple optical sensors based on a designated event occurrence, according to an embodiment.

DETAILED DESCRIPTION

(14) Embodiments are described in detail with reference to the accompanying drawings. The same or similar components may be designated by the same or similar reference numerals although they are illustrated in different drawings. Detailed descriptions of constructions or processes known in the art may be omitted to avoid obscuring the subject matter of the disclosure. The embodiments and the terms used herein are not intended to limit the technology disclosed herein to specific forms, and should be understood to include various modifications, equivalents, and/or alternatives to the corresponding embodiments. A singular expression may include a plural expression unless they are definitely different in context.

(15) FIG. **1** is a block diagram illustrating an electronic device in a network environment, according to an embodiment. Referring to FIG. **1**, an electronic device **101** in a network environment **100** may communicate with an electronic device **102** via a first network **198** (e.g., a short-range wireless communication network), or at least one of an electronic device **104** or a server **108** via a second network **199** (e.g., a long-range wireless communication network). According to an embodiment, the electronic device **101** may communicate with the electronic device **104** via the server **108**. According to an embodiment, the electronic device **101** may include a processor **120**, memory **130**, an input module **150**, a sound output module **155**, a display module **160**, an audio module **170**, a sensor module **176**, an interface **177**, a connecting terminal **178**, a haptic module **179**, a camera module **180**, a power management module **188**, a battery **189**, a communication module **190**, a subscriber identification module (SIM) **196**, or an antenna module **197**. In some embodiments, at least one of the components (e.g., the connecting terminal **178**) may be omitted from the electronic device **101**, or one or more other components may be added in the electronic device **101**. In some embodiments, some of the components (e.g., the sensor module **176**, the camera module **180**, or the antenna module **197**) may be implemented as a single component (e.g., the display module **160**).

(16) The processor **120** may execute, for example, software (e.g., a program **140**) to control at least one other component (e.g., a hardware or software component) of the electronic device **101** coupled with the processor **120**, and may perform various data processing or computation. According to one embodiment, as at least part of the data processing or computation, the processor **120** may store a command or data received from another component (e.g., the sensor module **176** or the communication module **190**) in volatile memory **132**, process the command or the data stored in the volatile memory **132**, and store resulting data in non-volatile memory **134**. According to an embodiment, the processor **120** may include a main processor **121** (e.g., a central processing unit (CPU) or an application processor (AP)), or an auxiliary processor **123** (e.g., a graphics processing unit (GPU), a neural processing unit (NPU), an image signal processor (ISP), a sensor hub processor, or a communication processor (CP)) that is operable independently from, or in conjunction with, the main processor **121**. For example, when the electronic device **101** includes the main processor **121** and the auxiliary processor **123**, the auxiliary processor **123** may be adapted to consume less power than the main processor **121**, or to be specific to a specified function. The auxiliary processor **123** may be implemented as separate from, or as part of the main processor **121**.

(17) The auxiliary processor **123** may control at least some of functions or states related to at least one component (e.g., the display module **160**, the sensor module **176**, or the communication module **190**) among the components of the electronic device **101**, instead of the main processor **121** while the main processor **121** is in an inactive (e.g., sleep) state, or together with the main processor **121** while the main processor **121** is in an active state (e.g., executing an application). According to an embodiment, the auxiliary processor **123** (e.g., an image signal processor or a communication processor) may be implemented as part of another component (e.g., the camera module **180** or the communication module **190**) functionally related to the auxiliary processor **123**. According to an embodiment, the auxiliary processor **123** (e.g., the neural processing unit) may include a hardware structure specified for artificial intelligence model processing. An artificial intelligence model may be generated by machine learning. Such learning may be performed, e.g., by the electronic device **101** where the artificial intelligence is performed or via a separate server (e.g., the server **108**). Learning algorithms may include, but are not limited to, e.g., supervised learning, unsupervised learning, semi-supervised learning, or reinforcement learning. The artificial intelligence model may include a plurality of artificial neural network layers. The artificial neural network may be a deep neural network (DNN), a convolutional neural network (CNN), a recurrent neural network (RNN), a restricted Boltzmann machine (RBM), a deep belief network (DBN), a bidirectional recurrent deep neural network (BRDNN), deep Q-network or a combination of two or more thereof but is not limited thereto. The artificial intelligence model may, additionally or alternatively, include a software structure other than the hardware structure.

(18) The memory **130** may store various data used by at least one component (e.g., the processor **120** or the sensor module **176**) of the electronic device **101**. The various data may include, for example, software (e.g., the program **140**) and input data or output data for a command related thereto. The memory **130** may include the volatile memory **132** or the non-volatile memory **134**.

(19) The program **140** may be stored in the memory **130** as software, and may include, for example, an operating system (OS) **142**, middleware **144**, or an application **146**.

(20) The input module **150** may receive a command or data to be used by another component (e.g., the processor **120**) of the electronic device **101**, from the outside (e.g., a user) of the electronic device **101**. The input module **150** may include, for example, a microphone, a mouse, a keyboard, a key (e.g., a button), or a digital pen (e.g., a stylus pen).

(21) The sound output module **155** may output sound signals to the outside of the electronic device **101**. The sound output module **155** may include, for example, a speaker or a receiver. The speaker may be used for general purposes, such as playing multimedia or playing record. The receiver may be used for receiving incoming calls. According to an embodiment, the receiver may be

implemented as separate from, or as part of the speaker.

(22) The display module **160** may visually provide information to the outside (e.g., a user) of the electronic device **101**. The display module **160** may include, for example, a display, a hologram device, or a projector and control circuitry to control a corresponding one of the display, hologram device, and projector. According to an embodiment, the display module **160** may include a touch sensor adapted to detect a touch, or a pressure sensor adapted to measure the intensity of force incurred by the touch.

(23) The audio module **170** may convert a sound into an electrical signal and vice versa. According to an embodiment, the audio module **170** may obtain the sound via the input module **150**, or output the sound via the sound output module **155** or a headphone of an external electronic device (e.g., an electronic device **102**) directly (e.g., wiredly) or wirelessly coupled with the electronic device **101**.

(24) The sensor module **176** may detect an operational state (e.g., power or temperature) of the electronic device **101** or an environmental state (e.g., a state of a user) external to the electronic device **101**, and then generate an electrical signal or data value corresponding to the detected state. According to an embodiment, the sensor module **176** may include, for example, a gesture sensor, a gyro sensor, an atmospheric pressure sensor, a magnetic sensor, an acceleration sensor, a grip sensor, a proximity sensor, a color sensor, an infrared (IR) sensor, a biometric sensor, a temperature sensor, a humidity sensor, or an illuminance sensor.

(25) The interface **177** may support one or more specified protocols to be used for the electronic device **101** to be coupled with the external electronic device (e.g., the electronic device **102**) directly (e.g., wiredly) or wirelessly. According to an embodiment, the interface **177** may include, for example, a high definition multimedia interface (HDMI), a universal serial bus (USB) interface, a secure digital (SD) card interface, or an audio interface.

(26) A connecting terminal **178** may include a connector via which the electronic device **101** may be physically connected with the external electronic device (e.g., the electronic device **102**). According to an embodiment, the connecting terminal **178** may include, for example, a HDMI connector, a USB connector, a SD card connector, or an audio connector (e.g., a headphone connector).

(27) The haptic module **179** may convert an electrical signal into a mechanical stimulus (e.g., a vibration or a movement) or electrical stimulus which may be recognized by a user via his tactile sensation or kinesthetic sensation. According to an embodiment, the haptic module **179** may include, for example, a motor, a piezoelectric element, or an electric stimulator.

(28) The camera module **180** may capture a still image or moving images. According to an embodiment, the camera module **180** may include one or more lenses, image sensors, image signal processors, or flashes.

(29) The power management module **188** may manage power supplied to the electronic device **101**. According to one embodiment, the power management module **188** may be implemented as at least part of, for example, a power management integrated circuit (PMIC).

(30) The battery **189** may supply power to at least one component of the electronic device **101**. According to an embodiment, the battery **189** may include, for example, a primary cell which is not rechargeable, a secondary cell which is rechargeable, or a fuel cell.

(31) The communication module **190** may support establishing a direct (e.g., wired) communication channel or a wireless communication channel between the electronic device **101** and the external electronic device (e.g., the electronic device **102**, the electronic device **104**, or the server **108**) and performing communication via the established communication channel. The communication module **190** may include one or more communication processors that are operable independently from the processor **120** (e.g., the application processor (AP)) and supports a direct (e.g., wired) communication or a wireless communication. According to an embodiment, the communication module **190** may include a wireless communication module **192** (e.g., a cellular communication module, a short-range wireless communication module, or a global navigation

satellite system (GNSS) communication module) or a wired communication module **194** (e.g., a local area network (LAN) communication module or a power line communication (PLC) module).

(32) A corresponding one of these communication modules may communicate with the external electronic device via the first network **198** (e.g., a short-range communication network, such as Bluetooth™, wireless-fidelity (Wi-Fi) direct, or infrared data association (IrDA)) or the second network **199** (e.g., a long-range communication network, such as a legacy cellular network, a 5G network, a next-generation communication network, the Internet, or a computer network (e.g., LAN or wide area network (WAN)). These various types of communication modules may be implemented as a single component (e.g., a single chip), or may be implemented as multi components (e.g., multi chips) separate from each other. The wireless communication module **192** may identify and authenticate the electronic device **101** in a communication network, such as the first network **198** or the second network **199**, using subscriber information (e.g., international mobile subscriber identity (IMSI)) stored in the subscriber identification module **196**.

