US 20250255540A1

(19) United States
(12) Patent Application Publication
CHO et al.

(10) Pub. No.: US 2025/0255540 A1
(43) Pub. Date: Aug. 14, 2025

(54) **WEARABLE DEVICE AND METHOD FOR MEASURING SKIN FLUORESCENCE USING THE SAME**

(71) Applicant: **Samsung Electronics Co., Ltd.**, Suwon-si (KR)

(72) Inventors: **Minhyun CHO**, Suwon-si (KR); **Euiseok SHIN**, Suwon-si (KR); **Hyunjoo JUNG**, Suwon-si (KR); **Taeseon KIM**, Suwon-si (KR); **Minho PARK**, Suwon-si (KR); **Joongwoo AHN**, Suwon-si (KR)

(21) Appl. No.: **19/051,615**

(22) Filed: **Feb. 12, 2025**

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2025/001958, filed on Feb. 11, 2025.

(30) **Foreign Application Priority Data**

Feb. 13, 2024 (KR) 10-2024-0020455
Apr. 5, 2024 (KR) 10-2024-0046478

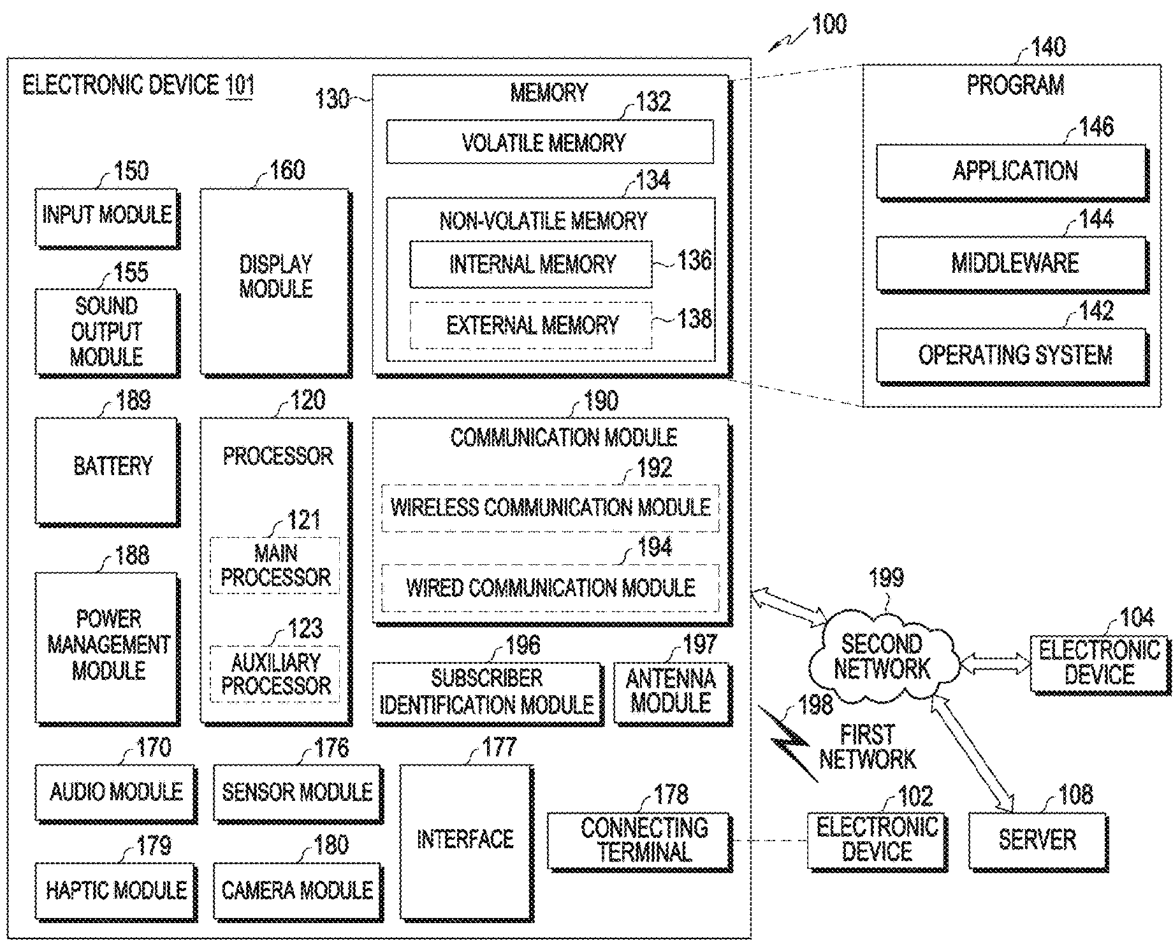
Publication Classification

(51) **Int. Cl.**
A61B 5/00 (2006.01)

(52) **U.S. Cl.**
CPC ***A61B 5/442*** (2013.01); ***A61B 5/0071*** (2013.01); ***A61B 5/443*** (2013.01); ***A61B 5/6802*** (2013.01)

(57) **ABSTRACT**

A wearable device is provided. The wearable device may include a housing including a light transmission area, a board disposed inside the housing and including a surface directed toward the light transmission area, a first photodetector disposed on the surface of the board and configured to detect light having a wavelength equal to or longer than a first wavelength, a second photodetector disposed on the surface of the board and configured to detect light having a wavelength equal to or longer than a second wavelength longer than the first wavelength, a first light emitter disposed between the first photodetector and the second photodetector and configured to emit light having a third wavelength toward the light transmission area, and a second light emitter disposed between the first light emitter and the second photodetector and configured to emit light having a fourth wavelength shorter than the third wavelength toward the light transmission area.



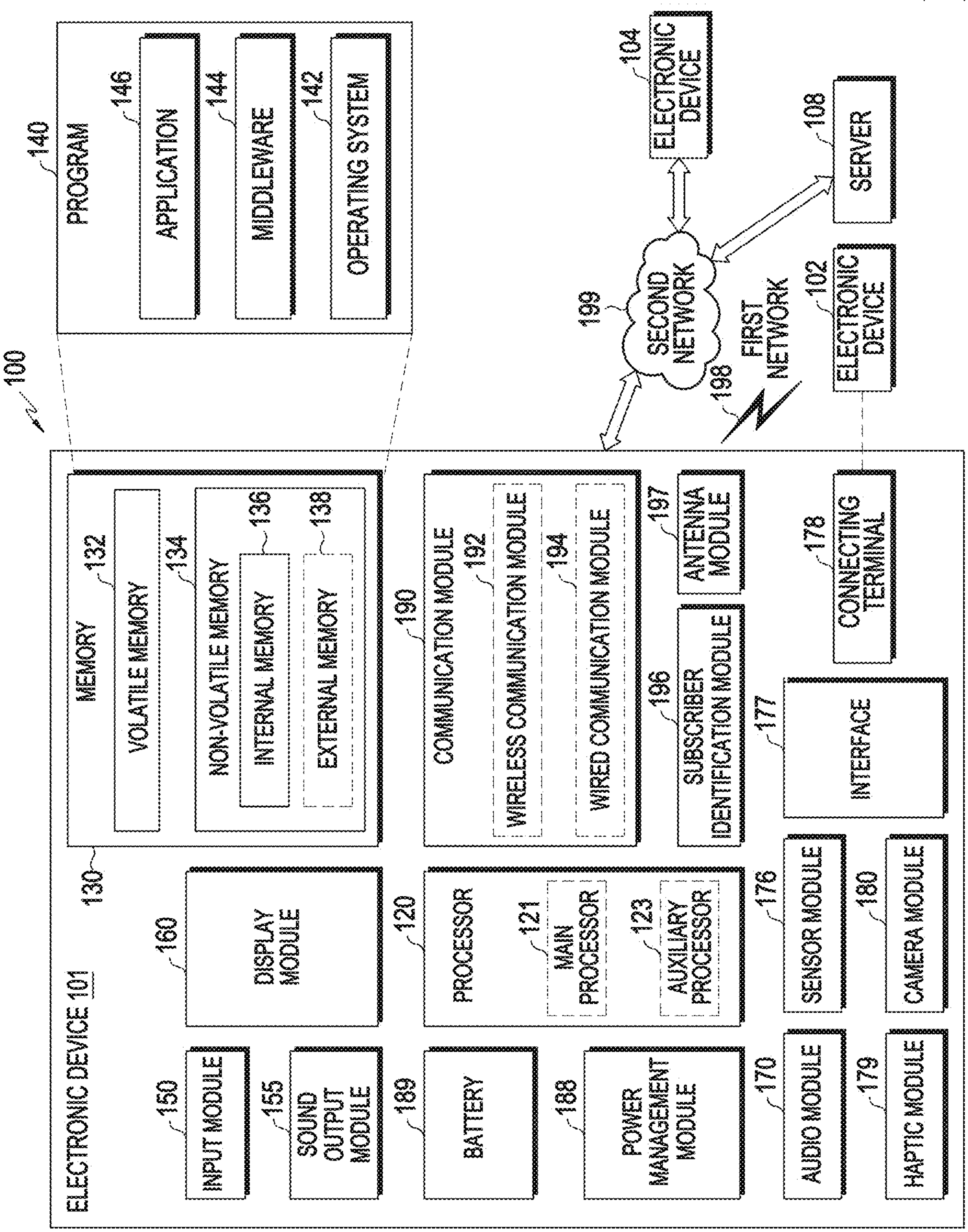

100
ELECTRONIC DEVICE 101
150
INPUT MODULE
155
SOUND OUTPUT MODULE
160
DISPLAY MODULE
130
MEMORY
132
VOLATILE MEMORY
134
NON-VOLATILE MEMORY
136
INTERNAL MEMORY
138
EXTERNAL MEMORY
140
PROGRAM
146
APPLICATION
144
MIDDLEWARE
142
OPERATING SYSTEM
189
BATTERY
188
POWER MANAGEMENT MODULE
120
PROCESSOR
121
MAIN PROCESSOR
123
AUXILIARY PROCESSOR
190
COMMUNICATION MODULE
192
WIRELESS COMMUNICATION MODULE
194
WIRED COMMUNICATION MODULE
197
ANTENNA MODULE
196
SUBSCRIBER IDENTIFICATION MODULE
170
AUDIO MODULE
176
SENSOR MODULE
177
INTERFACE
178
CONNECTING TERMINAL
179
HAPTIC MODULE
180
CAMERA MODULE
199
SECOND NETWORK
198
FIRST NETWORK
102
ELECTRONIC DEVICE
104
ELECTRONIC DEVICE
108
SERVER

FIG. 1

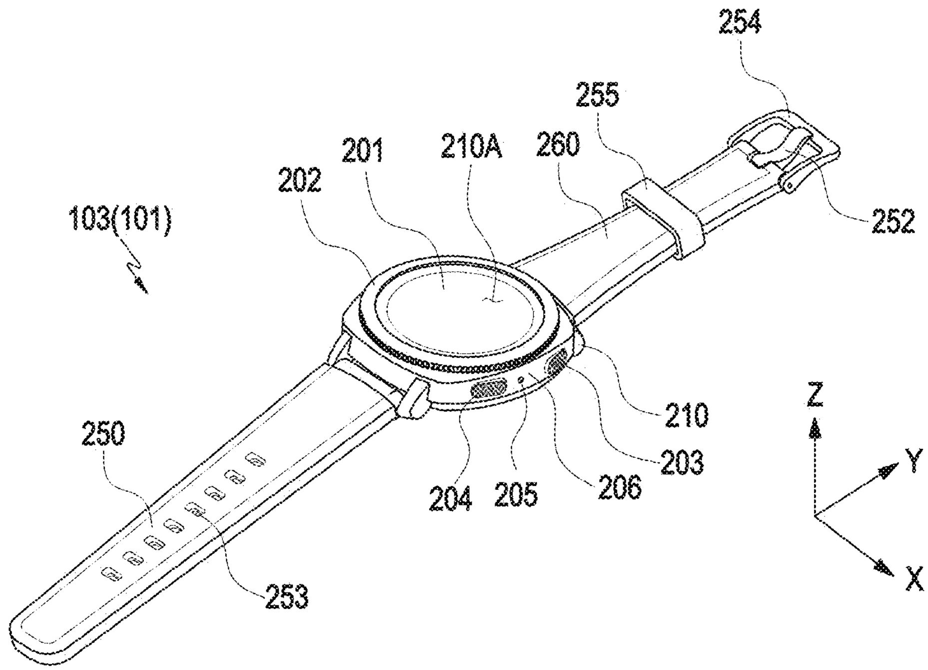

254
255
201
210A
260
202
103(101)
252
210
Z
203
Y
250
204
205
206
X
253

FIG. 2

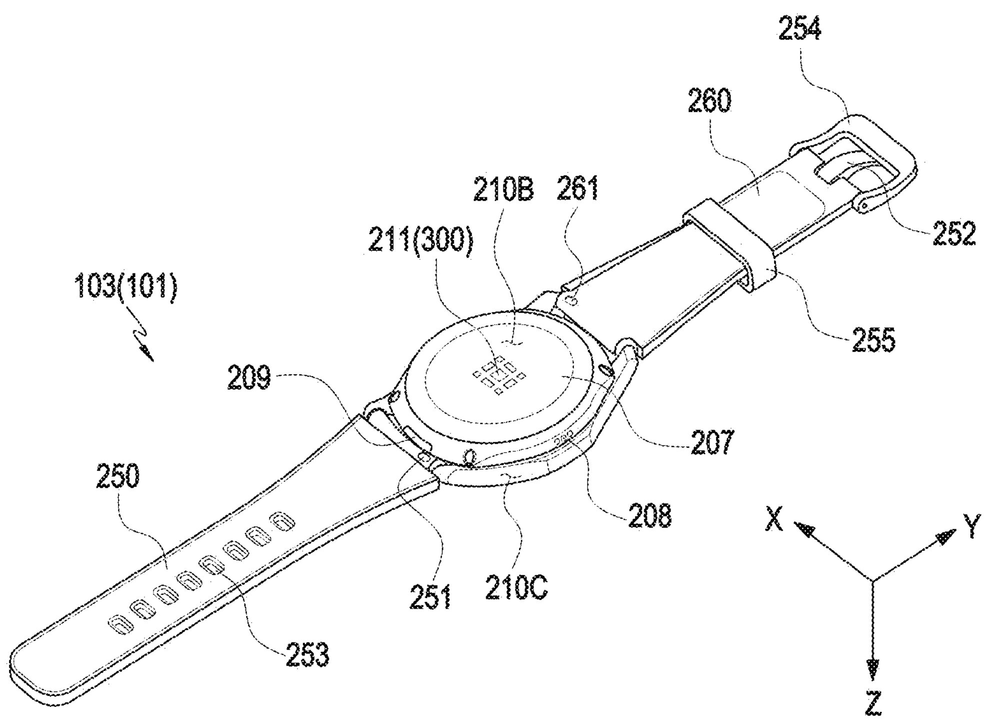

254
260
210B
261
211(300)
252
103(101)
255
209
207
250
208
X
Y
251
210C
253
Z

FIG. 3

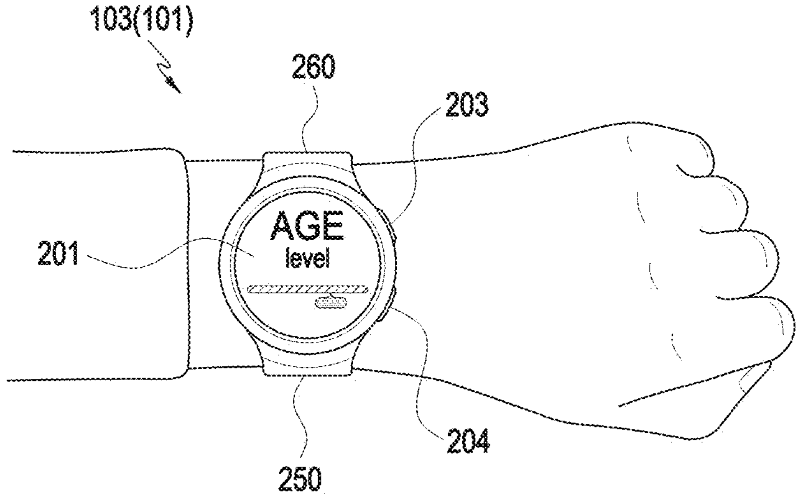


FIG. 4

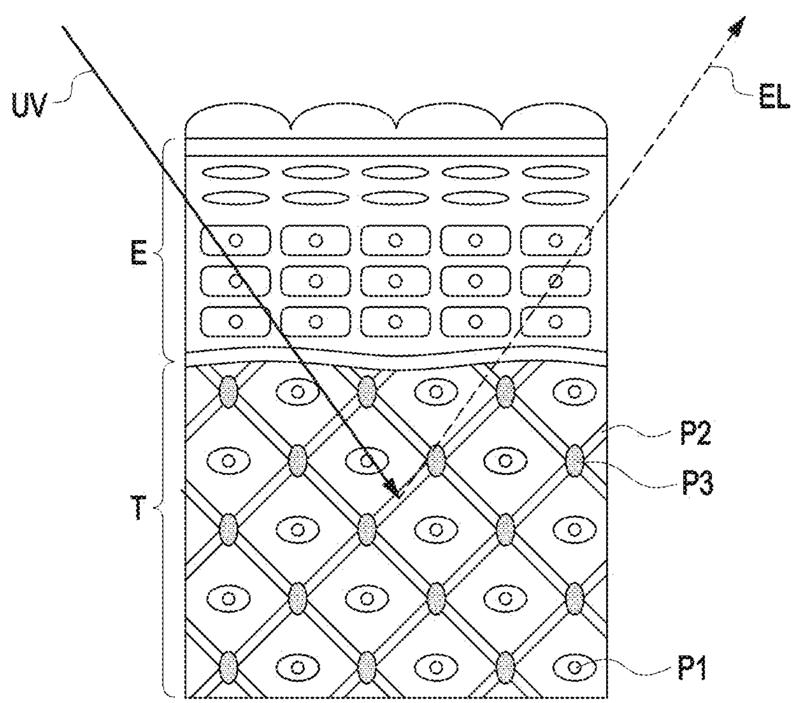


FIG. 5

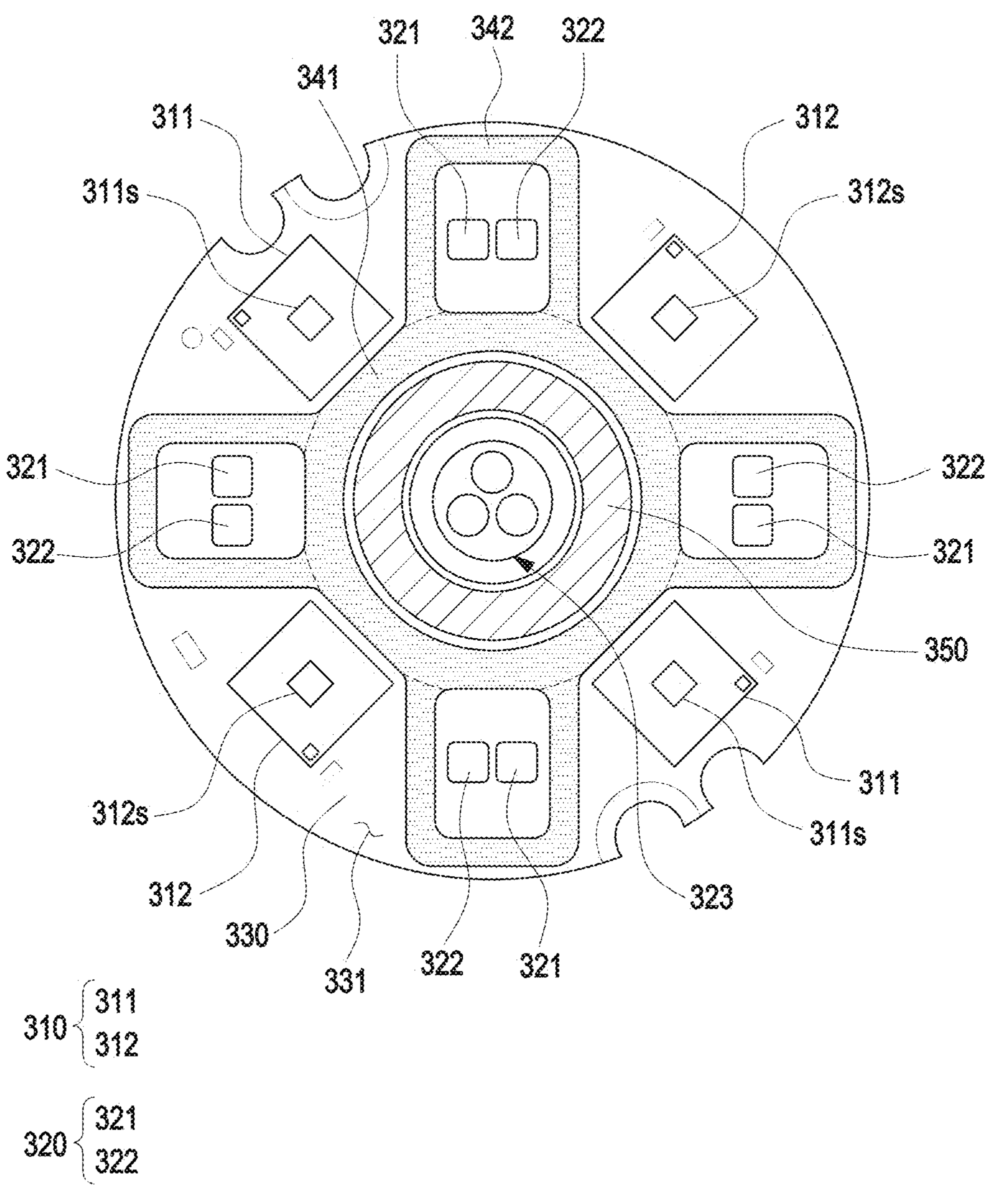

321
342
322
341
311
312
311s
312s
321
322
322
321
350
312s
311
311s
312
330
331
322
321
323
310
311
312
320
321
322

FIG. 6

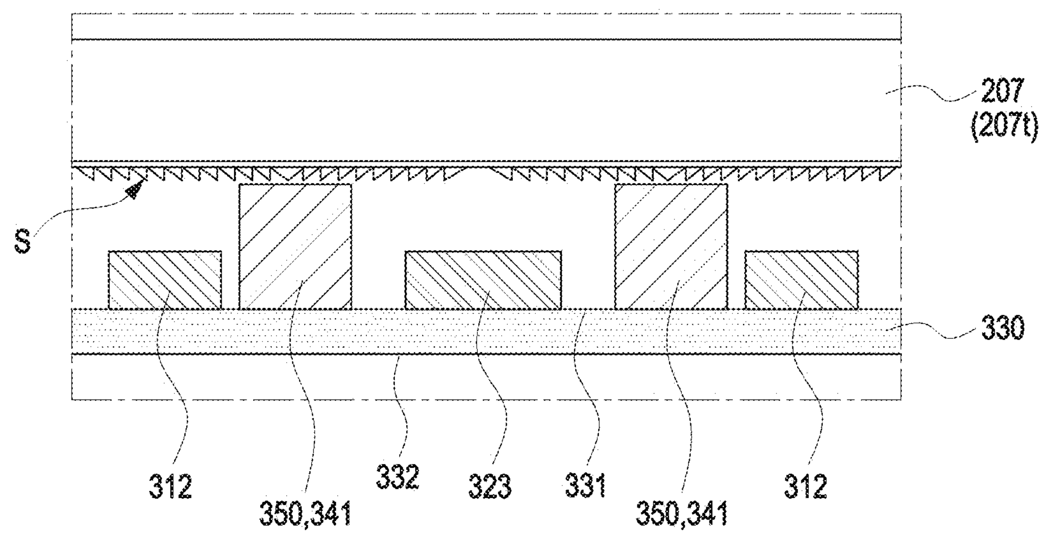


FIG. 7

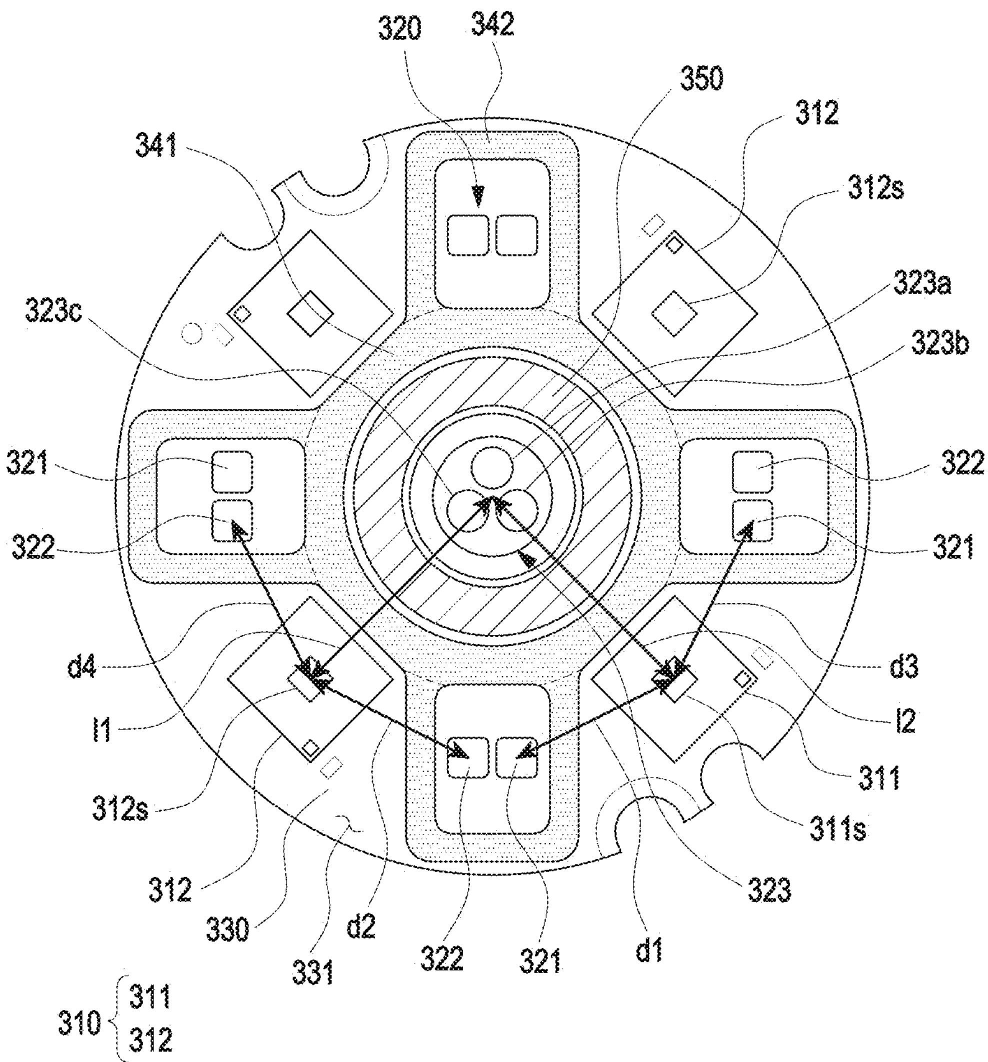

320
342
350
341
312
312s
323a
323c
323b
321
322
322
321
d4
d3
l1
l2
311
312s
311s
312
323
330
d2
322
321
d1
331
310
311
312