(33) The wireless communication module **192** may support a 5G network, after a 4G network, and next-generation communication technology, e.g., new radio (NR) access technology. The NR access technology may support enhanced mobile broadband (eMBB), massive machine type communications (mMTC), or ultra-reliable and low-latency communications (URLLC). The wireless communication module **192** may support a high-frequency band (e.g., the mmWave band) to achieve, e.g., a high data transmission rate. The wireless communication module **192** may support various technologies for securing performance on a high-frequency band, such as, e.g., beamforming, massive multiple-input and multiple-output (massive MIMO), full dimensional MIMO (FD-MIMO), array antenna, analog beam-forming, or large scale antenna. The wireless communication module **192** may support various requirements specified in the electronic device **101**, an external electronic device (e.g., the electronic device **104**), or a network system (e.g., the second network **199**). According to an embodiment, the wireless communication module **192** may support a peak data rate (e.g., 20 Gbps or more) for implementing eMBB, loss coverage (e.g., 164 dB or less) for implementing mMTC, or U-plane latency (e.g., 0.5 ms or less for each of downlink (DL) and uplink (UL), or a round trip of 1 ms or less) for implementing URLLC.

(34) The antenna module **197** may transmit or receive a signal or power to or from the outside (e.g., the external electronic device) of the electronic device **101**. According to an embodiment, the antenna module **197** may include an antenna including a radiating element composed of a conductive material or a conductive pattern formed in or on a substrate (e.g., a printed circuit board (PCB)). According to an embodiment, the antenna module **197** may include a plurality of antennas (e.g., array antennas). In such a case, at least one antenna appropriate for a communication scheme used in the communication network, such as the first network **198** or the second network **199**, may be selected, for example, by the communication module **190** (e.g., the wireless communication module **192**) from the plurality of antennas. The signal or the power may then be transmitted or received between the communication module **190** and the external electronic device via the selected at least one antenna. According to an embodiment, another component (e.g., a radio frequency integrated circuit (RFIC)) other than the radiating element may be additionally formed as part of the antenna module **197**.

(35) According to various embodiments, the antenna module **197** may form a mmWave antenna module. According to an embodiment, the mmWave antenna module may include a printed circuit board, a RFIC disposed on a first surface (e.g., the bottom surface) of the printed circuit board, or adjacent to the first surface and capable of supporting a designated high-frequency band (e.g., the mmWave band), and a plurality of antennas (e.g., array antennas) disposed on a second surface (e.g., the top or a side surface) of the printed circuit board, or adjacent to the second surface and capable of transmitting or receiving signals of the designated high-frequency band.

(36) At least some of the above-described components may be coupled mutually and communicate signals (e.g., commands or data) therebetween via an inter-peripheral communication scheme (e.g.,

a bus, general purpose input and output (GPIO), serial peripheral interface (SPI), or mobile industry processor interface (MIPI)).

(37) According to an embodiment, commands or data may be transmitted or received between the electronic device **101** and the external electronic device **104** via the server **108** coupled with the second network **199**. Each of the electronic devices **102** or **104** may be a device of a same type as, or a different type, from the electronic device **101**. According to an embodiment, all or some of operations to be executed at the electronic device **101** may be executed at one or more of the external electronic devices **102**, **104**, or **108**. For example, if the electronic device **101** should perform a function or a service automatically, or in response to a request from a user or another device, the electronic device **101**, instead of, or in addition to, executing the function or the service, may request the one or more external electronic devices to perform at least part of the function or the service. The one or more external electronic devices receiving the request may perform the at least part of the function or the service requested, or an additional function or an additional service related to the request, and transfer an outcome of the performing to the electronic device **101**. The electronic device **101** may provide the outcome, with or without further processing of the outcome, as at least part of a reply to the request. To that end, a cloud computing, distributed computing, mobile edge computing (MEC), or client-server computing technology may be used, for example. The electronic device **101** may provide ultra-low latency services using, e.g., distributed computing or mobile edge computing. In another embodiment, the external electronic device **104** may include an internet-of-things (IoT) device. The server **108** may be an intelligent server using machine learning and/or a neural network. According to an embodiment, the external electronic device **104** or the server **108** may be included in the second network **199**. The electronic device **101** may be applied to intelligent services (e.g., smart home, smart city, smart car, or healthcare) based on 5G communication technology or IoT-related technology.

(38) The electronic device according to various embodiments may be one of various types of electronic devices. The electronic devices may include, for example, a portable communication device (e.g., a smartphone), a computer device, a portable multimedia device, a portable medical device, a camera, a wearable device, or a home appliance. According to an embodiment of the disclosure, the electronic devices are not limited to those described above.

(39) It should be appreciated that various embodiments of the present disclosure and the terms used therein are not intended to limit the technological features set forth herein to particular embodiments and include various changes, equivalents, or replacements for a corresponding embodiment. With regard to the description of the drawings, similar reference numerals may be used to refer to similar or related elements. It is to be understood that a singular form of a noun corresponding to an item may include one or more of the things, unless the relevant context clearly indicates otherwise. As used herein, each of such phrases as "A or B," "at least one of A and B," "at least one of A or B," "A, B, or C," "at least one of A, B, and C," and "at least one of A, B, or C," may include any one of, or all possible combinations of the items enumerated together in a corresponding one of the phrases. As used herein, such terms as "1st" and "2nd," or "first" and "second" may be used to simply distinguish a corresponding component from another, and does not limit the components in other aspect (e.g., importance or order). It is to be understood that if an element (e.g., a first element) is referred to, with or without the term "operatively" or "communicatively", as "coupled with," "coupled to," "connected with," or "connected to" another element (e.g., a second element), it means that the element may be coupled with the other element directly (e.g., wiredly), wirelessly, or via a third element.

(40) As used in connection with various embodiments of the disclosure, the term "module" may include a unit implemented in hardware, software, or firmware, and may interchangeably be used with other terms, for example, "logic," "logic block," "part," or "circuitry". A module may be a single integral component, or a minimum unit or part thereof, adapted to perform one or more functions. For example, according to an embodiment, the module may be implemented in a form of

an application-specific integrated circuit (ASIC).

(41) Various embodiments as set forth herein may be implemented as software (e.g., the program **140**) including one or more instructions that are stored in a storage medium (e.g., internal memory **136** or external memory **138**) that is readable by a machine (e.g., the electronic device **101**). For example, a processor (e.g., the processor **120**) of the machine (e.g., the electronic device **101**) may invoke at least one of the one or more instructions stored in the storage medium, and execute it, with or without using one or more other components under the control of the processor. This allows the machine to be operated to perform at least one function according to the at least one instruction invoked. The one or more instructions may include a code generated by a complier or a code executable by an interpreter. The machine-readable storage medium may be provided in the form of a non-transitory storage medium. Wherein, the term "non-transitory" simply means that the storage medium is a tangible device, and does not include a signal (e.g., an electromagnetic wave), but this term does not differentiate between where data is semi-permanently stored in the storage medium and where the data is temporarily stored in the storage medium.

(42) A method according to various embodiments of the disclosure may be included and provided in a computer program product. The computer program product may be traded as a product between a seller and a buyer. The computer program product may be distributed in the form of a machine-readable storage medium (e.g., compact disc read only memory (CD-ROM)), or be distributed (e.g., downloaded or uploaded) online via an application store (e.g., PlayStore™) or between two user devices (e.g., smart phones) directly. If distributed online, at least part of the computer program product may be temporarily generated or at least temporarily stored in the machine-readable storage medium, such as memory of the manufacturer's server, a server of the application store, or a relay server.

(43) According to various embodiments, each component (e.g., a module or a program) of the above-described components may include a single entity or multiple entities, and some of the multiple entities may be separately disposed in different components. According to various embodiments, one or more of the above-described components may be omitted, or one or more other components may be added. Alternatively or additionally, a plurality of components (e.g., modules or programs) may be integrated into a single component. In such a case, according to various embodiments, the integrated component may still perform one or more functions of each of the plurality of components in the same or similar manner as they are performed by a corresponding one of the plurality of components before the integration. According to various embodiments, operations performed by the module, the program, or another component may be carried out sequentially, in parallel, repeatedly, or heuristically, or one or more of the operations may be executed in a different order or omitted, or one or more other operations may be added.

(44) FIGS. **2**A and **2**B are diagrams illustrating exterior shapes of an electronic device, according to an embodiment.

(45) As illustrated in FIGS. **2**A and **2**B, an electronic device **200** may be a wearable device that can be worn on a finger. However, the electronic device **200** is not limited thereto. Various types of electronic devices, each of which having an optical sensor module (e.g., a PPG sensor) mounted thereto and acquiring biometric information of a user, may correspond to the electronic device **200** described herein. For example, the electronic device **200** may also be implemented as various wearable devices such as body-attachable devices (e.g., health patches or digital tattoos), clothing-type devices (e.g., smart clothing or gloves), or band-type devices (e.g., wrist/arm/finger bands or smart rings).

(46) As illustrated in FIGS. **2**A and **2**B, the electronic device **200** includes a housing **201**. The housing **201** may be implemented in a ring shape so as to at least partially surround the outer surface of an object to be measured (e.g., a finger of a user) when being worn, thereby preventing the housing **201** from being separated by the movement of the object to be measured.

(47) The housing **201** includes a first surface **203**, which is an inner surface brought into contact

with the outer surface of a part of the user's body when the user wears the electronic device. The housing also includes a second surface **205**, which is an outer surface viewable from the outside when the user wears the electronic device.