FIG. 8

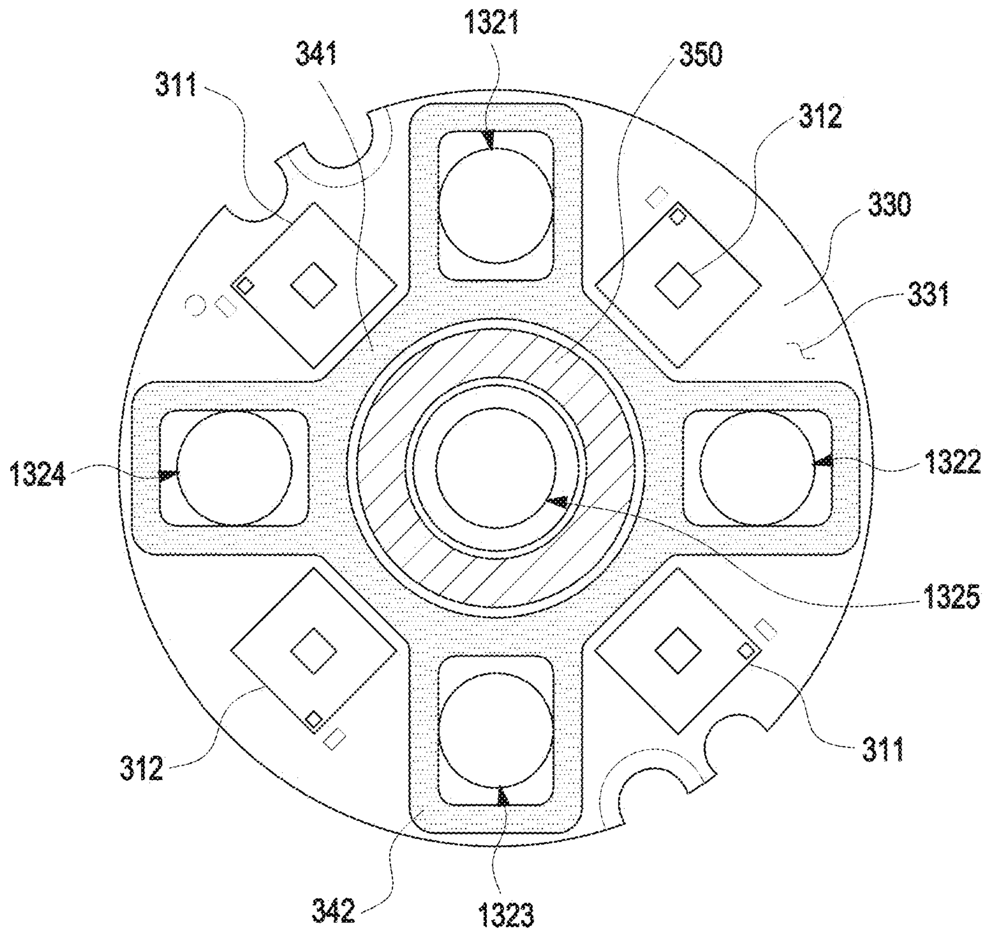


FIG. 9

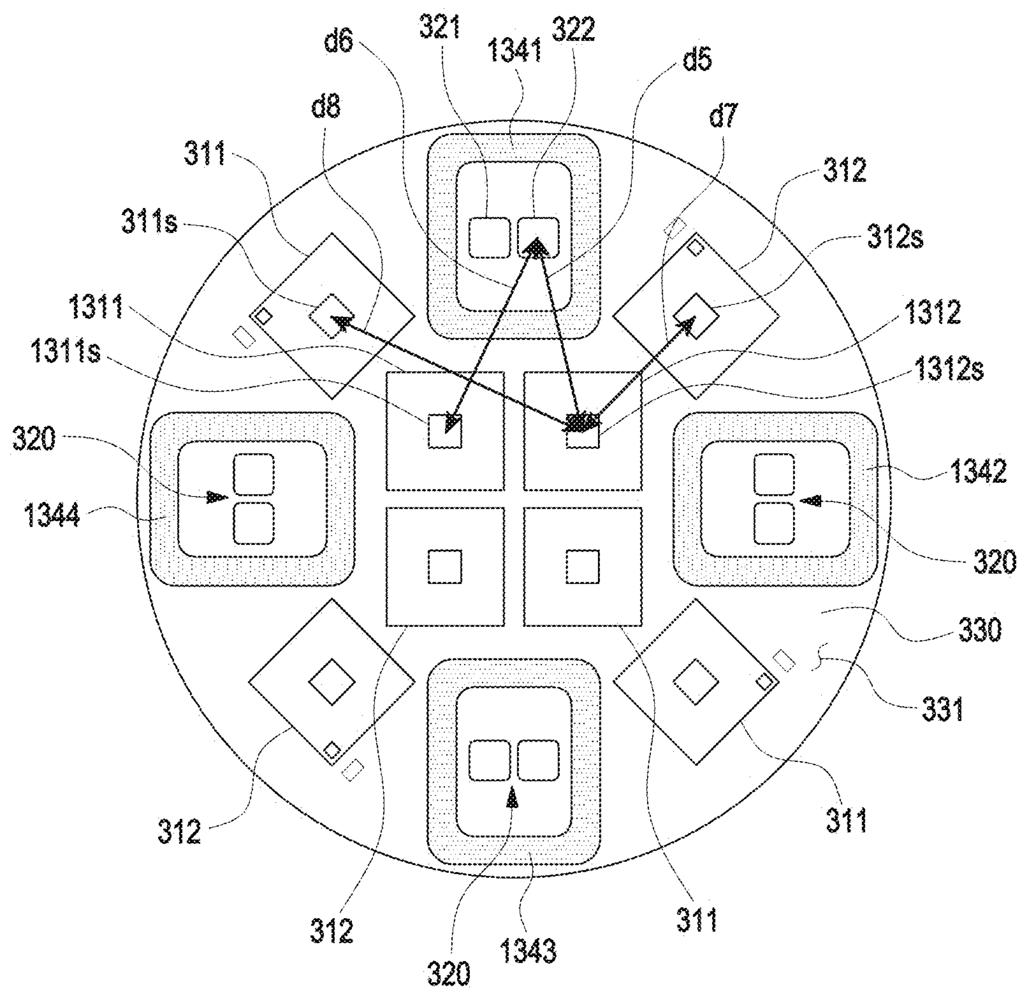

321
1341
322
d6
d5
d8
d7
311
312
311s
312s
1311
1312
1311s
1312s
320
1344
1342
320
330
331
312
311
312
311
320
1343

FIG. 10

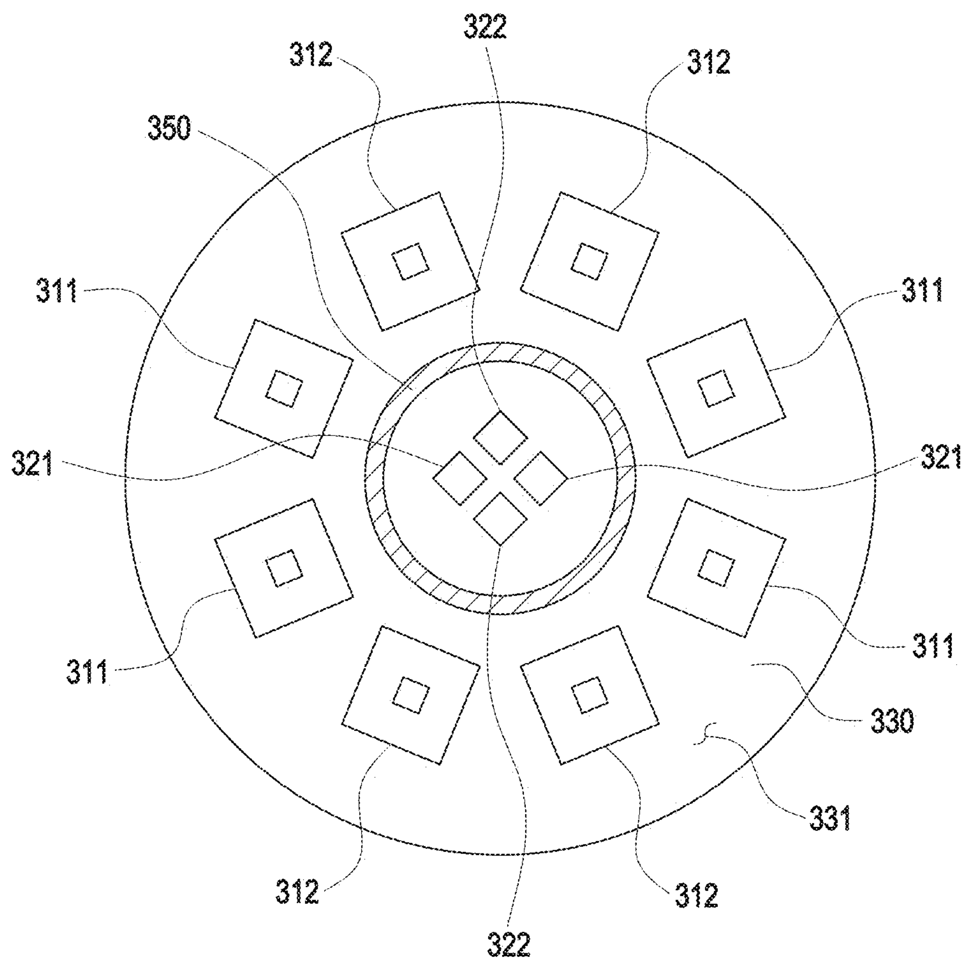


FIG. 11

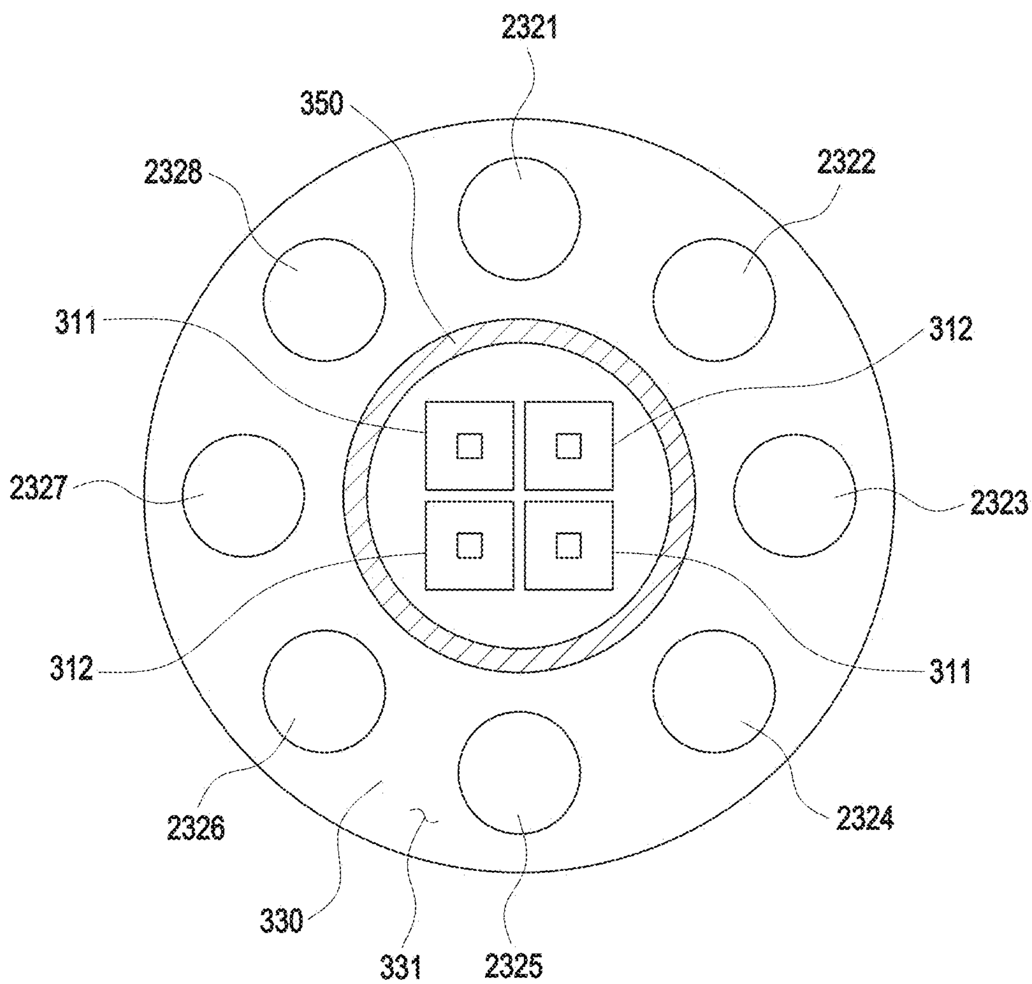

2321
350
2328
2322
311
312
2327
2323
312
311
2326
2324
330
331
2325

FIG. 12

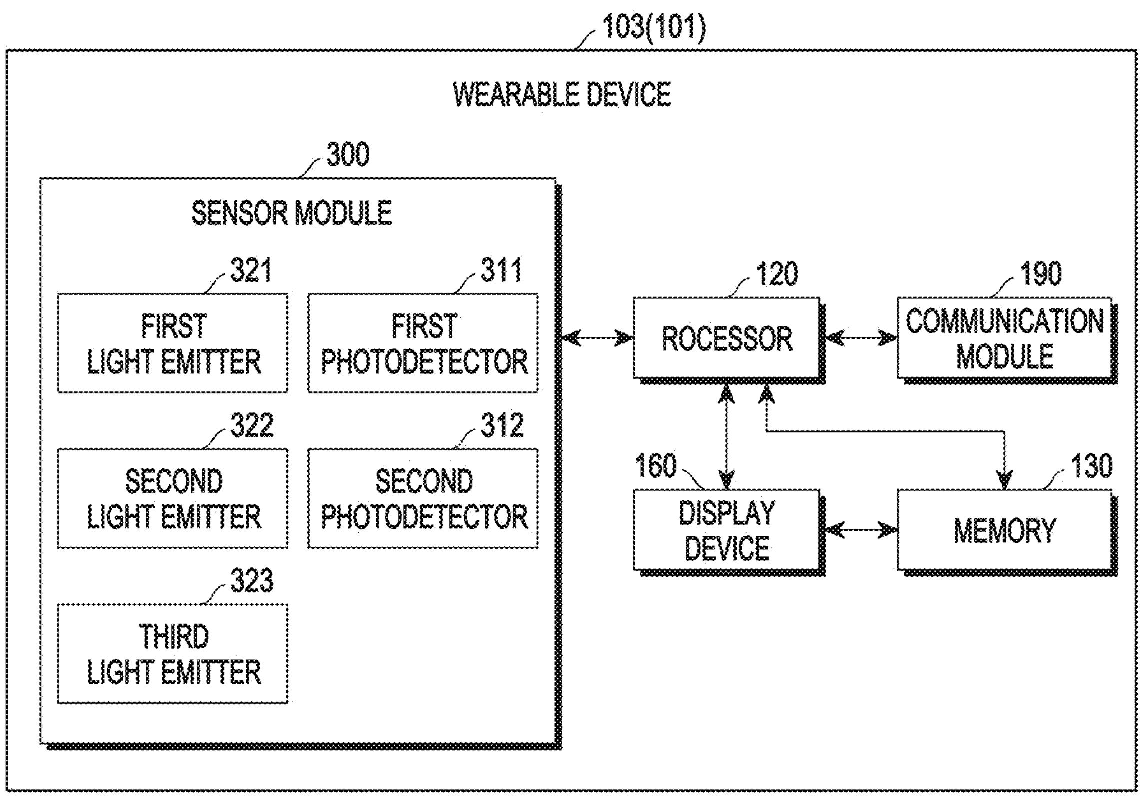

103(101)
WEARABLE DEVICE
300
SENSOR MODULE
321
FIRST LIGHT EMITTER
311
FIRST PHOTODETECTOR
322
SECOND LIGHT EMITTER
312
SECOND PHOTODETECTOR
323
THIRD LIGHT EMITTER
120
ROCESSOR
190
COMMUNICATION MODULE
160
DISPLAY DEVICE
130
MEMORY

FIG. 13

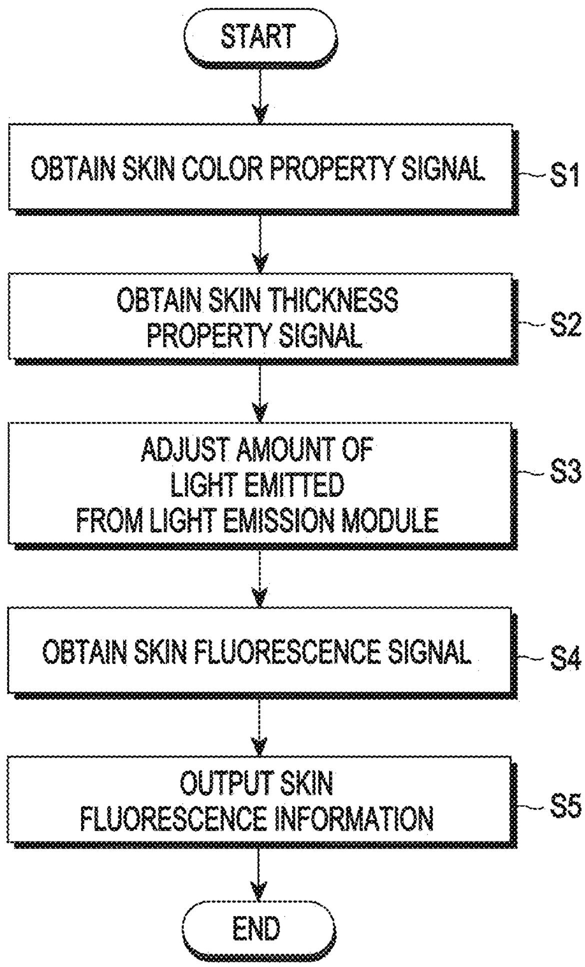

START
OBTAIN SKIN COLOR PROPERTY SIGNAL
S1
OBTAIN SKIN THICKNESS PROPERTY SIGNAL
S2
ADJUST AMOUNT OF LIGHT EMITTED FROM LIGHT EMISSION MODULE
S3
OBTAIN SKIN FLUORESCENCE SIGNAL
S4
OUTPUT SKIN FLUORESCENCE INFORMATION
S5
END

FIG. 14

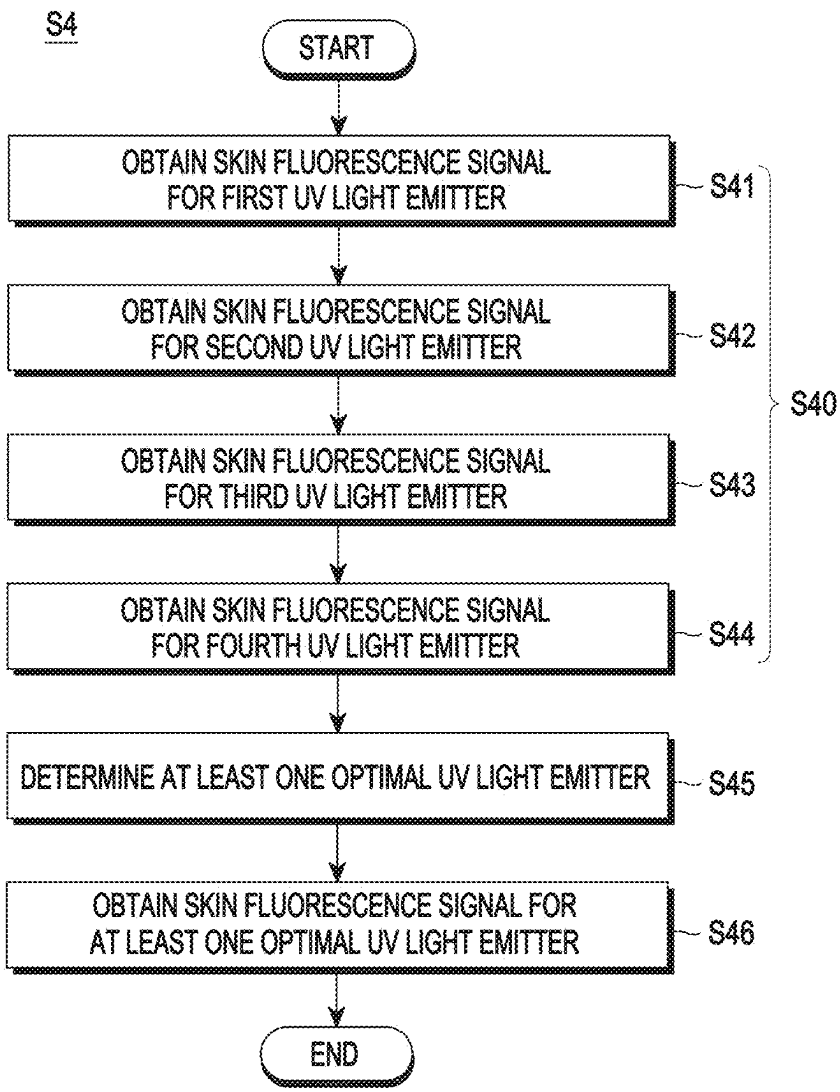

S4
START
OBTAIN SKIN FLUORESCENCE SIGNAL FOR FIRST UV LIGHT EMITTER
S41
OBTAIN SKIN FLUORESCENCE SIGNAL FOR SECOND UV LIGHT EMITTER
S42
OBTAIN SKIN FLUORESCENCE SIGNAL FOR THIRD UV LIGHT EMITTER
S43
OBTAIN SKIN FLUORESCENCE SIGNAL FOR FOURTH UV LIGHT EMITTER
S44
S40
DETERMINE AT LEAST ONE OPTIMAL UV LIGHT EMITTER
S45
OBTAIN SKIN FLUORESCENCE SIGNAL FOR AT LEAST ONE OPTIMAL UV LIGHT EMITTER
S46
END

FIG. 15

WEARABLE DEVICE AND METHOD FOR MEASURING SKIN FLUORESCENCE USING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application is a continuation application, claiming priority under 35 U.S.C. § 365(c), of an International application No. PCT/KR2025/001958, filed on Feb. 11, 2025, which is based on and claims the benefit of a Korean patent application number 10-2024-0020455, filed on Feb. 13, 2024, in the Korean Intellectual Property Office, and of a Korean patent application number 10-2024-0046478, filed on Apr. 5, 2024, in the Korean Intellectual Property Office, the disclosure of each of which is incorporated by reference herein in its entirety.

TECHNICAL FIELD

[0002] The disclosure relates to an electronic device. More particularly, the disclosure relates to a wearable device including a light emitter and a photodetector and a method for measuring skin fluorescence using the same.

BACKGROUND ART

[0003] An electronic device may refer to a device that executes a specific function according to a loaded program, such as a home appliance, an electronic notebook, a portable multimedia player, a mobile communication terminal, a tablet personal computer (PC), a video/audio device, a desktop/laptop computer, or a vehicle navigation device. For example, these electronic devices may output stored information as sound or an image.

[0004] As the integration level of electronic devices increases and high-speed, large-capacity wireless communication becomes more common, a single electronic device such as a mobile communication terminal may recently be equipped with various functions. For example, an entertainment function such as games, a multimedia function such as music/video playback, a communication and security function for mobile banking, and a function such as schedule management or an electronic wallet in addition to a communication function are integrated into a single electronic device. Such electronic devices are miniaturized so that users may carry them conveniently.

[0005] The above information is presented as background information only to assist with an understanding of the disclosure. No determination has been made, and no assertion is made, as to whether any of the above might be applicable as prior art with regard to the disclosure.

DISCLOSURE OF INVENTION

Solution to Problems

[0006] Aspects of the disclosure are to address at least the above-mentioned problems and/or disadvantages and to provide at least the advantages described below. Accordingly, an aspect of the disclosure is to provide a wearable device including a light emitter and a photodetector and a method for measuring skin fluorescence using the same.

[0007] Additional aspects will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the presented embodiments.

[0008] In accordance with an aspect of the disclosure, a wearable device is provided. The wearable device includes a housing including a light transmission area, a board disposed inside the housing and including a surface directed toward the light transmission area, a first photodetector disposed on the surface of the board and configured to detect light having a wavelength equal to or longer than a first wavelength, a second photodetector disposed on the surface of the board and configured to detect light having a wavelength equal to or longer than a second wavelength longer than the first wavelength, a first light emitter disposed between the first photodetector and the second photodetector and configured to emit light having a third wavelength toward the light transmission area, and a second light emitter disposed between the first light emitter and the second photodetector and configured to emit light having a fourth wavelength shorter than the third wavelength toward the light transmission area.

[0009] In accordance with another aspect of the disclosure, a method performed by a wearable device for measuring skin fluorescence including a light emission module configured to emit light toward a user's skin and a photodetecting module configured to detect light emitted from the user's skin is provided. The method includes emitting, by the wearable device, at least one of red light, blue light, or green light toward the user's skin through the light emission module and obtaining a skin color property signal value through the photodetecting module, emitting, by the wearable device, an infrared (IR) light toward the user's skin through the light emission module and obtaining a skin thickness property signal value through the photodetecting module, setting, by the wearable device, an illuminance of an ultraviolet (UV) light emitted through the light emission module based on the obtained skin color property signal value and the obtained skin thickness property signal value, and emitting, by the wearable device, the UV light with the set illuminance toward the user's skin through the light emission module and obtaining a skin fluorescence signal value through the photodetecting module.

[0010] In accordance with another aspect of the disclosure, one or more non-transitory computer-readable storage media storing one or more computer programs including computer-executable instructions that, when executed by one or more processors of a wearable device individually or collectively, cause the wearable device to perform operations are provided. The operations include emitting, by the wearable device, at least one of red light, blue light, or green light toward a user's skin through a light emission module and obtaining a skin color property signal value through a photodetecting module, emitting, by the wearable device, infrared (IR) light toward the user's skin through the light emission module and obtaining a skin thickness property signal value through the photodetecting module, setting, by the wearable device, an illuminance of ultraviolet (UV) light emitted through the light emission module based on the obtained skin color property signal value and the obtained skin thickness property signal value; and emitting, by the wearable device, UV light with the set illuminance toward the user's skin through the light emission module and obtaining a skin fluorescence signal value through the photodetecting module.

[0011] Other aspects, advantages, and salient features of the disclosure will become apparent to those skilled in the art from the following detailed description, which, taken in conjunction with the annexed drawings, discloses various embodiments of the disclosure.