(48) The electronic device **200** includes multiple optical sensors **210**. The multiple optical sensors **210** are mounted on the first surface **203** of the housing **201** so as to be brought into contact with the outer surface of a part of the user's body, and so as to emit at least light in the inward direction of the housing **201**. For example, when the user wears the electronic device **200**, the multiple optical sensors **210** may emit light to the outer surface of a part of the user's body placed in the inward direction of the housing **201**, and may sense light reflected therefrom.

(49) The multiple optical sensors **210** may include at least one PPG sensor. In the PPG sensor, a light receiver **213** (e.g., a photodiode) may at least partially sense reflected light when light output by a light emitter **211** (e.g., a light emitting diode (LED)) is reflected by an external object (e.g., a finger of the user). The electronic device **200** may acquire, biometric information such as heart rate, stress, and blood oxygen saturation of (SpO.sub.2) of the user, based on the reflected light sensed by the at least one light receiver **213**.

(50) The multiple optical sensors **210** may be viewable from the outside through at least a part of the housing **201**.

(51) The multiple optical sensors **210** may be arranged in a ring shape of a one-column array at designated intervals (e.g., identical intervals or different intervals) along the first surface **203** of the housing **201**, for example, along the inner circumference thereof. The number and/or arrangement of the multiple optical sensors **210** is not limited to those illustrated, and various numbers of optical sensors **210** may be arranged in consideration of the size or shape (e.g., the circumferential length and width) of the housing **201** of the electronic device **200**. Furthermore, the multiple optical sensors **210** may be arranged in various forms in consideration of the size and/or sensing efficiency of the optical sensors **210**.

(52) Each of the multiple optical sensors **210** may include at least one light emitter **211** and at least one light receiver **213**. As illustrated in FIGS. **2**A and **2**B, each optical sensor **210** includes one light emitter **211** and one light receiver **213**, but the number and/or arrangement of light emitters **211** and light receivers **213**, included in each optical sensor **210**, may not be limited thereto. For example, each optical sensor **210** may include multiple light emitters **211** and/or multiple light receivers **213**.

(53) The light emitter **211** included in each of the multiple optical sensors **210** may output light of a visible light band (e.g., green, red, blue) and/or an infrared band (e.g., infra-red). For example, the light emitter **211** may output blue light having a wavelength of about 400 nm to about 550 nm, green light having a wavelength of about 450 nm to about 650 nm, red light having a wavelength of about 550 nm to about 700 nm, and/or infra-red (IR) light having a wavelength of about 880 nm to about 940 nm. When green light is used, the green light may be not sensitive to motion, but may have low skin transmissivity. When red light or IR is used, the red light or IR light may have high skin transmissivity, but may have a low signal intensity and may be sensitive to motion.

(54) The light emitter **211** included in each of the multiple optical sensors **210** may be implemented so as to be able to output light of various wavelength bands and/or various intensities. For example, the light emitter **211** included in each of the multiple optical sensors **210** may include multiple light-emitting elements (e.g., LEDs) capable of outputting at least one of green light, red light, and/or IR light. For example, the light emitter **211** may include at least one among an LED, an organic LED (OLED), a laser diode (LD), a solid laser, and an infrared (IR) diode.

(55) The light receiver **213** included in each of the multiple optical sensors **210** may include various elements capable of sensing a light signal, converting the light signal to an electrical signal, and outputting the electrical signal. For example, the light receiver **213** may include at least one among a photo diode (PD), an avalanche PD (APD), a phototransistor, and an image sensor.

(56) An optical sensor module may further include an analog front end (AFE), such as, for

example, an amplifier, a band pass filter (BPF), and/or an analog-to-digital converter (ADC), for processing the electrical signal output by the light receiver **213**.

(57) The electronic device **200** may filter the electrical signal output by the light receiver **213** through analog control, such as, for example, offset correction and gain adjustment, using the AFE, and then may acquire biometric row data in the form of a digital signal. The electronic device **200** may calculate, based on the biometric raw data, biometric information such as the heart rate, stress, and blood oxygen saturation (SpO.sub.2) of the user.

(58) The light receiver **213** included in each of the multiple optical sensors **210** may sense reflected light of at least a part of the light output by the light emitter **211** included in the same optical sensor **210** among the multiple optical sensors **210**, may sense reflected light of at least a part of light output by a light emitter **211** included in a different optical sensor **210**, and/or may sense reflected light of at least a part of light output by all light emitters **211** included in the multiple optical sensors **210**. The principle of acquiring biometric information of a user using the optical sensors **210** is described in greater detail below with reference to FIG. **3**.

(59) A display may be disposed on the second surface **205** (e.g., a surface viewable from the outside when the user wears the electronic device) of the housing **201**. For example, the display may display various application screens, such as, for example, time information, a message, or a call.

(60) The electronic device **200** may further include a motion sensor. The motion sensor may include various types of sensors capable of sensing motion of the electronic device **200**, such as, for example, a gyro sensor, an acceleration sensor, or a geomagnetic sensor. The motion sensor may acquire at least one sensing signal changing depending on the motion of a user wearing the electronic device **200**. The electronic device **200** may determine, based on the sensing signal of the motion sensor, the degree of motion of the electronic device **200** and/or the user wearing the electronic device **200**.

(61) FIG. **3** is a diagram illustrating a principle of an optical sensor, according to an embodiment.

(62) FIG. **3** illustrates a principle by which reflected light of at least a part of light, which has been output from light-emitting elements of the light emitter **211**, has hit an external object **310** (e.g., a user's finger), and then has been reflected, is sensed through the light receiver **213** while a user wears the electronic device **200**. FIG. **3** illustrates an optical sensor which includes the light emitter **211** having two light-emitting elements, and the light receiver **213**. However, as described above, the electronic device **200** may include multiple optical sensors **210**, and each optical sensor may include multiple light emitters **211** and light receivers **213**.

(63) The light emitter **211** may output light of a designated wavelength band (e.g., green, red, blue, IR), based on a control signal of a processor. Light output by the light emitter **211** may be reflected by a perfused tissue **311** and/or a bone **313**, and the properties of a reflected light signal received by the light receiver **213** may vary depending on the user's body condition. For example, when blood flowing through a blood vessel of the user's wrist increases, the blood vessel dilates, and thus, the amount of reflected light, which is reflected and sensed by the light receiver **213**, may decrease. Therefore, the electronic device **200** may measure biometric information such as the heart rate, stress, and blood oxygen saturation (SpO.sub.2) of the user based on the properties of the reflected light sensed by the light receiver **213**.

(64) FIG. **4** is a block diagram illustrating an electronic device, according to an embodiment.

(65) As illustrated in FIG. **4**, an electronic device **400** includes an optical sensor module **410**, a motion sensor **420**, a processor **430**, a memory **440**, a display **450**, and a communication module **460**. The elements illustrated in FIG. **4** are merely an example, and some elements may be omitted or replaced, or may be integrated as a single module.

(66) The electronic device **400** may include the wearable electronic device **200** described above through FIGS. **2**A and **2**B, but is not limited thereto. Thus, various types of electronic devices, which include the optical sensor module **410** and can acquire biometric information of a user, may

correspond to the electronic device **400**. For example, the electronic device **400** may include wearable devices such as a body-attachable device (e.g., a health patch, or a digital tattoo), a clothing device (e.g., smart clothing or gloves), and a band-type device (e.g., a wrist/arm/finger band, or a smart ring).

(67) The optical sensor module **410** includes multiple optical sensors **411-1**, **411-2**, . . . , **411**-N. The multiple optical sensors **411-1**, **411-2**, . . . , **411**-N included in the optical sensor module **410** include respective light emitters **413-1**, **413-2**, . . . , **413**-N and respective light receivers **415-1**, **415-2**, . . . , **415**-N.

(68) As described with reference to FIGS. **2**A and **2**B, the multiple optical sensors **411-1**, **411-2**, . . . , **411**-N of the optical sensor module **410** may be arranged in a line at a predetermined interval along the circumference of the inner surface of a housing of the electronic device **400**, and may be brought into contact with (or may approach) the surface of a part of the user's body when the user wears the electronic device **400**.

(69) Each of the light emitters **413-1**, **413-2**, . . . , **413**-N included in the respective optical sensors **411-1**, **411-2**, . . . , **411**-N may include multiple light-emitting elements in order to output light having a designated wavelength band and/or different light intensities and including green light, red light, blue light and/or IR light. Each optical sensor is shown to include one light emitter **413-1**, **413-2**, . . . , **413**-N, but there may be more than one light emitter included in each optical sensor. Each of the light receivers **415-1**, **415-2**, . . . , **415**-N included in the multiple optical sensors **411-1**, **411-2**, . . . , **411**-N may include at least one light-receiving element (e.g., a PD, an APD, a phototransistor, or an image sensor) capable of sensing a light signal, converting the light signal to an electrical signal, and outputting the electrical signal. Each optical sensor is shown to include one light receiver **415-1**, **415-2**, . . . , **415**-N, but there may be more than one light receiver included in each optical sensor.

(70) The optical sensor module **410** may be electrically connected to the processor **430**, and each of the multiple optical sensors **411-1**, **411-2**, . . . , **411**-N may independently operate based on a control signal of the processor **430**.

(71) The multiple optical sensors **411-1**, **411-2**, . . . , **411**-N may be controlled to operate at different timings, based on a control signal of the processor **430**, or the multiple optical sensors may be controlled to operate at a substantially identical timing. For example, the respective light emitters **413-1**, **413-2**, . . . , **413**-N of the multiple optical sensors **411-1**, **411-2**, . . . , **411**-N may be controlled to sequentially emit light at different timings, respectively, or all of the light emitters **413-1**, **413-2**, . . . **413**-N may be controlled to emit light at a substantially identical timing.