BRIEF DESCRIPTION OF DRAWINGS

[0012] 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:

[0013] FIG. **1** is a block diagram illustrating an electronic device in a network environment according to an embodiment of the disclosure;

[0014] FIG. **2** is a perspective view of a wearable device, illustrating a front surface of the wearable device according to an embodiment of the disclosure;

[0015] FIG. **3** is a perspective view of a wearable device illustrating a rear surface of the wearable device according to an embodiment of the disclosure;

[0016] FIG. **4** illustrates an example in which a wearable device according to an embodiment of the disclosure is worn on a user's wrist;

[0017] FIG. **5** is a cross-sectional view illustrating a user's skin composed of an epidermal layer and a dermal layer, referred to for describing the principle of skin fluorescence measurement of a wearable device according to an embodiment of the disclosure;

[0018] FIG. **6** illustrates light emitters and photodetectors of a sensor module according to an embodiment of the disclosure;

[0019] FIG. **7** is a cross-sectional view illustrating a portion of a wearable device and sensor module according to an embodiment of the disclosure;

[0020] FIG. **8** illustrates distances between light emitters and photodetectors of a sensor module according to an embodiment of the disclosure;

[0021] FIG. **9** illustrates a plurality of light emission modules and photodetectors according to an embodiment of the disclosure;

[0022] FIG. **10** illustrates first light emission modules and photodetectors according to an embodiment of the disclosure;

[0023] FIG. **11** illustrates light emitters and photodetectors according to an embodiment of the disclosure;

[0024] FIG. **12** illustrates light emission modules and photodetectors according to an embodiment of the disclosure;

[0025] FIG. **13** is a block diagram illustrating a portion of a wearable device according to an embodiment of the disclosure;

[0026] FIG. **14** is a flowchart illustrating a method for measuring skin fluorescence using a wearable device according to an embodiment of the disclosure; and

[0027] FIG. **15** is a flowchart illustrating an operation of obtaining a skin fluorescence signal value according to an embodiment of the disclosure.

[0028] The same reference numerals are used to represent the same elements throughout the drawings.

MODE FOR THE INVENTION

[0029] The following description with reference to the accompanying drawings is provided to assist in a comprehensive understanding of various embodiments of the disclosure as defined by the claims and their equivalents. It includes various specific details to assist in that understanding but these are to be regarded as merely exemplary. Accordingly, those of ordinary skill in the art will recognize that various changes and modifications of the various embodiments described herein can be made without departing from the scope and spirit of the disclosure. In addition, descriptions of well-known functions and constructions may be omitted for clarity and conciseness.

[0030] The terms and words used in the following description and claims are not limited to the bibliographical meanings, but, are merely used by the inventor to enable a clear and consistent understanding of the disclosure. Accordingly, it should be apparent to those skilled in the art that the following description of various embodiments of the disclosure is provided for illustration purpose only and not for the purpose of limiting the disclosure as defined by the claims and their equivalents.

[0031] Unless the context clearly dictates otherwise, the singular forms "a", "an", and "the" should be understood to include plural meanings. Therefore, for example, a "surface of a component" may be understood to include one or more of the surfaces of the component.

[0032] It should be appreciated that the blocks in each flowchart and combinations of the flowcharts may be performed by one or more computer programs which include instructions. The entirety of the one or more computer programs may be stored in a single memory device or the one or more computer programs may be divided with different portions stored in different multiple memory devices.

[0033] FIG. **1** is a block diagram illustrating an electronic device **103** in a network environment **100** according to an embodiment of the disclosure.

[0034] 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**).

[0035] The processor **120** may include various processing circuitry and/or multiple processors. For example, as used herein, including the claims, the term "processor" may include various processing circuitry, including at least one processor, wherein one or more of at least one processor, individually and/or collectively in a distributed manner, may be configured to perform various functions described herein. As used herein, when "a processor", "at least one processor", and "one or more processors" are described as being configured to perform numerous functions, these terms cover situations, for example and without limitation, in which one processor performs some of recited functions and another processor(s) performs other of recited functions, and also situations in which a single processor may perform all recited functions. Additionally, the at least one processor may include a combination of processors performing various of the recited/disclosed functions, e.g., in a distributed manner. At least one processor may execute program instructions to achieve or perform various functions.

[0036] 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 an 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**.

[0037] 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.

[0038] 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**.

[0039] 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**.

[0040] 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).

[0041] 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.

[0042] 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 strength of force incurred by the touch.

[0043] 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**.

[0044] 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.

[0045] 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.

[0046] 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, an HDMI connector, a USB connector, an SD card connector, or an audio connector (e.g., a headphone connector).

[0047] 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.

[0048] 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.

[0049] The power management module **188** may manage power supplied to the electronic device **101**. According to an embodiment, the power management module **188** may be implemented as at least part of, for example, a power management integrated circuit (PMIC).

[0050] 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.

[0051] 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). 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 fifth generation (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**.

[0052] The wireless communication module **192** may support a 5G network, after a fourth generation (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 millimeter wave (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.

[0053] 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**.

[0054] According to various embodiments, the antenna module **197** may form an mmWave antenna module. According to an embodiment, the mmWave antenna module may include a printed circuit board, an 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.

[0055] 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)).

[0056] 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** or **104**, or the server **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.

[0057] 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.

[0058] It should be appreciated that various embodiments of the 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. 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.

[0059] 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).

[0060] 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., the internal memory **136** or the 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.

[0061] According to an embodiment, 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.

[0062] 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.

[0063] FIG. **2** is a perspective view of a wearable device **103**, illustrating a front surface of the wearable device according to an embodiment of the disclosure.

[0064] FIG. **3** is a perspective view of a wearable device **103**, illustrating a rear surface of the wearable device **103** according to an embodiment of the disclosure.

[0065] The description of the electronic device **101** made with reference to FIG. **1** is applicable substantially equally to the wearable device **103** described with reference to FIGS. **2** to **15**, unless conflicting each other.

[0066] Referring to FIGS. **2** and **3**, the wearable device **103** (e.g., the electronic device **101** in FIG. **1**) according to an embodiment of the disclosure may include a housing **210** or wearing members **250** and **260**. The housing **210** may include a first surface (or front surface) **210**A, a second surface (or rear surface) **210**B, or a side surface **210**C. The side surface **210**C may surround a space between the first surface **210**A and the second surface **210**B.

[0067] According to an embodiment of the disclosure, the housing **210** may refer to a structure that forms a portion of the first surface **210**A of FIG. **2** and the second surface **210**B and side surface **210**C of FIG. **3**. At least a portion of the first surface **210**A may be formed by a front plate **201** (e.g., a glass plate or polymer plate including various coating layers) which is at least partially substantially transparent. The second surface **210**B may be formed by a substantially opaque rear plate **207**. The housing **210** may include the front plate **201**, a side bezel structure **206**, and/or the rear plate **207**.

[0068] According to an embodiment of the disclosure, the rear plate **207** may include an at least partially transparent area. Light may pass from the outside to the inside of the wearable device **103** through the transparent area, and light may be emitted from the inside of the wearable device **103** to the outside. Accordingly, the transparent area may be referred to as a light transmission area.

[0069] According to an embodiment of the disclosure, the rear plate **207** may be formed of, for example, coated or tinted glass, ceramic, a polymer, a metal (e.g., aluminum, stainless steel (STS), or magnesium), or a combination of at least two of these materials. The side surface **210**C may be formed by the side bezel structure (or "side member") **206** coupled to the front plate **201** and the rear plate **207** and including a metal and/or a polymer. In an embodiment, the rear plate **207** and the side bezel structure **206** may be integrally formed and include the same material (e.g., a metallic material such as aluminum).

[0070] According to an embodiment of the disclosure, the wearable device **103** may include at least one of a display (e.g., the display module **160** in FIG. **1**), audio modules **205** and **208** (e.g., the audio module **170** in FIG. **1**), a sensor module **211** (e.g., the sensor module **176** in FIG. **1**), key input devices **202**, **203** and **204** (e.g., the input module **150** in FIG. **1**), or a connector hole **209** (e.g., the connecting terminal **178** in FIG. **1**). In an embodiment, the wearable device **103** may not be provided with at least one (e.g., the key input devices **202**, **203** and **204**, the connector hole **209**, or the sensor module **211**) of the components or additionally include other components.

[0071] According to an embodiment of the disclosure, the display may be exposed, for example, through a substantial portion of the front plate **201**. The shape of the display may correspond to that of the front plate **201**, and may be in any of various shapes such as circle, oval, or polygon. The display may be incorporated with or disposed adjacent to a touch sensing circuit, a pressure sensor that measures the intensity (pressure) of a touch, and/or a fingerprint sensor.

[0072] According to an embodiment of the disclosure, the audio modules **205** and **208** may include a microphone hole **205** and a speaker hole **208**. A microphone for obtaining an external sound may be disposed in the microphone hole **205**, and in some embodiments, a plurality of microphones may be disposed to detect the direction of a sound. The speaker hole **208** may be used as an external speaker and a receiver for calls. In an embodiment, a speaker (e.g., a piezo speaker) may be included without the speaker hole.

[0073] According to an embodiment of the disclosure, the key input devices **202**, **203**, and **204** may include a wheel key **202** disposed on the first surface **210**A of the housing **210** and rotatable in at least one direction, and/or side key buttons **203** and **204** disposed on the side surface **210**C of the housing **210**. The wheel key **202** may have a shape corresponding to that of the front plate **201**. In an embodiment, the wearable device **103** may not include some or any of the above-mentioned key input devices **202**, **203**, and **204**, and the key input devices **202**, **203**, and **204** which are not included may be implemented in other forms such as soft keys on the display. The connector hole **209** may accommodate a connector (e.g., a USB connector) for transmitting and receiving power and/or data to and from an external electronic device, and include another connector hole (not shown) for accommodating a connector for transmitting and receiving an audio signal to and from an external electronic device. The wearable device **103** may further include, for example, a connector cover (not shown) that covers at least a portion of the connector hole **109** and blocks the introduction of a foreign material into the connector hole **109**.

[0074] According to an embodiment of the disclosure, the wearable device **103** may be configured to be detachably fastened to a user's body part (e.g., wrist, ankle, or the like) through the wearing members **250** and **260**. The wearing members **250** and **260** may be connected to at least a portion of the housing **210**. The wearing members **250** and **260** may be formed of various materials in various shapes. An integrated link and a plurality of unit links may be formed of fabric, leather, rubber, urethane, metal, ceramic, or a combination of at least two of these materials, to be movable together.

[0075] According to an embodiment of the disclosure, the wearing members **250** and **260** may be detachably fastened to at least a partial area of the housing **210** using locking members **251** and **261**. The locking members **251** and **261** may include fastening components, such as pogo pins, and may be replaced by protrusion(s) or recess(es) formed on the wear members **250** and **260** according to an embodiment. For example, the wearing members **250** and **260** may be coupled in such a manner that they are engaged with grooves or protrusions formed on the housing **210**. The wearing members **250** and **260** may include one or more of a fixing member **252**, a fixing member fastening hole **253**, a band guide member **254**, and a band fixing loop **255**.

[0076] According to an embodiment of the disclosure, the fixing member **252** may be configured to fix the housing **210** and the wearing members **250** and **260** to the user's body part (e.g., wrist or ankle). The fixing member fastening hole **253** may fix the housing **210** and the wearing members **250** and **260** to the user's body part in correspondence with the fixing member **252**. The band guide member **254** may be configured to limit a movement range of the fixing member **252**, when the fixing member **252** is fastened in the fixing member fastening hole **253**, so that the wearing members **250** and **260** are fastened to the user's body part in close contact. The band fixing loop **255** may limit movement ranges of the wearing members **250** and **260**, with the fixing member **252** fastened in the fixing member fastening hole **253**.

[0077] According to an embodiment of the disclosure, the sensor module **211** or **300** may measure biometric information about the user through a light transmission area **207***t* (see FIG. **7**) of the rear plate **207** directed toward the user's body. The sensor module **211** or **300** may include, for example, a biometric sensor module **211** or **300** disposed on the second surface **210**B of the housing **210**. The sensor module **211** or **300** will be described in detail later with reference to FIGS. **4** to **15**.

[0078] FIG. **4** illustrates an example in which a wearable device **103** is worn on the user's wrist according to an embodiment of the disclosure.

[0079] Referring to FIG. **4**, the wearable device **103** according to an embodiment of the disclosure may be worn on the user's body part (e.g., wrist). The wearable device **103** may be worn on the user's body such that the rear plate **207** (see FIG. **3**) is directed toward the user's skin and the front plate **201** is directed toward the outside of the user's body part. Data measured (or detected) by the wearable device **103** may be displayed on the display to provide information to the user. In addition, the sensor module **211** or **300** (see FIG. **3**) disposed on the rear plate **207** may measure biometric information about the user by emitting light to the user's skin through the rear plate **207** and detecting reflected light of the emitted light or light (e.g., light absorbed into and emitted by skin proteins) generated by the emitted light.

[0080] FIG. **5** is a cross-sectional view illustrating a user's skin composed of an epidermal layer E and a dermal layer T to describe the principle of skin fluorescence measurement of a wearable device **103** according to an embodiment of the disclosure.

[0081] Excess glucose or fructose in the body may be combined with dermal layer proteins P**1**, P**2**, and P**3** of the dermal layer T to produce an advanced glycated end products (AGEs). The AGEs may be accumulated in the dermal layer proteins P**1**, P**2**, and P**3**. For example, the dermal layer proteins P**1**, P**2**, and P**3** may include hyaluronic acid P**1**, collagen P**2**, elastin P**3**, and so on.

[0082] Referring to FIG. **5**, according to an embodiment of the disclosure, light UV emitted from the sensor module **300** toward the user's skin may reach the epidermal layer E and dermal layer T of the skin. For example, the light UV emitted toward the user's skin may be ultraviolet (UV) light. A portion of the emitted light UV may be absorbed by the dermal layer proteins P**1**, P**2**, and P**3** with the combined AGEs, located in the dermal layer T, and emitted to the outside of the skin in the form of fluorescence. As the energy of the emitted light UV is absorbed by the dermal layer proteins P**1**, P**2**, and P**3**, the wavelength of the emitted light EL may be longer than that of the emitted light UV. The light EL emitted in the form of fluorescence from the dermal layer proteins P**1**, P**2**, and P**3** may be detected by the sensor module **300**.

[0083] According to an embodiment of the disclosure, the wearable device **103** may calculate the amount of the dermal layer proteins P**1**, P**2**, and P**3** in which the AGEs are accumulated, based on the wavelength of the light UV emitted toward the user's skin, the wavelength of the emitted light EL, and the amount (illuminance) of the emitted light EL. Accordingly, the amount of the AGEs in the body may be measured. The measurement of AGEs described with reference to FIG. **5** may be understood as an example of applying the skin fluorescence measurement method of the wearable device **103** **101** according to an embodiment of the disclosure.

[0084] FIG. **6** illustrates light emitters **321** and **322** and photodetectors **311** and **312** in a sensor module **300** according to an embodiment of the disclosure.

[0085] Referring to FIG. **6**, the wearable device **103** according to an embodiment of the disclosure may include a board **330** disposed inside the housing **210**. The board **330** may include a plate on which, for example, light emitters **321**, **322**, and **323** and/or the photodetectors **311** and **312** are disposed, or a PCB on which the light emitters **321**, **322**, and **323** and/or the photodetectors **311** and **312** are mounted by surface mounted technology (SMT). The board **330** may also be referred to as a plate or PCB.

[0086] According to an embodiment of the disclosure, the board **330** may include a surface **331** directed toward the light transmission area **207***t* of the housing **210** (see FIG. **2**). In an example, the surface **331** of the board **330** may face the light transmission area **207***t* formed on the rear plate **207**. The board **330** may have a shape corresponding to the light transmission area **207***t* of the housing **210**. In an example, when viewed from the outside of the light transmission area **207***t*, the board **330** and the light transmission area **207***t* may at least partially overlap.

[0087] According to an embodiment of the disclosure, the wearable device **103** may include a photodetecting module **310** configured to detect light reflected or emitted from the user's skin. The photodetecting module **310** may include a first photodetector **311**. The first photodetector **311** may be disposed on the surface **331** of the board **330**. The first photodetector **311** may be configured to detect (or receive) light in a band of a first wavelength or longer. In an example, the first photodetector **311** may detect light in a band of 430 nm or longer. In an example, the first photodetector **311** may include a photodiode.

[0088] According to an embodiment of the disclosure, a plurality of first photodetectors **311** may be provided. In an example, the plurality of first photodetectors **311** may be arranged on the surface **331** of the board **330** along an edge of the surface **331** of the board **330**. In another example, the plurality of first photodetectors **311** may be arranged on the surface **331** of the board **330** along an edge of the light transmission area **207***t*.

[0089] According to an embodiment of the disclosure, the photodetecting module **310** may include a second photodetector **312**. The second photodetector **312** may be disposed on the surface **331** of the board **330**. The second photodetector **312** may be spaced apart from the first photodetector **311**. The second photodetector **312** may be configured to detect (or receive) light in a band of a wavelength equal to or longer than a second wavelength longer than the first wavelength. In an example, the second photodetector **312** may include a photodiode equipped with a filter that passes light having a specific wavelength or longer (e.g., 500 nm or longer), to measure the amount of light corresponding to the wavelength of the emitted light EL (see FIG. **5**).

[0090] According to an embodiment of the disclosure, a plurality of second photodetectors **312** may be provided. In an example, the plurality of second photodetectors **312** may be arranged on the surface **331** of the board **330** along the edge of the surface **331** of the board **330**. In another example, the plurality of second photodetectors **312** may be arranged on the surface **331** of the board **330** along the edge of the light transmission area **207***t*.

[0091] The wearable device **103** according to an embodiment of the disclosure may include a first light emitter **321**. In an example, the first light emitter **321** may include an LED. The first light emitter **321** may be configured to emit light having a third wavelength toward the light transmission area **207***t*. In an example, the first light emitter **321** may emit blue light. A band of the third wavelength used by the first light emitter **321** may be included in a wavelength band between 430 nm and 480 nm.

[0092] According to an embodiment of the disclosure, the first light emitter **321** may be disposed on the surface **331** of the board **330**. The first light emitter **321** may be spaced apart from the first photodetector **311** and the second photodetector **312**. The first light emitter **321** may be located between the first photodetector **311** and the second photodetector **312**.

[0093] According to an embodiment of the disclosure, a plurality of first light emitters **321** may be provided. In an example, the plurality of first light emitters **321** may be arranged on the surface **331** of the board **330** along the edge of the surface **331** of the board **330**. In another example, the plurality of first light emitters **321** may be arranged on the surface **331** of the board **330** along the edge of the light transmission area **207***t*.

[0094] The wearable device **103** according to an embodiment of the disclosure may include a second light emitter **322**. In an example, the second light emitter **322** may include an LED. The second light emitter **322** may be configured to emit light having a fourth wavelength shorter than the third wavelength toward the light transmission area **207***t*. In an example, the first light emitter **321** may emit blue light, and the second light emitter **322** may emit UV light.

[0095] According to an embodiment of the disclosure, the first light emitter **321** and the second light emitter **322** may be referred to as a first light emission module **320**. When the second light emitter **322** operates, the first light emitter **321** may also operate. Accordingly, signal values obtained through the photodetectors **311** and **312** may be corrected by emitting light through the second light emitter **322** with the first light emitter **321**.

[0096] According to an embodiment of the disclosure, the second light emitter **322** may be disposed on the surface **331** of the board **330**. The second light emitter **322** may be spaced apart from the first photodetector **311** and the second photodetector **312**. The second light emitter **322** may be located between the second photodetector **312** and the first light emitter **321**. In an example, the first photodetector **311**, the first light emitter **321**, the second light emitter **322**, and the second photodetector **312** may be sequentially arranged along the edge of the surface of the board **330**.

[0097] According to an embodiment of the disclosure, a plurality of second light emitters **322** may be provided. In an example, the plurality of second light emitters **322** may be arranged on the surface **331** of the board **330** along the edge of the surface **331** of the board **330**. In another example, the plurality of second light emitters **322** may be arranged on the surface **331** of the board **330** along the edge of the light transmission area **207***t*.

[0098] The wearable device **103** according to an embodiment of the disclosure may include a second light emission module **323** configured to emit light having a fifth wavelength longer than the third wavelength toward the light transmission area **207***t*. The second light emission module **323** may include a plurality of third light emitters **323***a*, **323***b*, and **323***c*. The second light emission module **323** may be disposed on the surface **331** of the board **330**.

[0099] According to an embodiment of the disclosure, the plurality of third light emitters **323***a*, **3223***b*, and **323***c* may be configured to emit light having a wavelength equal to or longer than the third wavelength. The plurality of third light emitters **323***a*, **3223***b*, and **323***c* may include an IR light emitter **323***a* configured to emit IR light. A band of the fourth wavelength used by the IR light emitter **323***a* may be included in a wavelength band of 780 nm or longer. The plurality of third light emitters **323***a*, **3223***b*, and **323***c* may include a red light emitter **323***b* configured to emit red light. A wavelength band used by the red light emitter **323***b* may be included in a wavelength band between 645 nm and 700 nm. The plurality of third light emitters **323***a*, **3223***b*, and **323***c* may include a green light emitter **323***c* configured to emit green light. A wavelength band used by the green light emitter **323***c* may be included in a wavelength band between 490 nm and 530 nm. In an example, the second light emission module **323** may include at least one of the IR light emitter **323***a*, the red light emitter **323***b*, or the green light emitter **323***c*.

[0100] According to an embodiment of the disclosure, the first photodetector **311**, the second photodetector **312**, the first light emitter **321**, and the second light emitter **322** may be arranged around the second light emission module **323** to at least partially surround the second light emission module **323**. In an example, the first photodetector **311**, the second photodetector **312**, the first light emitter **321**, and the second light emitter **322** may be arranged at radial positions of the second light emission module **323**.

[0101] According to an embodiment of the disclosure, the wearable device **103** may include a first wall **350**. The first wall **350** may protrude from the surface **331** of the board **330** toward the light transmission area **207***t*. The first wall **350** may surround the second light emission module **323**. The first wall **350** may be disposed between the third light emitters **323***a*, **3223***b*, and **323***c* and the first photodetector **311**. The first wall **350** may be disposed between the third light emitters **323***a*, **3223***b*, and **323***c* and the second photodetector **312**. The first wall **350** may be disposed between the third light emitters **323***a*, **3223***b*, and **323***c* and the first light emitter **321**. The first wall **350** may be disposed between the third light emitters **323***a,* **3223***b,* and **323***c* and the second light emitter **322**.

[0102] According to an embodiment of the disclosure, the wearable device **103** may include a second wall **341** and **342**. The second wall **341** and **342** may protrude from the surface **331** of the board **330** toward the light transmission area **207***t*. The second wall **341** and **342** may include a first portion **341** and a second portion **342**.

[0103] According to an embodiment of the disclosure, the first portion **341** of the second wall **341** and **342** may surround the first wall **350**. The second portion **342** of the second wall **341** and **342** may at least partially surround the first light emission module **320**. In an example, the first portion **341** and the second portion **342** of the second wall **341** and **342** may surround the first light emission module **320** together.

[0104] According to an embodiment of the disclosure, the first portion **341** of the second wall **341** and **342** may be disposed between the third light emitters **323***a,* **3223***b* and **323***c* and the first photodetector **311**. The first portion **341** of the second wall **341** and **342** may be disposed between the third light emitters **323***a,* **3223***b,* and **323***c* and the second photodetector **312**.

[0105] According to an embodiment of the disclosure, the second portion **342** of the second wall **341** and **342** may be disposed between the first photodetector **311** and the first light emitter **321**. The second portion **342** of the second wall **341** and **342** may be disposed between the second photodetector **312** and the second light emitter **322**.

[0106] FIG. **7** is a cross-sectional view illustrating a portion of a wearable device **103** and a sensor module **300** according to an embodiment of the disclosure.

[0107] Referring to FIGS. **6** and **7**, according to an embodiment of the disclosure, the light transmission area **207***t* of the rear plate **207** may include a serration pattern S. Light emitted from the light emitters **321** and **322** may easily reach the user's body part by the serration pattern S. Due to the serration pattern S, light from the outside of the wearable device **103** may easily reach the photodetectors **311** and **312** through the light transmission area **207***t*. The walls **341**, **342**, and **350** may protrude from one surface of the board **330** toward the light transmission area **207***t*. The other surface **332** of the board **330** may be directed toward the inside of the wearable device **103**.

[0108] FIG. **8** illustrates distances between light emitters **321** and **322** and photodetectors **311** and **312** in a sensor module **300** according to an embodiment of the disclosure.

[0109] Referring to FIG. **8**, the second light emission module **323** according to an embodiment of the disclosure may be located on an inner side of the board **330**. The first light emitter **321**, the second light emitter **322**, and/or the photodetectors **311** and **312** may be located on an outer side (e.g., edge) of the board **330**. In an example, the second light emission module **323** may be located at a center of the surface **331** of the board **330** and surrounded by a plurality of light emitters **321** and **322** and a plurality of photodetectors **311** and **312**.

[0110] Accordingly, as the first light emission module **320** configured to emit light (e.g., blue light and UV light) having a relatively short wavelength is disposed closer to the photodetectors **311** and **312** than the second light emission module **323** configured to emit light (e.g., green light, red light, and IR light) having a relatively long wavelength, the photodetectors **311** and **312** may detect the light having the relatively short wavelength more effectively.

[0111] According to an embodiment of the disclosure, a distance dl between a light receiving portion **311***s* of the first photodetector **311** and a light source of the first light emitter **321** may be smaller than a distance **12** between the light receiving portion **311***s* of the first photodetector **311** and a light source of the third light emitters **323***a,* **3223***b,* and **323***c*. In an example, the light receiving portion **311***s* of the first photodetector **311** may be a photosensitive layer of a photodiode.

[0112] According to an embodiment of the disclosure, a distance d**2** between a light receiving portion **312***s* of the second photodetector **312** and a light source of the second light emitter **322** may be smaller than a distance **11** between the light receiving portion **312***s* of the second photodetector **312** and the light source of the third light emitter **323***a,* **3223***b,* and **323***c*. In an example, the light receiving portion **312***s* of the second photodetector **312** may be a photosensitive layer of a photodiode.

[0113] According to an embodiment of the disclosure, when viewed from above the surface **331** of the board **330**, the distance d**2** or d**4** between the light source of the second light emitter **322** and the light receiving portion **312***s* of the second photodetector **312** may range from 3 mm to 4 mm. More specifically, it may range from 3 mm to 3.5 mm.

[0114] According to an embodiment of the disclosure, when viewed from above the surface **331** of the board **330**, the distance d**1** or d**3** between the light source of the first light emitter **321** and the light receiving portion **311***s* of the first photodetector **311** may range from 3 mm to 4 mm. More specifically, it may range from 3 mm to 3.5 mm.

[0115] FIG. **9** illustrates a plurality of light emission modules **1321**, **1322**, **1323**, **1324**, and **1325** and photodetectors **311** and **312** according to an embodiment of the disclosure.

[0116] The description of the components (e.g., the first light emission module **320** and the second light emission module **323**) made with reference to FIGS. **6** to **8** is applicable substantially equally to the components (e.g., light emission modules **1321**, **1322**, **1323**, **1324**, and **1325**) of the same names described with reference to FIG. **9**, unless conflicting each other.

[0117] Referring to FIG. **9**, the wearable device **103** according to an embodiment of the disclosure may include the plurality of light emission modules **1321**, **1322**, **1323**, **1324**, and **1325**. Each of the light emission modules **1321**, **1322**, **1323**, **1324**, and **1325** may correspond to the first light emission module **320** or the second light emission module **323** described with reference to FIG. **6**.