(72) Operations of the respective light emitters **413-1**, **413-2**, . . . , **413**-N and the respective light receivers **415-1**, **415-2**, . . . , **415**-N of the multiple optical sensors **411-1**, **411-2**, . . . , **411**-N may be independently controlled based on the control signal of a processor **430**.

(73) Each of the light receivers **415-1**, **415-2**, . . . , **415**-N of the multiple optical sensors **411-1**, **411-2**, . . . , **411**-N may receive, when light is emitted from a light emitter of an identical optical sensor among the respective light emitters **413-1**, **413-2**, . . . , **413**-N of the multiple optical sensors **411-1**, **411-2**, . . . , **411**-N, a light signal received by reflection of the emitted light. For example, a light receiver **415**-n of an optical sensor (e.g., **411**-n, $1 \leq n \leq N$) may receive a light signal when light emitted by a light emitter **413**-n of the optical sensor **411**-n is reflected and received.

(74) Each of the light receivers **415-1**, **415-2**, . . . , **415**-N of the multiple optical sensors **411-1**, **411-2**, . . . , **411**-N may receive, even when light is emitted from light emitters of other optical sensors among the respective light emitters **413-1**, **413-2**, . . . , **413**-N of the multiple optical sensors **411-1**, **411-2**, . . . , **411**-N, light signals received by reflection of the emitted light. For example, a light receiver (**415**-n) of an optical sensor (e.g., **411**-n, $1 \leq n \leq N$) may receive a light signal received by reflection of light emitted by a light emitter (**413**-m) of another optical sensor (e.g., **411**-m, $1 \leq m \leq N$, $m \neq n$) different from the optical sensor (**411**-n).

(75) When light is emitted from all the light emitters **413-1**, **413-2**, . . . , **413**-N of the multiple

optical sensors **411-1**, **411-2**, . . . , **411**-N, the respective light receivers **415-1**, **415-2**, . . . , **415**-N of the multiple optical sensors **411-1**, **411-2**, . . . , **411**-N may receive light signals received by reflection of the emitted light. For example, when the respective light emitters **413-1**, **413-2**, . . . , **413**-N of the multiple optical sensors **411-1**, **411-2**, . . . , **411**-N emit light while being controlled to substantially simultaneously emit light, reflected light signals may be received by the respective light receivers **415-1**, **415-2**, . . . , **415**-N.

(76) The optical sensor module **410** further includes a sensor controller **417** electrically connected to the multiple optical sensors **411-1**, **411-2**, . . . , **411**-N and capable of independently controlling an operation of each of the optical sensors.

(77) The sensor controller **417** may operate as an analog front end for processing a light signal received from the multiple optical sensors **411-1**, **411-2**, . . . , **411**-N and transmitting the light signal to the processor **430**. For example, the sensor controller **417** may perform a signal pre-processing process through filtering such as gain control and/or offset correction with respect to an electrical signal converted from the light signal received from the multiple optical sensors **411-1**, **411-2**, . . . **411**-N, and may convert the electrical signal to a digital signal.

(78) The sensor controller **417** may be operatively connected to the processor **430** and the multiple optical sensors **411-1**, **411-2**, . . . , **411**-N, and may function as an interface for controlling signal transmission/reception between the processor **430** and the multiple optical sensors **411-1**, **411-2**, . . . , **411**-N. For example, the sensor controller **417** may receive a control signal of the processor **430** to drive a light emitter (**413**-*n*) of at least one optical sensor (e.g., **411**-*n,* $1 \leq n \leq N$) among the multiple optical sensors **411-1**, **411-2**, . . . , **411**-N, such that the light emitter emits light having a designated intensity in a designated wavelength band. For example, the sensor controller **417** may receive a control signal of the processor **430** to process a light signal sensed by a light receiver (**415**-*m*) of at least one optical sensor (e.g., **411**-*m,* $1 \leq m \leq N$) among the multiple optical sensors **411-1**, **411-2**, . . . , **411**-N, and may provide the processed light signal to the processor **430**.

(79) The motion sensor **420** may include various types of sensors capable of sensing the motion of the electronic device **400**, such as gyro sensor and an acceleration sensor. The motion sensor **420** may be electrically connected to the processor **430**, and may provide, to the processor **430**, a motion signal generated based on sensing of the motion of the electronic device **400**.

(80) The memory **440** may include a volatile memory and/or a nonvolatile memory **440**, may be electrically connected to the processor **430**, and may store various instructions executed by the processor **430**. The instructions may include a control command, such as arithmetic and logic calculation, data movement, or an input/output, which can be recognized by a control circuit, and may be defined on a framework stored in the memory **440**. Furthermore, the memory **440** may store at least a part of the program **140** in FIG. **1**.

(81) The processor **430** may perform calculation or data processing regarding communication and/or control of each of the elements of the electronic device **400**, and may include at least a part of the configuration and/or function of the processor **120** in FIG. **1**. For example, the processor **430** may be electrically connected to the optical sensor module **410**, the motion sensor **420**, the memory **440**, the display **450**, and the communication module **460** to control these elements and/or process calculation and/or data related to operations of these elements.

(82) The processor **430** may load the instructions stored in the memory **440**, and may control the elements of the electronic device **400** to perform operations of implementing various embodiments based on the loaded instructions and/or may process calculation and/or data related to operations of these elements.

(83) The processor **430** may use the optical sensor module **410** to acquire a bio-signal from a part of a user's body (e.g., a user's finger), and may calculate, based on the bio-signal, biometric information such as the heart rate, stress, and blood oxygen saturation (SpO.sub.2) of the user.

(84) In order to acquire desired biometric information, the processor **430** may determine, based on signals sensed by the optical sensor module **410** and/or the motion sensor **420**, the current state

(e.g., a normal state, a sleep state, an exercise state, or an event occurrence state) of the user wearing the electronic device **400**.

(85) The processor **430** may control, based on the determined current state of the user, the sensor controller **417** of the optical sensor module **410** such that, based on signal characteristics of the multiple optical sensors **411-1**, **411-2**, . . . , **411**-N, the light emitter (**413**-*n*) of the at least one optical sensor (e.g., **411**-*n*, 1≤n≤N) emits light and such that a reflected and received light signal is received through the light receiver (**415**-*m*) of the at least one optical sensor (e.g., **411**-*m*, 1≤m≤N).

(86) The display **450** may include at least a part of the configuration and/or function of the display module in FIG. **1**. For example, the display **450** may include a liquid crystal display (LCD), an LED display, or an OLED display.

(87) The display **450** may provide various types of visual information related to biometric information acquired by the processor **430**. For example, the display **450** may display various types of visual information generated based on biometric information or a necessary visual notification in relation to biometric information acquisition.

(88) The communication module **460** may include at least a part of the configuration and/or function of the communication module **190** in FIG. **1**. For example, the communication module **460** may provide, under control of the processor **430**, communication with various external electronic devices (e.g., the electronic devices **102** and **104** or the server **108** in FIG. **1**). For example, the electronic device **400** may perform short-range wireless communication by using the communication module **460**. The electronic device **400** may communicate with at least one external electronic device **102**, **104**, or **108**, based on near field communication (NFC), Bluetooth, Bluetooth low energy (BLE), Wi-Fi Direct, and/or ultra-wideband (UWB) communication. In another example, the electronic device **400** may perform long-range wireless communication by using the communication module **460**. The electronic device **400** may be connected to an external network (e.g., a cellular network) by using the communication module **460**.

(89) FIG. **5** is a block diagram illustrating an optical sensor module of an electronic device, according to an embodiment.

(90) FIG. **5** illustrates the circuit structure of an optical sensor unit **510** and a sensor controller **520** for controlling the optical sensor unit of an optical sensor module of an electronic device **500**.

(91) For example, the optical sensor unit **510** includes multiple optical sensors (e.g., a first optical sensor **511**, a second optical sensor **512**, a third optical sensor **513**, and a fourth optical sensor **514**). Four optical sensors are illustrated as an example, however, the number of multiple optical sensors is not limited, and various numbers of optical sensors may be adopted.

(92) As illustrated in FIG. **5**, each of the optical sensors **511**, **512**, **513**, and **514** of the multiple optical sensors may include one light emitter (e.g., a first light emitter **511***a*, a second light emitter **512***a*, a third light emitter **513***a*, and a fourth light emitter **514***a*) and one light receiver (e.g., a first light receiver **511***b*, a second light receiver **512***b*, a third light receiver **513***b*, and a fourth light receiver **514***b*), respectively. Each of the optical sensors has been illustrated as including one light emitter and one light receiver, but embodiments are not limited thereto. Each of the optical sensors may be implemented so as to have at least two light emitters and/or at least two light receivers.

(93) The sensor controller **520** is electrically provided between a processor **530** and the optical sensor unit **510**, and may control the multiple optical sensors **511**, **512**, **513**, and **514** based on a control signal of the processor **530** to drive the respective light emitters **511***a*, **512***a* **513***a*, and **514***a*. The sensor controller **520** may provide, to the processor **530**, signals received from the respective light receivers **511***b*, **512***b*, **513***b*, and **514***b*. For example, the sensor controller **520** may include the sensor controller **417** described with reference to FIG. **4**. Under control of the processor **530**, the sensor controller **520** may emit light through at least one light emitter **511***a*, **512***a*, **513***a*, or **514***a* of the multiple optical sensors **511**, **512**, **513**, and **514**, and may perform a signal pre-processing process through filtering, such as, for example, gain control and/or offset correction, with respect to a light signal received through at least one light receiver **511***b*, **512***b*, **513***b*, or **514***b*, to convert the

light signal to a digital signal.