[0118] According to an embodiment of the disclosure, the wearable device **103** may include a plurality of second light emission modules **323**, unlike FIG. **6**. In an example, the plurality of second light emission modules **323** may be located at positions corresponding to some **1322**, **1324**, and **1325** of the light emission modules **1321**, **1322**, **1323**, **1324**, and **1325** illustrated in FIG. **9**, and a plurality of first light emission modules **320** may be arranged at positions corresponding to the remaining light emission modules **1321** and **1323**.

[0119] FIG. **10** illustrates first light emission modules **320** and photodetectors **1311** and **1312** according to an embodiment of the disclosure.

[0120] Referring to FIG. **10**, the wearable device **103** according to an embodiment of the disclosure may include a third photodetector **1311**. The description of the first photodetector **311** made with reference to FIG. **6** is applicable substantially equally to the third photodetector **1311**, unless conflicting each other. The third photodetector **1311** may be disposed on the inner side of the surface **331** of the board **330**. In an example, the third photodetector **1311** may be disposed at the center of the surface **331** of the board **330**, surrounded by first photodetectors **311** and second photodetectors **312**.

[0121] The wearable device **103** according to an embodiment of the disclosure may include a fourth photodetector **1312**. The description of the second photodetector **312** given with reference to FIG. **6** is applicable substantially equally to the fourth photodetector **1312**, unless conflicting each other. The fourth photodetector **1312** may be disposed on the inner side of the surface **331** of the board **330**. In an example, the fourth photodetector **1312** may be disposed at the center of the surface **331** of the board **330**, surrounded by the first photodetectors **311** and the second photodetectors **312**.

[0122] According to an embodiment of the disclosure, the first photodetectors **311**, the second photodetectors **312**, the first light emitter **321**, and the second light emitter **322** may be arranged around the third photodetector **1311** and the fourth photodetector **1312** to at least partially surround the third photodetector **1311** and the fourth photodetector **1312**. In an example, the first photodetectors **311**, the second photodetectors **312**, the first light emitter **321**, and the second light emitter **322** may be arranged at radial positions of the third photodetector **1311** and the fourth photodetector **1312**.

[0123] According to an embodiment of the disclosure, the wearable device **103** may include the third photodetector **1311** configured to detect light having the first wavelength or longer. The wearable device **103** may include the fourth photodetector **1312** configured to detect light having the second wavelength or longer. The third photodetector **1311** and the fourth photodetector **1312** may detect light emitted from the user's skin.

[0124] According to an embodiment of the disclosure, when viewed from above the surface **331** of the board **330**, the fourth photodetector **1312** may be disposed closer to the second light emitter **322** than to the first light emitter **321**. In an example, when viewed from above the surface **331** of the board **330**, a distance d**5** between the light source of the second light emitter **322** and a light receiving portion **1312***s* of the fourth photodetector **1312** may be smaller than a distance d**6** between the light source of the second light emitter **322** and a light receiving portion **1311***s* of the third photodetector **1311**.

[0125] According to an embodiment of the disclosure, when viewed from above the surface **331** of the board **330**, the fourth photodetector **1312** may be disposed closer to the second photodetector **312** than to the first photodetector **311**. In an example, a distance d**7** between the light receiving portion **1312***s* of the fourth photodetector **1312** and the light receiving portion **312***s* of the second photodetector **312** may be smaller than a distance d**8** between the light receiving portion **1312***s* of the fourth photodetector **1312** and the light receiving portion **311***s* of the first photodetector **311**.

[0126] According to an embodiment of the disclosure, the wearable device **103** may include wall structures **1341**, **1342**, **1343**, and **1344**. The wall structures **1341**, **1342**, **1343**, and **1344** may surround a second light emission modules **320**. In an example, a plurality of wall structures **1341**, **1342**, **1343**, and **1344** may be provided and surround a plurality of second light emission modules **320**, respectively.

[0127] FIG. **11** illustrates light emitters **321** and **322** and photodetectors **311** and **312** according to an embodiment of the disclosure.

[0128] Referring to FIG. **11**, the first wall **350** may be disposed between the light emitters **321** and **322** and the photodetectors **311** and **312**. In an example, the first wall **350** may surround a plurality of light emitters **321** and **322**, and a plurality of photodetectors **311** and **312** may surround the first wall **350**.

[0129] According to an embodiment of the disclosure, an order in which the light emitters **321** and **322** are arranged along a longitudinal direction of the first wall **350** may be identical to an order in which the photodetectors **311** and **312** are arranged along the longitudinal direction of the first wall **350**. In an example, the light emitters **321** and **322** may be arranged in the order of the first light emitter **321** and the second light emitter **322** along the longitudinal direction of the first wall **350**, and the photodetectors **311** and **312** may be arranged in the order of the first photodetector **311** and the second photodetector **312** along the longitudinal direction of the first wall **350**.

[0130] According to an embodiment of the disclosure, the first photodetector **311** may be spaced apart from the first light emitter **321** toward the edge of the board **330**. In an example, the first photodetector **311** may be spaced apart from the first light emitter **321** in a radial direction of the board **330**. The second photodetector **312** may be spaced apart from the second light emitter **322** toward the edge of the board **330**. In an example, the second photodetector **312** may be spaced apart from the second light emitter **322** in the radial direction of the board **330**.

[0131] According to an embodiment of the disclosure, the first photodetectors **311** and the second photodetectors **312** may be arranged around the first light emitter **321** and the second light emitter **322** to at least partially surround the first light emitter **321** and the second light emitter **322**. In an example, the first photodetectors **311** and the second photodetectors **312** may be arranged at radial positions of the first light emitter **321** and the second light emitter **322**.

[0132] FIG. **12** illustrates light emission modules **2321**, **2322**, **2323**, **2324**, **2325**, **2326**, **2327**, and **2328** and photodetectors **311** and **312** according to an embodiment of the disclosure.

[0133] The description of the light emission modules **320** and **323** given with reference to FIGS. **6** to **8** is applicable substantially equally to the light emission modules **2321**, **2322**, **2323**, **2324**, **2325**, **2326**, **2327**, and **2328** of the same names described with reference to FIG. **12**, unless conflicting with each other.

[0134] Referring to FIG. **12**, the wearable device **103** according to an embodiment of the disclosure may include a plurality of light emission modules **2321**, **2322**, **2323**, **2324**, **2325**, **2326**, **2327**, and **2328**. Each of the light emission modules **2321**, **2322**, **2323**, **2324**, **2325**, **2326**, **2327**, and **2328** may correspond to the first light emission module **320** or the second light emission module **323** described with reference to FIG. **6**.

[0135] According to an embodiment of the disclosure, the plurality of light emission modules **2321**, **2322**, **2323**, **2324**, **2325**, **2326**, **2327**, and **2328** may surround the photodetectors **311** and **312**. The photodetectors **311** and **312** may correspond to the first photodetector **311** and the second photodetector **312** described with reference to FIG. **6**. Light emitted from the plurality of light emission modules **2321**, **2322**, **2323**, **2324**, **2325**, **2326**, **2327**, and **2328** may correspond to the first photodetector **311** and the second photodetector **312**.

[0136] According to an embodiment of the disclosure, the plurality of light emission modules **2321**, **2322**, **2323**, **2324**, **2325**, **2326**, **2327**, and **2328** may be arranged around the photodetectors **311** and **312** to at least partially surround the photodetectors **311** and **312**. In an example, the plurality of light emission modules **2321**, **2322**, **2323**, **2324**, **2325**, **2326**, **2327**, and **2328** may be arranged on radial positions of the photodetectors **311** and **312**.

[0137] According to an embodiment of the disclosure, the wearable device **103** may include the first wall **50** disposed between the photodetectors **311** and **312** and the plurality of light emission modules **2321**, **2322**, **2323**, **2324**, **2325**, **2326**, **2327**, and **2328**. The first wall **350** may surround the photodetectors **311** and **312**.

[0138] FIG. **13** is a block diagram illustrating a portion of the wearable device **103** according to an embodiment of the disclosure.

[0139] Referring to FIG. **13**, the wearable device **103** according to an embodiment of the disclosure may include the processor **120**, the memory **130**, a display device **160** (e.g., the display module **160** in FIG. **1**), the sensor module **300** (e.g., the sensor module **176** in FIG. **1** or the sensor module **211** in FIG. **2**), and the communication module **190**. The processor **120**, the memory **130**, the display device **160**, the sensor module **300**, and the communication module **190** may be operatively coupled to an electrical interface such as a communication bus (not shown). The communication module **190** may perform at least one of transmission or reception of a wired or wireless signal including information related to the user's blood sugar level. Each of the light emitters **321**, **322**, and **323** and the photodetectors **311** and **312** may be controlled by the processor **120**.

[0140] According to an embodiment of the disclosure, the display device **160** may be controlled by the processor **120** to provide a visual user interface (UI) to the user. For example, the display device **160** may include a display that is at least partially visible to the outside through a housing of the electronic device **101**. The display may output information visually to the user using at least one of an organic light emitting diode (OLED), a liquid crystal display (LCD), or a light emitting diode (LED). A UI output through the display may include the amount of AGEs in the body or biometric information (e.g., body age) about the user based the amount of AGEs (see FIG. **4**).

[0141] FIG. **14** is a flowchart illustrating a method for measuring skin fluorescence in the wearable device **103** according to an embodiment of the disclosure. The method for measuring skin fluorescence illustrated in FIG. **14** may be performed using the wearable device **103** described with reference to FIGS. **6** to **12**.

[0142] Referring to FIGS. **13** and **14**, according to an embodiment of the disclosure, the wearable device **103** may include the light emission modules **320** and **323** configured to emit light to the user's skin, and the photodetecting module **310** (see FIG. **6**) configured to detect light emitted from the user's skin. The light emission modules **320** and **323** may include the first light emission module **320** and the second light emission module **323** described with reference to FIG. **6**. The photodetecting module **310** may include the first photodetector **311** and the second photodetector **312** described with reference to FIG. **6**.

[0143] The method for measuring skin fluorescence in the wearable device **103** according to an embodiment of the disclosure may include operation S**1** for emitting at least one of red light, blue light, or green light to the user's skin through the light emission modules **320** and **323**, and obtaining a skin color property signal value through the photodetecting module **310**.

[0144] According to an embodiment of the disclosure, in operation S**1** for obtaining a skin color property signal value, the blue light emitter **321** of the first light emission module **320**, and the red light emitter **323***b* and green light emitter **323***c* of the second light emission module **323** may operate sequentially in a random order to emit light toward the user's skin. In an example, the blue light emitter **321**, the green light emitter **323***c*, and the red light emitter **323***b* may sequentially emit light, and light emitted from the user's skin may be detected through the photodetecting module **310** in each operation.

[0145] According to an embodiment of the disclosure, the photodetecting module **310** may obtain a signal value corresponding to the detected emitted light. In an example, the first photodetector **311** and/or the second photodetector **312** may obtain a signal value corresponding to the intensity of the detected emitted light, and the processor **120** may determine the skin color of the user's body part (e.g., wrist) by comparing the signal value with a value stored in the memory **130**.

[0146] According to an embodiment of the disclosure, the method for measuring skin fluorescence in the wearable device **103** may include an operation of emitting UV light to the user's skin by sequentially operating a plurality of UV light emission modules **320**, and obtaining a signal value corresponding to each of the light emission modules **320** through the photodetecting module **310**, which is performed before operation S**1** for obtaining the skin color property signal value. In an example, a signal value corresponding to each of UV light emitters **322** included in a light emission module **320** may be obtained by emitting UV light to the user's skin by sequentially operating the UV light emitters **322** and detecting light emitted from the user's skin through the photodetecting module **310**.

[0147] According to an embodiment of the disclosure, the processor **120** may determine whether the wearable device **103** is worn based on the signal value corresponding to each of the UV light emitters **322**. In an example, when the differences between the signal values corresponding to the respective UV light emitters **322** and a reference value stored in the memory **130** are less than or equal to a reference deviation, the processor **120** may determine that the wearable device **103** is worn properly. Further, when at least one of the differences between the signal values corresponding to the respective UV light emitters **322** and the reference value stored in the memory **130** is greater than the reference deviation, the processor **120** may determine that the wearable device **103** is not worn properly.

[0148] According to an embodiment of the disclosure, the method for measuring skin fluorescence in the wearable device **103** may include an operation of notifying whether the device is worn or not. When at least one of the differences between the signal values corresponding to the respective UV light emitters **322** and the reference value stored in the memory **130** is greater than the reference deviation, the wearable device **103** may provide wearable device wearing information to the user. The wearable device wearing information may include information for indicating that the wearable device **103** is not properly worn on the user's body part. In an example, the display device **160** may include the display, and a UI displayed on the display may include the wearable device wearing information. In another example, the wearable device wearing information may be audibly delivered to the user through an audio output module (e.g., the sound output module **155** in FIG. **1**) of the wearable device **103**. In another example, the wearable device wearing information may be tactilely delivered to the user through a haptic module (e.g., the haptic module **179** in FIG. **1**) of the wearable device **103**.

[0149] The method for measuring skin fluorescence in the wearable device **103** according to an embodiment of the disclosure may include operation S**2** for emitting IR light to the user's skin through the light emission modules **320** and **323** and obtaining a skin thickness property signal value through the photodetecting module **310**. In operation S**2** for obtaining a skin thickness property signal value, IR light may be emitted toward the user's skin through the light emission module **323**, and light emitted from the user's skin may be detected by the photodetecting module **310**.

[0150] According to an embodiment of the disclosure, the photodetecting module **310** may obtain a signal value corresponding to the detected emitted light. In an example, the first photodetector **311** and/or the second photodetector **312** may obtain a signal value corresponding to the intensity of the detected emitted light, and the processor **120** may determine the thickness of the epidermal layer E of the user's body part (e.g., wrist) by comparing the signal value with a value stored in the memory **130**.