(94) The sensor controller **520** includes a light emitter driving circuit **521**, a multiplexer (MUX) **523**, and an analog-to-digital converter (ADC) **525**.

(95) The light emitter driving circuit **521** may drive, based on a control signal of the processor **530**, at least one light emitter, for example, the first light emitter **511***a*, the second light emitter **512***a*, the third light emitter **513***a*, and/or the fourth light emitter **514***a*, of the multiple optical sensors, for example, the first optical sensor **511**, the second optical sensor **512**, the third optical sensor **513**, and/or the fourth optical sensor **514**.

(96) The first light emitter **511***a*, the second light emitter **512***a*, the third light emitter **513***a*, and/or the fourth light emitter **514***a* may have various output intensities and output wavelengths. For example, the first light emitter **511***a*, the second light emitter **512***a*, the third light emitter **513***a*, and/or the fourth light emitter **514***a* may have multiple light-emitting elements having different attributes in output intensity and/or output wavelength. The control signal, which the sensor controller **520** (or, the light emitter driving circuit **521**) receives from the processor **530**, may include information about a light emitter to be driven and information about the output intensity and/or output wavelength of light that is to be output by the light emitter to be driven.

(97) The first light receiver **511***b*, the second light receiver **512***b*, the third light receiver **513***b*, and/or the fourth light receiver **514***b* of the multiple optical sensors may sense the amount of light and may output an analog electrical signal (hereinafter, referred to as "light signal") corresponding to the sensed amount of light. For example, each of the first light receiver **511***b*, the second light receiver **512***b*, the third light receiver **513***b*, and/or the fourth light receiver **514***b* may include at least one light-receiving element (e.g., a PD, an APD, a phototransistor, and/or an image sensor) capable of sensing the amount of light and outputting an analog electrical signal corresponding to the sensed amount of light.

(98) A light signal that is output from each of the first light receiver **511***b*, the second light receiver **512***b*, the third light receiver **513***b*, and/or the fourth light receiver **514***b* of the multiple optical sensors may be input into the MUX **523**, and the MUX **523** may transfer, under control the processor **530**, the light signal to the processor **530** through the ADC **525**. For example, the MUX **523** may output signals transferred from the light receivers **511***b*, **512***b*, **513***b*, and **514***b* to the ADC **525** through separate respective channels. The MUX **523** may output some signals selected from among signals transmitted from the respective light receivers **511***b*, **512***b*, **513***b*, and **514***b* to the ADC **525** through corresponding channels. The MUX **523** may output all of the signals transmitted from the respective light receivers **511***b*, **512***b*, **513***b*, and **514***b* to the ADC **525** through corresponding channels. All of the signals transmitted from the respective light receivers **511***b*, **512***b*, **513***b*, and **514***b* may be outputted to the ADC **525** through one channel.

(99) FIG. **6** is a diagram illustrating a state in which an electronic device including multiple optical sensors is worn, according to an embodiment.

(100) The structure and operation of an electronic device **600** illustrated in FIG. **6** is similar or identical to the structure of the electronic device **200** illustrated in FIGS. **2**A and **2**B and the operation of the electronic device **400** or **500** illustrated in FIG. **4** or **5**, and a description of technical features described above are omitted below. For example, the electronic device **600** in FIG. **6** will be described with, for example, four optical sensors among multiple optical sensors as in the electronic device **500** of FIG. **5** for convenience of description.

(101) A first surface **603** of a housing **601** of the electronic device **600** may be brought into contact with a part (e.g., a finger) of a user's body when the electronic device **600** is worn by the user, and a second surface **605** may be visually viewable from the outside. A first optical sensor **611**, a second optical sensor **612**, a third optical sensor **613**, and a fourth optical sensor **614** of the electronic device **600** respectively include a first light emitter **611***a*, a second light emitter **612***a*, a third light emitter **613***a*, and a fourth light emitter **614***a*, each of which emits light in a designated intensity and/or a designated wavelength band. For example, each of the first light emitter **611***a*, the second

light emitter **612***a*, the third light emitter **613***a*, and the fourth light emitter **614***a* may include multiple light-emitting elements (e.g., LEDs) that can output blue light having a wavelength of about 400 nm to about 550 nm, green light having a wavelength of about 450 nm to about 650 nm, red light having a wavelength of about 550 nm to about 700 nm, and/or infra-red (IR) light having a wavelength of about 880 nm to about 940 nm, respectively.

(102) The first optical sensor **611**, the second optical sensor **612**, the third optical sensor **613**, and the fourth optical sensor **614** of the electronic device **600** respectively include at least one first light receiver **611***b*, at least one second light receiver **612***b*, at least one third light receiver **613***b*, and at least one fourth light receiver **614***b*. For example, the at least one first light receiver **611***b*, the at least one second light receiver **612***b*, the at least one third light receiver **613***b*, and the at least one fourth light receiver **614***b* may output light signals corresponding to the amount of light which is emitted by at least one of the first light emitter **611***a*, the second light emitter **612***a*, the third light emitter **613***a*, and the fourth light emitter **614***a*, is reflected by a part of the user's body, and is received. For example, each of the first light receiver **611***b*, the second light receiver **612***b*, the third light receiver **613***b*, and the fourth light receiver **614***b* may include at least one light-receiving element (e.g., a PD, an APD, a phototransistor, or an image sensor).

(103) The first optical sensor **611**, the second optical sensor **612**, the third optical sensor **613**, and the fourth optical sensor **614** of the electronic device **600** are disposed on the first surface **603** of the housing **601** along the inner circumference at a designated interval.

(104) The electronic device **600** includes a display **620** that is mounted on the second surface **605** of the housing **601** and is viewed from the outside when the user wears the electronic device **600**. For example, the electronic device **600** may display various application screens, such as, for example, time information, a message notification, and a call through the display **620**. In another example, the electronic device **600** may provide, through the display **620**, various types of visual information related to biometric information acquired by the processor **430** or **530** of FIG. **4** or **5**. For example, the display **620** may display various types of visual information generated based on biometric information or a necessary visual notification related to biometric information acquisition.

(105) When the electronic device **600** is worn, each of the first optical sensor **611**, the second optical sensor **612**, the third optical sensor **613**, and the fourth optical sensor **614** may be brought into contact with a part (e.g., a finger) of the user's body at a designated position or in a designated direction along the circumference of the user's finger.

(106) For example, in the case of the ring-type wearable electronic device **600**, the electronic device **600** may often rotate without being fixed to the finger of the user while being worn. The position or direction in which each optical sensor of the electronic device **600** is brought into contact with the finger may be changed over time.

(107) FIG. **6** illustrates an example in which, while the electronic device **600** is worn on an object **790** (e.g., the user's finger) to be measured, the first optical sensor **611** among the multiple optical sensors along the circumference of the finger is positioned in the palmar-side direction **791**, the second optical sensor **612** is positioned at about 90 degrees in the clockwise direction from the first optical sensor **611**, the third optical sensor **613** is positioned in the dorsal-side direction **793**, and the fourth optical sensor **614** is positioned at about 270 degrees in the clockwise direction from the first optical sensor **611**.

(108) A processor may separately operate each of the first optical sensor **611**, the second optical sensor **612**, the third optical sensor **613**, and the fourth optical sensor **614**. For example, the processor **430** or **530** may drive and control at least one among the first light emitter **611***a*, the second light emitter **612***a*, the third light emitter **613***a*, and the fourth light emitter **614***a* of the first optical sensor **611**, the second optical sensor **612**, the third optical sensor **613**, and the fourth optical sensor **614**, to output light. The processor **430** or **530** may receive a light signal from at least one among the first light receiver **611***b*, the second light receiver **612***b*, the third light receiver

613*b*, and the fourth light receiver **614***b* of the first optical sensor **611**, the second optical sensor **612**, the third optical sensor **613**, and the fourth optical sensor **614**.

(109) The processor **430** or **530** may separately operate each of the first optical sensor **611**, the second optical sensor **612**, the third optical sensor **613**, and the fourth optical sensor **614** at a different timing to receive a light signal.

(110) The processor **430** or **530** may sequentially operate the first optical sensor **611**, the second optical sensor **612**, the third optical sensor **613**, and the fourth optical sensor **614**, to receive light signals. For example, the processor **430** or **530** may drive the first light emitter **611***a* to receive a light signal through the first light receiver **611***b*, may subsequently operate the second light emitter **612***a* to receive a light signal through the second light receiver **612***b*, may subsequently operate the third light emitter **613***a* to receive a light signal through the third light receiver **613***b*, and may subsequently operate the fourth light emitter **614***a* to receive a light signal through the fourth light receiver **614***b*. The processor **430** or **530** may sequentially drive the first light emitter **611***a*, the second light emitter **612***a*, the third light emitter **613***a*, and the fourth light emitter **614***a* at a designated interval (e.g., an interval of 0.025 see) to receive light signals through the respective light receivers.

(111) An electronic device is provided that includes a housing, a motion sensor, and optical sensors disposed on one surface of the housing so as to be brought into contact with an object to be measured when the electronic device is worn. Each of the optical sensors comprises a respective light emitter and a respective light receiver. The electronic device also includes a sensor controller configured to control the optical sensors, and a processor operatively connected to the motion sensor and the sensor controller. The processor is configured to separately drive the optical sensors through the sensor controller to determine a respective signal characteristic of each of the optical sensors, and determine a current state of the object to be measured, based on at least one signal received through the motion sensor or the optical sensors. The processor is also configured to drive a light emitter of at least one of the optical sensors through the sensor controller, based on the respective signal characteristics of the optical sensors according to the current state of the object to be measured, and select and receive, based on the respective signal characteristics of the optical sensors, a light signal sensed through a light receiver of at least one of the optical sensors.

(112) The housing may include a ring type housing, and the optical sensors may be disposed at a designated interval on the inner surface of the housing.

(113) The processor may be configured to separately receive light signals, reflected from light output by driving, through the sensor controller, respective light emitters included in at least two of the optical sensors, and sensed by the light receivers of the at least two optical sensors. When intensities of at least two of the separately received light signals are larger than a designated value, the processor may be configured to drive the optical sensors to determine the respective signal characteristic of each of the optical sensors.

(114) The processor may be configured to receive light signals, reflected from light output by driving, through the sensor controller, light emitters included in the optical sensors at different timings and sensed by the light receivers of the optical sensors. The processor may be further configured to determine, based on the light signals, the respective signal characteristics of the optical sensors.

(115) The processor may be further configured to analyze characteristics of the light signals to determine an optical sensor having an optimal signal characteristic from among the optical sensors.

(116) The processor may be further configured to drive, based on the current state, a light emitter of the optical sensor having the optimal signal characteristic to emit light.

(117) The processor may be further configured to select and receive, based on the current state, a light signal sensed through a light receiver of the optical sensor having the optimal signal characteristic, through the sensor controller.

(118) The processor may be further configured to select and receive, based on the current state, a

light signal sensed through a light receiver of an optical sensor positioned, in the housing, opposite to the optical sensor having the optimal signal characteristic, through the sensor controller.

(119) The processor may be further configured to cause, through the sensor controller, the light emitters included in the optical sensors to emit, based on the current state, light at an identical timing. The processor may be further configured to select and receive light signals sensed by the light receivers included in the optical sensors.

(120) The processor may be further configured to determine, based on the at least one signal received through the motion sensor or the multiple optical sensors, that the current state of the object is at least one among a normal state, a sleep state, an exercise state, and an event occurrence state.

(121) The processor may be further configured to adjust, based on the current state, at least one of an intensity and a wavelength of at least one light emitter included in the optical sensors so as to emit light.

(122) The processor may be further configured to, when the current state is determined to be the exercise state, separately receive light signals, which are reflected from light output by driving, through the sensor controller, the light emitters included in the optical sensors at different timings and, which are sensed by light receivers of the optical sensors.

(123) The processor may be further configured to separately drive the optical sensors through the sensor controller for each designated period to determine the respective signal characteristic of each of the optical sensors. The processor may be further configured to determine the current state of the object, based on the at least one signal received through the motion sensor or the optical sensors.

(124) The processor may be further configured to, when a designated event occurs according to the determination of the current state of the object, control, based on the type of the designated event, driving of the light emitter of at least one of the optical sensors through the sensor controller to emit light, and select and receive a light signal sensed through the light receiver of the at least one of the optical sensors.

(125) FIG. **7** is a diagram illustrating signal characteristics of multiple optical sensors of an electronic device, according to an embodiment. In FIG. **7**, the horizontal axis indicates the number of samples. Samples may be acquired in units of about 5 ms, and 200 samples may imply one second. In FIG. **7**, the vertical axis indicates a magnitude value of a light signal.

(126) Referring to FIG. **7**, a first signal **711** indicates a light signal that has been received through the first light receiver **611***b* of the first optical sensor **611** positioned in the palmar-side direction by driving the first light emitter **611***a* of the first optical sensor **611** positioned in the palmar-side direction. A third signal **713** indicates a light signal that has been received through the third light receiver **613***b* of the third optical sensor **613** positioned in the dorsal-side direction by driving the third light emitter **613***a* of the third optical sensor **613** positioned in the dorsal-side direction. A second signal **712** indicates a light signal that has been received through the second light receiver **612***b* of the second optical sensor **612** by driving the second light emitter **612***a* of the second optical sensor **612**. A fourth signal **714** indicates a light signal that has been received through the fourth light receiver **614***b* of the fourth optical sensor **614** by driving the fourth light emitter **614***a* of the fourth optical sensor **614**.

(127) A processor may analyze and compare signal characteristics of the first signal **711**, the second signal **712**, the third signal **713**, and the fourth signal **714**, which are light signals sensed through the first optical sensor **611**, the second optical sensor **612**, the third optical sensor **613**, and the fourth optical sensor **614**, respectively. The processor may determine a signal, which is the most suitable for biometric information acquisition, based on the result of comparison between the signal characteristics. For example, the signal characteristics may include the magnitude of noise (e.g., a signal-to-noise ratio (SNR) or an AC component (e.g., a peak-to-peak value).

(128) Referring to FIG. **7** again, for example, it can be found that an AC component **711***a* (e.g., a

peak-to-peak value) of the first signal **711**, which is a light signal sensed by the first optical sensor **611** positioned in the palmar-side direction, has a largest value when compared with other signals (e.g., the second signal **712**, the third signal **713**, and the fourth signal **714**).

(129) The processor **430** or **530** may determine, based on the signal characteristics of light signals sensed by the first optical sensor **611**, the second optical sensor **612**, the third optical sensor **613**, and the fourth optical sensor **614**, an optical sensor that is to be used as a main sensor among the first optical sensor **611**, the second optical sensor **612**, the third optical sensor **613**, and the fourth optical sensor **614** in order to sense a bio-signal. For example, the processor may determine that the AC component of the first signal **711**, which is a light signal sensed by the first optical sensor **611**, has the largest value when compared with AC components of other signals (e.g., the second signal **712**, the third signal **713**, and the fourth signal **714**), and may determine, based on the signal characteristics, that the first optical sensor **611** is a main sensor to be used to sense a bio-signal.

(130) When time passes, the positions of contact of multiple optical sensors with a part (e.g., a finger) of a user's body may vary depending on the motion of the electronic device, and thus, for example, the processor may drive each of the first optical sensor **611**, the second optical sensor **612**, the third optical sensor **613**, and the fourth optical sensor **614** at a different timing at a designated time interval (e.g., every 10 minutes) or at the time of occurrence of a biometric information measurement event to determine, as described above, a signal characteristic of a light signal sensed by each optical sensor, and may determine, based thereon, a sensor to be used as a main sensor.

(131) FIG. **8** is a flowchart illustrating a method for determining signal characteristics of multiple optical sensors of an electronic device, according to an embodiment.

(132) Operations of an electronic device including multiple optical sensors, illustrated in FIG. **8**, may be performed by a processor, and, hereinafter, will be described with main reference to the structure of the electronic device **600** in FIG. **6**. A description of technical features that are described in detail above, are omitted below.

(133) At **801**, the processor determines whether the electronic device is worn on a user's body.

(134) For example, the processor may control multiple optical sensors to be separately driven. When at least two, or most, of the magnitudes of respectively received light signals have a value greater than a designated value, the processor may determine that the electronic device is in a worn state. Optical sensors that are driven in order to determine whether the electronic device is in a worn state may be all of the multiple optical sensors, or may be limited to at least two optical sensors that are designated based on each direction (e.g., four optical sensors at a 90-degree interval, or three optical sensors at a 120-degree interval) among the multiple optical sensors.

(135) For example, the processor may control, through a sensor controller, the first optical sensor **611**, the second optical sensor **612**, the third optical sensor **613**, and the fourth optical sensor **614** of FIG. **6** to respectively drive the first light emitter **611***a*, the second light emitter **612***a*, the third light emitter **613***a*, and the fourth light emitter **614***a* of FIG. **6**, so as to emit light (e.g., IR light) having a designated intensity and/or wavelength. The processor may determine that the electronic device is in the worn state, when the magnitude of a IR light signal received through each of the first light receiver **611***b*, the second light receiver **612***b*, the third light receiver **613***b*, and the fourth light receiver **614***b* is greater than or equal to a designated value.

(136) At **803**, the processor drives the multiple optical sensors at different timings in order to determine a signal characteristic of each of the multiple optical sensors. For example, with respect to FIG. **6**, the processor may sequentially drive the first light emitter **611***a*, the second light emitter **612***a*, the third light emitter **613***a*, and the fourth light emitter **614***a* of the first optical sensor **611**, the second optical sensor **612**, the third optical sensor **613**, and the fourth optical sensor **614**.

(137) When the multiple optical sensors are sequentially driven in at **803**, the processor receives, at **805**, light signals sequentially sensed by the multiple optical sensors. For example, the processor may receive light signals sequentially sensed through the first light receiver **611***b*, the second light

receiver **612***b*, the third light receiver **613***b*, and the fourth light receiver **614***b* of FIG. **6**, respectively, when light emitted by sequentially driving the first light emitter **611***a*, the second light emitter **612***a*, the third light emitter **613***a*, and the fourth light emitter **614***a* is reflected by a part of the user's body.

(138) At **807**, the processor analyzes a signal characteristic of each of the sensed light signals. For example, the processor may analyze an AC component of each of the light signals sensed through the first light receiver **611***b*, the second light receiver **612***b*, the third light receiver **613***b*, and the fourth light receiver **614***b* of FIG. **6** to determine signal characteristics of the first optical sensor **611**, the second optical sensor **612**, the third optical sensor **613**, and the fourth optical sensor **614**.

(139) FIG. **9** is a flowchart illustrating a method for controlling multiple optical sensors of an electronic device based on signal characteristics of the multiple optical sensors, according to an embodiment.

(140) Operations of an electronic device including multiple optical sensors according to various embodiments, illustrated in FIG. **9**, may be performed by a processor, and, hereinafter, will be described with main reference to the structure of the electronic device **600** of FIG. **6**. A description of technical features described in detail above are omitted below.

(141) At **901**, the processor determines signal characteristics of multiple optical sensors. For example, the processor may analyze signal characteristics of the first optical sensor **611**, the second optical sensor **612**, the third optical sensor **613**, and the fourth optical sensor **614** of FIG. **6**, according to operations **801** to **807** of FIG. **8**, and may determine, based on the analysis result, an optical sensor (e.g., the first optical sensor **611**) to be used as a main sensor.

(142) At **903**, the processor determines the current state (e.g., a normal state, a sleep state, an exercise state, or a designated event occurrence state) of a user wearing the electronic device.

(143) For example, the processor may determine, based on a sensing signal of a motion sensor, the current state (e.g., a normal state, a sleep state, an exercise state, or a designated event state) of a user wearing the electronic device. For example, the processor may determine the current state of the user to be an exercise state when it is determined, based on the sensing signal of the motion sensor, that the motion of the electronic device has a value greater than or equal to a designated first threshold value, may determine the current state of the user to be a sleep state when it is determined that the motion of the electronic device has a value less than or equal to a designated second threshold value, and may determine the current state of the user to be a normal state in the other cases. To this end, the processor may determine sensing signals of the motion sensor periodically (e.g., every 10 minutes).

(144) For example, the processor may acquire biometric information (e.g., heart rate information) from a light signal received through at least one of the multiple optical sensors, and may determine, based thereon, the current state (e.g., a normal state, a sleep state, an exercise state, or a designated event state) of the user. To this end, the processor may periodically drive at least one optical sensor (e.g., the optical sensor determined as a main sensor) among the multiple optical sensors to receive a light signal, and may determine the current state of the user.

(145) For example, the processor may also determine the current state (e.g., a normal state, a sleep state, an exercise state, or a designated event state) of the user wearing the electronic device, based on a sensing signal of a motion sensor and biometric information (e.g., heart rate information) acquired from a light signal received through at least one of the multiple optical sensors.

(146) At **905**, in order to acquire biometric information according to the determined current state of the user, the processor may control driving of a light emitter of at least one optical sensor selected from among the multiple optical sensors, based on the signal characteristics of the multiple optical sensors.

(147) At **907**, in order to acquire biometric information according to the determined current state of the user, the processor may receive a light signal sensed by a light receiver of at least one optical sensor selected from among the multiple optical sensors, based on the signal characteristics of the

multiple optical sensors. The processor may be configured to acquire a bio-signal, based thereon. The at least one light receiver, which receives a light signal, is controlled to be identical to a light receiver of an optical sensor, which includes the at least one selected light emitter driven at **905** (e.g., the first light receiver **611***b* receives a light signal from light emitted by the first light emitter **611***a*), but may be controlled to be different from the optical sensor (e.g., the third light receiver **613***b* receives a light signal from light emitted by the first light emitter **611***a*), and the number thereof may be different (e.g., each light receiver simultaneously receives light signals from light emitted by multiple light emitters **611***a*, **612***a*, **613***a*, and **614***a*).

(148) FIGS. **10**A, **10**B, and **10**C are diagrams illustrating operations of controlling multiple optical sensors based on signal characteristics of the multiple optical sensors, according to an embodiment. In order to acquire biometric information according to the current state of a user, the processor may determine, based on signal characteristics of multiple optical sensors, the position and/or the number of light emitters of optical sensors to be driven among the multiple optical sensors. The processor may determine the driving timing, light intensity, and/or light wavelength of a light emitter to be driven.

(149) Referring to FIG. **10**A, for example, when it is determined that the current state of the user is a normal state, the processor may drive, based on the signal characteristics of the multiple optical sensors determined at **901** of FIG. **9**, the first light emitter **611***a* of the first optical sensor **611** determined as a main sensor to emit light. For example, the processor may receive, through the first light receiver **611***b*, reflected light of light emitted by the first light emitter **611***a* of the first optical sensor **611**.

(150) Referring to FIG. **10**B, for example, when it is determined that the current state of the user is an exercise state, the processor may drive the first light emitter **611***a*, the second light emitter **612***a*, the third light emitter **613***a*, and the fourth light emitter **614***a* of the multiple optical sensors, may receive light signals through the first light receiver **611***b*, the second light receiver **612***b*, the third light receiver **613***b*, the fourth light receiver **614***b* of the multiple optical sensors, and may acquire biometric information in consideration of all of the received light signals. For example, the first light emitter **611***a*, the second light emitter **612***a*, the third light emitter **613***a*, and the fourth light emitter **614***a* of the multiple optical sensors may be separately driven at different timings, and light signals may be separately received through the first light receiver **611***b*, the second light receiver **612***b*, the third light receiver **613***b*, and the fourth light receiver **614***b* of the multiple optical sensors. In the exercise state, the motion of the electronic device becomes more frequent, and thus, the position of contact of the multiple optical sensors with a part of the user's body may be frequently changed and signal characteristics may also be frequently changed. Therefore, it may be required to acquire as much light signal information as possible from each optical sensor. For example, the processor may control all light-emitting elements, included in each light emitter, to be driven at the time of driving of the each light emitter such that the each light emitter can emit light in as large amount as possible.

(151) Referring to FIG. **10**C, for example, when it is determined that the current state of the user is a sleep state, the processor may drive the first light emitter **611***a* of the first optical sensor **611** determined as a main sensor based on the signal characteristics of the multiple optical sensors, where a wavelength band of light to be emitted may be designated, thereby controlling the light emitter to be driven therein. For example, in order to prevent the wavelength band of light emitted in the sleep state from disturbing sleep, the processor may drive only a light-emitting element of the remaining designated wavelength band excluding a green wavelength, or may drive a red light-emitting element or an IR light-emitting element to emit only light having a red wavelength or IR wavelength.

(152) In order to acquire biometric information, the processor may drive multiple optical sensors when a request is made or when a designated event occurs.

(153) For example, in order to acquire biometric information at the time point of determining the

current state of the user or at the time point of determining a change in the current state of the user, the processor may determine the signal characteristics of the multiple optical sensors, and may control, based on the determination, driving of a light emitter of at least one of the multiple optical sensors.

(154) In contrast, for example, when a biometric information measurement request is made through an input module, the processor **430** or **530** may control, based on the signal characteristics of the multiple optical sensors, driving of a light emitter of at least one of the multiple optical sensors.

(155) Furthermore, for example, the processor may periodically (e.g., every 10 minutes) measure the signal characteristics of the multiple optical sensors, and may control, based thereon, driving of a light emitter of at least one of the multiple optical sensors to acquire a bio-signal. For example, the processor may periodically determine the current state of the user. When it is determined, based on the determined current state of the user, that a designated event has occurred, the processor may control driving of a light emitter of at least one of the multiple optical sensors based on the signal characteristics of the multiple optical sensors according to the type of the designated event to emit light. The processor may select a light signal received through a light receiver of at least one of the multiple optical sensors to acquire a bio-signal. For example, the designated event may include the case in which the current state of the user of the electronic device is rapidly changed or is maintained as a designated state for a designated time or longer. A detailed description thereof is provided below with reference to FIG. **11**.

(156) FIG. **11** is a flowchart illustrating operations of controlling multiple optical sensors of an electronic device based on designated event occurrence, according to an embodiment.

(157) Operations of an electronic device including multiple optical sensors, illustrated in FIG. **11**, may be performed by a processor, and, hereinafter, will be described with main reference to the structure of the electronic device **600** in FIG. **6**. Detailed descriptions of the technical features illustrated above are omitted below.

(158) At **1101**, the processor determines whether a designated event has occurred.

(159) For example, the processor may determine whether a designated event has occurred, based on sensor signals received through a motion sensor and/or multiple optical sensors.

(160) For example, the occurrence of the designated event and the type of the designated event may be determined in overall consideration of change or maintenance of a sensor signal value by the motion sensor and/or the multiple optical sensors, the degree of change, time required for change, or time for which the sensor signal value remains constant. The designated event may include the case in which the motion of the electronic device rapidly increases, the case in which is a lot of the motion of the electronic device is maintained and then the motion of electronic device decreases, the case in which the motion of the electronic device, which is almost motionless, increases and then the time for which there is no motion is maintained, the case in which the time for which the motion of the electronic device is scarcely made is maintained, the case in which a heart rate is maintained in a designated interval, the case in which a heart rate is rapidly increased, or the case in which a heart rate is high but gradually decreases.

(161) For example, considering a situation in which the user has a cough, the motion of the electronic device or the heart rate may rapidly increase. When it is determined that this type of designated event has occurred, the processor may control driving of the multiple optical sensors in order to measure, for example, SpO.sub.2.

(162) For example, considering a situation in which the user intensely exercises and then enters a recovery time, a state in which there is a lot of motion is maintained or the heart rate is maintained at a predetermined level or higher, and then the motion rapidly decreases or the heart rate gradually decreases. When it is determined that this type of designated event has occurred, the processor may control driving of the multiple optical sensors in order to measure, for example, SpO.sub.2.

(163) For example, considering a situation in which the user maintains the same posture without any motion, a state in which there is no motion of the electronic device may be maintained

according to a sensor signal of the motion sensor. When it is determined that this type of designated event has occurred, the processor may control driving of the multiple optical sensors in order to measure, for example, blood pressure.

(164) For example, considering a situation in which the user switches from a wakened state to a sleep state or from a sleep state to a wakened state, the processor may determine this event type, based on a sensor signals of the motion sensor and/or the optical sensor, and may change and control a method for driving the multiple optical sensors.

(165) For example, considering a situation in which the user switches from a normal state to an exercise state or from an exercise state to a normal state, the processor may determine this event type, based on a sensor signal of the motion sensor and/or the optical sensor, and may change and control a method for driving the multiple optical sensors.

(166) Referring back to FIG. **11**, when it is determined that the event occurs at **1101**, the processor controls driving of a light emitter of at least one of multiple optical sensors, based on the signal characteristics of the multiple optical sensors according to an event type, in order to emit light, at **1103**.

(167) At **1105**, the processor acquires a bio-signal based on a signal that is received by a light receiver of at least one of the multiple optical sensors, based on the signal characteristics of the multiple optical sensors according to the event type.

(168) FIGS. **12**A and **12**B are diagrams illustrating operations of controlling multiple optical sensors based on a designated event occurrence, according to an embodiment.

(169) Referring to FIG. **12**A, in order to measure SpO.sub.2 according to the event type, the processor may drive the first light emitter **611***a* of the first optical sensor **611** (determined as a main sensor according to the signal characteristics) to emit light, may selectively receive a light signal received by the third light receiver **613***b* of the third optical sensor **613** positioned in the opposite direction among the multiple optical sensors and measure SpO.sub.2, based on the light signal. For example, in order to measure SpO.sub.2, the processor may drive the first light emitter **611***a*) of the first optical sensor **611** (determined as a main sensor according to the signal characteristics) of the multiple optical sensors to sequentially emit light of a red wavelength band and light of a IR wavelength band, and may substantially simultaneously receive a light signal by the third light receiver **613***b* of the third optical sensor **613** positioned in the opposite direction among the multiple optical sensors and measure SpO.sub.2, based on the light signal.

(170) The received light signal may be considered emitted light that has passed through the user's body (e.g., a finger) and then received.

(171) For example, in order to measure SpO.sub.2 according to the event type, in the case of an event type in which measurement is made in an exercise state, the processor may drive, at different timings, the second light emitter **612***a*, the third light emitter **613***a*, and the fourth light emitter **614***a* of the second optical sensor **612**, the third optical sensor **613**, and the fourth optical sensor **614**, in addition to the first optical sensor **611** determined as a main sensor. In response thereto, the processor may select light signals received by the fourth light receiver **614***b*, the first light receiver **611***b*, and the second light receiver **612***b* of the fourth optical sensor **614**, the first optical sensor **611**, and the second optical sensor **612**, positioned in the opposite direction, and to process the selected light signals such that SpO.sub.2 is obtained.

(172) Referring to FIG. **12**B, for example, in order to measure blood pressure according to an event type, the processor may substantially simultaneously drive the first light emitter **611***a*, the second light emitter **612***a*, the third light emitter **613***a*, and the fourth light emitter **614***a* of the first optical sensor **611**, the second optical sensor **612**, the third optical sensor **613**, and the fourth optical sensor **614** to emit light in as large amount as possible, may receive all of light signals received by the first light receiver **611***b*, the second light receiver **612***b*, the third light receiver **613***b*, and the fourth light receiver **614***b* of the multiple optical sensors, respectively, and may acquire blood pressure information based on the light signals.

(173) For example, light, which has been substantially simultaneously emitted from all light emitters (e.g., the first light emitter **611***a*, the second light emitter **612***a*, the third light emitter **613***a*, and the fourth light emitter **614***a*), and has been reflected or has passed through a part (e.g., a finger) of the user's body, may be sensed by light receivers (e.g., the third light receiver **613***b*, the fourth light receiver **614***b*, the first light receiver **611***b*, and the second light receiver **612***b* in order) disposed at opposite positions, respectively, and blood pressure may be measured in overall consideration of the sensed signal values. Therefore, the amount of light can be maximally ensured and multiple light signals can be simultaneously acquired, thereby minimizing noise and reducing time necessary for blood pressure measurement.

(174) While the disclosure has been shown and described with reference to certain embodiments therefor, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the scope of the disclosure. Therefore, the scope of the disclosure should not be defined as being limited to the embodiments, but should be defined by the appended claims and equivalents thereof.

Claims

1. An electronic device comprising: a ring-type housing; at least one motion sensor; a plurality of light emitters and a plurality of light receivers disposed along a circumference of the ring-type housing at different directions to each other and configured to emit and receive lights through an inner surface of the ring-type housing to be in contact with a finger of a user wearing the electronic device, the plurality of light emitters including a first wavelength band light emitter, a second wavelength band light emitter, and a third wavelength band light emitter; and processing circuitry operatively connected to memory, the at least one motion sensor, the plurality of light emitters and the plurality of light receivers, wherein instructions stored in the memory, when executed by the processing circuitry, cause the electronic device to: determine whether a current state of the user is a sleep state or an exercise state based on signals received through the at least one motion sensor and the plurality of light receivers; in case that the current state of the user is the sleep state, selectively drive a first number of the plurality of light emitters to acquire biometric information; and in case that the current state of the user is the exercise state, selectively drive a second number of the plurality of light emitters to acquire the biometric information, wherein the first number is different from the second number.

2. The electronic device of claim 1, wherein instructions stored in the memory, when executed by the processing circuitry, cause the electronic device to, when the current state of the user is determined as the exercise state: drive at least two of the plurality of light emitters to output light, and receive, via at least two of the plurality of light receivers, light emitted by the at least two of the plurality of light emitters and reflected by the finger of the user to acquire biometric information.

3. The electronic device of claim 1, wherein instructions stored in the memory, when executed by the processing circuitry, cause the electronic device to, when the current state of the user is determined as the sleep state: drive at least one of the plurality of light emitters to output light, wherein the at least one of the plurality of light emitters comprises the first wavelength band light emitter or the second wavelength band light emitter and excludes the third wavelength band light emitter, and receive, via at least one of the plurality of light receivers, light emitted by the at least one of the plurality of light emitters and reflected by the finger of the user to acquire biometric information.

4. The electronic device of claim 3, wherein the first wavelength band light emitter includes an infra-red light emitter, the second wavelength band light emitter includes a red light emitter, and the third wavelength band light emitter includes a green light emitter.

5. The electronic device of claim 1, wherein instructions stored in the memory, when executed by

the processing circuitry, cause the electronic device to selectively drive at least one of the plurality of light emitters based on the state of the user to acquire heart rate or SpO2.

6. A method of controlling an electronic device having a ring-type housing, at least one motion sensor, and a plurality of light emitters and a plurality of light receivers disposed along a circumference of the ring-type housing at different directions to each other and configured to emit and receive lights through an inner surface of the ring-type housing to be in contact with a finger of a user wearing the electronic device, the plurality of light emitters including a first wavelength band light emitter, a second wavelength band light emitter, and a third wavelength band light emitter, the method comprising: determining whether a current state of the user is a sleep state or an exercise state based on signals received through the at least one motion sensor and the plurality of light receivers; in case that the current state of the user is the sleep state, selectively driving a first number of the plurality of light emitters to acquire biometric information; and in case that the current state of the user is the exercise state, selectively driving a second number of the plurality of light emitters to acquire the biometric information, wherein the first number is different from the second number.

7. The method of claim 6, wherein the selectively driving comprises, when the current state of the user is determined as the exercise state: driving at least two of the plurality of light emitters to output light, and receiving, via at least two of the plurality of light receivers, light emitted by the at least two of the plurality of light emitters and reflected by the finger of the user to acquire biometric information.

8. The method of claim 6, wherein the selectively driving comprises, when the current state of the user is determined as the sleep state: driving at least one of the plurality of light emitters to output light, wherein the at least one of the plurality of light emitters comprises the first wavelength band light emitter or the second wavelength band light emitter and excludes the third wavelength band light emitter, and receiving, via at least one of the plurality of light receivers, light emitted by the at least one of the plurality of light emitters and reflected by the finger of the user to acquire biometric information.

9. The method of claim 8, wherein the first wavelength band light emitter includes an infra-red light emitter, the second wavelength band light emitter includes a red light emitter, and the third wavelength band light emitter includes a green light emitter.

10. The method of claim 6, wherein the selectively driving selectively drives at least one of the plurality of light emitters based on the state of the user to acquire heart rate or SpO2.

11. An electronic device comprising: a ring-type housing; at least one motion sensor; a plurality of light emitters and a plurality of light receivers disposed along a circumference of the ring-type housing at different directions to each other and configured to emit and receive lights through an inner surface of the ring-type housing to be in contact with a finger of a user wearing the electronic device, the plurality of light emitters including an infra-red light emitter, a red light emitter, and a green light emitter; and processing circuitry operatively connected to memory, the at least one motion sensor, the plurality of light emitters and the plurality of light receivers, wherein instructions stored in the memory, when executed by the processing circuitry, cause the electronic device to: determine whether a current state of the user is a sleep state or an exercise state based on signals received through the at least one motion sensor and the plurality of light receivers; in case that the current state of the user is determined asan the exercise state: drive a first number of the plurality of light emitters to output light, and receive, via at least two of the plurality of light receivers, light emitted by the first number of light emitters and reflected by the finger of the user to acquire biometric information; and in case that the current state of the user is determined asa the sleep state: drive a second number of the plurality of light emitters to output light, wherein the second number of the plurality of light emitters comprises an infra-red light emitter or a red light emitter and excludes a green light emitter, and receive, via at least one of the plurality of light receivers, light emitted by the second number of the plurality of light emitters and reflected by the

finger of the user to acquire biometric information, wherein the first number is different from the second number.