[0151] According to an embodiment of the disclosure, in operation S**2** for obtaining a skin thickness property signal value, the illuminance of IR light emitted through the light emission module **323** may correspond to the obtained skin color property signal value. In an example, when the skin color of the user's body part is determined to be a first skin color, IR light with an illuminance corresponding to the first skin color may be emitted in operation S**2** for obtaining a skin thickness property signal value. In another example, when the skin color of the user's body part is determined to be a second skin color darker than the first skin color, IR light with an illuminance greater than the illuminance corresponding to the first skin color may be emitted in operation S**2** for obtaining a skin thickness property signal value.

[0152] The method for measuring skin fluorescence in the wearable device **103** according to an embodiment of the disclosure may include operation S**3** for setting an illuminance of UV light emitted through the light emission module **320** based on the obtained skin color property signal value and the obtained skin thickness property signal value.

[0153] According to an embodiment of the disclosure, the illuminance of UV light may be set differently depending on the user's skin color in the operation S**3** for setting an illuminance of UV light. In an example, when the skin color of the body part is determined to be the first skin color, the illuminance of UV light corresponding to the first skin color may be set in operation S**3** for setting an illuminance of UV color. In another example, when the skin color of the user's body part is determined to be the second skin color darker than the first skin color, an illuminance greater than the illuminance corresponding to the first skin color may be set in operation S**3** for setting an illuminance of UV color.

[0154] According to an embodiment of the disclosure, the illuminance of UV light may be set differently depending on the thickness of the user's epidermis in operation S**3** for setting an illuminance of UV color. In an example, when the epidermal thickness of the body part is greater than a predetermined thickness value, the illuminance of UV light may be set to be greater than when the epidermal thickness of the body part is smaller than the predetermined thickness value. In another example, when the epidermal thickness of the body part is smaller than the predetermined thickness value, the illuminance of UV light may be set to be less than when the epidermal thickness of the body part is greater than the predetermined thickness value.

[0155] The method for measuring skin fluorescence in the wearable device **103** according to an embodiment of the disclosure may include operation S**4** for radiating UV light with the set illuminance to the user's skin through the light emission module **320** and obtaining a skin fluorescence signal value through the photodetecting module **310**. In operation S**4** for obtaining a skin fluorescence signal value, UV light may be emitted to the user's skin through the light emission module **320**, and light emitted from the user's skin may be detected by the photodetecting module **310**.

[0156] Referring to FIG. **5**, according to an embodiment of the disclosure, the UV light UV emitted to the user's skin through the light emission module **320** may reach the dermal layer T of the user's skin and be absorbed by the dermal layer proteins P**1**, P**2**, and P**3** in which AGEs are combined, and the dermal layer proteins P**1**, P**2**, and P**3** may emit the light EL in the form of fluorescence. In an example, the wavelength of the UV light UV emitted from the light emission module **320** may be about 365 nm, and the wavelength of the emitted light EL from the dermal layer proteins P**1**, P**2**, and P**3** may be in a band of 500 nm.

[0157] According to an embodiment of the disclosure, the emitted light EL may be detected through the photodetecting module **310**. The photodetecting module **310** may obtain a signal value corresponding to the intensity of the emitted light EL. In an example, the first photodetector **311** and/or the second photodetector **312** may obtain a signal value corresponding to the intensity of the detected emitted light EL, and the processor **120** may determine a skin fluorescence value of the user's body part (e.g., wrist) by comparing the signal value with a skin fluorescence value stored in the memory **130**. In an example, the skin fluorescence value may include the amount of the AGEs in the body.

[0158] According to an embodiment of the disclosure, the method for measuring skin fluorescence in the wearable device **103** may further include an operation S**5** of outputting skin fluorescence information. The skin fluorescence information may include the amount of the AGEs in the body or information (e.g., the user's body age) that may be estimated from the amount of the AGEs.

[0159] According to an embodiment of the disclosure, the skin fluorescence information may be visually delivered to the user through the display device **160**. In an example, the display device **160** may include the display, and a UI displayed on the display may include the skin fluorescence information. In another example, the skin fluorescence information may be audibly delivered to the user through the audio output module (e.g., the sound output module **155** in

FIG. **1**) of the wearable device **103**. In another example, the skin fluorescence information may be tactilely delivered to the user through the haptic module (e.g., the haptic module **179** in FIG. **1**) of the wearable device **103**.

[0160] FIG. **15** is a flowchart illustrating operation S**4** for obtaining a skin fluorescence signal value according to an embodiment of the disclosure.

[0161] Referring to FIG. **15**, the light emission modules **320** and **323** according to an embodiment of the disclosure may include a plurality of first light emission modules **320** comprising UV light emitter **322**. In an example, the plurality of first light emission modules **320** may be arranged on the surface **331** of the board **330**, as illustrated in FIG. **6**.

[0162] According to an embodiment of the disclosure, operation S**4** for obtaining a skin fluorescence signal value may include operation S**40** for emitting UV light to the user's skin by sequentially operating the plurality of first light emission modules **320**, and obtaining a signal value corresponding to each of the first light emission modules **320** through the photodetectors **311** and **312**.

[0163] According to an embodiment of the disclosure, operation S**40** for obtaining a signal value corresponding to each first light emission module **320** may include operations S**41**, S**42**, S**43**, and S**44** for sequentially emitting UV light through a plurality of UV light emitters **322** of each first light emission module **320** and obtaining skin fluorescence signal values through the photodetecting module **310** (see FIG. **6**). In an example, the plurality of UV light emitters **322** may correspond to the second light emitters **322** illustrated in FIG. **6**, and for convenience of the description made with reference to FIG. **15**, the plurality of UV light emitters **322** may be referred to as a first to fourth UV light emitters.

[0164] According to an embodiment of the disclosure, operation S**40** for obtaining a signal value corresponding to each first light emission module **320** may be performed in the order of operation S**41** for obtaining a skin fluorescence signal for the first UV light emitter **322**, operation S**42** for obtaining a skin fluorescence signal for the second UV light emitter **322**, operation S**43** for obtaining a skin fluorescence signal for the third UV light emitter **322**, and operation S**44** for obtaining a skin fluorescence signal for the fourth UV light emitter **322**.

[0165] According to an embodiment of the disclosure, in operations S**41**, S**42**, S**43**, and S**44** for obtaining skin fluorescence signals for the first to fourth UV light emitters **322**, the light EL (see FIG. **5**) emitted from the user's skin may be detected through the photodetecting module **310**. The photodetecting module **310** may obtain a signal value corresponding to the intensity of the emitted light EL. In an example, the first photodetector **311** and/or the second photodetector **312** may obtain a signal value corresponding to the intensity of the detected emitted light EL, and the processor **120** may determine the skin fluorescence value of the user's body part (e.g., wrist) by comparing the signal value with a skin fluorescence value stored in the memory **130**. In an example, the skin fluorescence value may include the amount of AGEs in the body.

[0166] According to an embodiment of the disclosure, operation S**4** for obtaining a skin fluorescence signal value may include operation S**45** for determining at least one optimal first light emission module among the plurality of first light emission modules **320** by comparing a signal value corresponding to each of the first light emission modules **320** with a preset value.

[0167] According to an embodiment of the disclosure, in operation S**45** for determining an optimal first light emission module **320**, the processor **120** may determine a UV light emitter **322** having the highest of the skin fluorescence signal values obtained in operations S**41**, S**42**, S**43**, and S**44** for obtaining skin fluorescence signal values for the first to fourth UV light emitters **322** as an optimal UV light emitter **322**. Additionally, a first light emission module **320** including the optimal UV light emitter **322** may be determined as an optimal first light emission module **320**. The UV light emitter **322**, which has the highest skin fluorescence signal value, may be understood as a UV light emitter that facilitates measurement of the degree of fluorescence of the user's skin (e.g., the amount of AGEs in the body).

[0168] According to an embodiment of the disclosure, operation S**4** for obtaining a skin fluorescence signal value may include operation S**46** for obtaining a skin fluorescence signal value for the optimal UV light emitter. In operation S**46** for obtaining a skin fluorescence signal value for the optimal UV light emitter, UV light directed to the user's skin may be emitted through the optimal UV light emitter, and light EL (see FIG. **5**) emitted from the user's skin may be detected through the photodetecting module **310**. The first photodetector **311** and/or the second photodetector **312** may obtain a signal value corresponding to the intensity of the detected emitted light EL, and the processor **120** may determine a skin fluorescence value of the user's body part (e.g., wrist) by comparing the signal value with the skin fluorescence value stored in the memory **130**.

[0169] According to an embodiment of the disclosure, operation S**46** of obtaining a skin fluorescence signal value for the optimal UV light emitter may be omitted. The processor **120** may determine the highest of the skin fluorescence signal values obtained in operations S**41**, S**42**, S**43**, and S**44** for obtaining skin fluorescence signals for the first to fourth UV light emitters **322** to be the skin fluorescence value of the user's body part (e.g. wrist).

[0170] A wearable device is a device worn on a user's body part (e.g., wrist, ankle, or the like), which may detect biometric information about the user through the user's skin or effectively provide information to the user. However, it is difficult to stably fix the wearable device to the user's body part due to the user's physical activity. Accordingly, much research is being conducted to improve biometric information measurement through a wearable device.

[0171] An object to be achieved by the disclosure may be to improve the performance of measuring user biometric information (e.g., the amount of AGEs) by a wearable device.

[0172] An object to be achieved by the disclosure may be to effectively arrange a plurality of components (e.g., light emitters and photodetectors) for detecting biometric information in a wearable device.

[0173] The objects to be addressed by the disclosure are not limited to the above-mentioned objects, and may be determined in various ways without departing from the spirit and scope of the disclosure.

[0174] An electronic device according to various embodiments of the disclosure may improve the performance of biometric information measurement of a wearable device by disposing a short-wavelength light emitter closer to a photodetector than a long-wavelength light emitter.

[0175] An electronic device according to various embodiments of the disclosure may enable effective arrangement of components in a wearable device by closely arranging a plurality of light emitters that emit light of different wavelengths and a plurality of photodetectors that detect light in different wavelength ranges.

[0176] The effects that may be obtained from the disclosure are not limited to the effects mentioned above, and other effects not mentioned may be clearly understood by those skilled in the art from the aforementioned description.

[0177] The wearable device **103** according to an embodiment of the disclosure may include the housing **210** including the light transmission area **207***t*.

[0178] The wearable device **103** according to an embodiment of the disclosure may include the board **330** disposed inside the housing **210** and including the surface **331** directed toward the light transmission area **207***t*.

[0179] The wearable device **103** according to an embodiment of the disclosure may include the first photodetector **311** disposed on the surface **331** of the board **330** and configured to detect light having a wavelength equal to or longer than a first wavelength.

[0180] The wearable device **103** according to an embodiment of the disclosure may include the second photodetector **312** disposed on the surface **331** of the board **330** and spaced apart from the first photodetector **311**.

[0181] The second photodetector **312** according to an embodiment of the disclosure may be configured to detect light having a wavelength equal to or longer than a second wavelength longer than the first wavelength.

[0182] The wearable device **103** according to an embodiment of the disclosure may include the first light emitter **321** disposed between the first photodetector **311** and the second photodetector **312** and configured to emit light having a third wavelength toward the light transmission area **207***t*.

[0183] The wearable device **103** according to an embodiment of the disclosure may include the second light emitter **322** disposed between the first light emitter **321** and the second photodetector **312** and configured to emit light having a fourth wavelength shorter than the third wavelength toward the light transmission area **207***t*.

[0184] The wearable device **103** according to an embodiment of the disclosure may include the light emission module **323** configured to emit light having a fifth wavelength longer than the third wavelength toward the light transmission area **207***t*.

[0185] According to an embodiment of the disclosure, the first photodetector **311**, the second photodetector **312**, the first light emitter **321**, and the second light emitter **322** may be arranged around the light emission module **323** to at least partially surround the light emission module **323**.

[0186] According to an embodiment of the disclosure, the light emission module **323** may include at least one of the IR light emitter **323***a* configured to emit IR light, the red light emitter **323***b* configured to emit red light, or the green light emitter **323***c* configured to emit green light.

[0187] The wearable device **103** according to an embodiment of the disclosure may further include the walls **341** and **350** surrounding the light emission module **323** and protruding from the surface **331** of the board **330** toward the light transmission area **207***t*.

[0188] According to an embodiment of the disclosure, the first photodetector **311**, the first light emitter **321**, the second light emitter **322**, and the second photodetector **312** may be sequentially arranged along an edge of the light transmission area **207***t*.

[0189] The wearable device **103** according to an embodiment of the disclosure may include the wall **342** disposed between the second photodetector **312** and the second light emitter **322** and protruding from the surface **331** of the board **330** toward the light transmission area **207***t*.

[0190] According to an embodiment of the disclosure, the first light emitter **321** may be configured to emit blue light, and the second light emitter **322** may be configured to emit UV light.

[0191] According to an embodiment of the disclosure, the wearable device **103** may include the third light emitters **323***a*, **323***b*, and **323***c* configured to emit light having a wavelength equal to or longer than the third wavelength toward the light transmission area **207***t*.

[0192] According to an embodiment of the disclosure, the wearable device **103** may include the wall **341** disposed between the third light emitters **323***a*, **323***b*, and **323***c* and the first photodetector **311** and protruding from the surface **331** of the board **330** toward the light transmission area **207***t*.

[0193] According to an embodiment of the disclosure, the distance between the light receiving portion **311***s* of the first photodetector **311** and the light source of the third light emitters **323***a*, **323***b*, and **323***c* may be greater than the distance between the light receiving portion **312***s* of the second photodetector **312** and the light source of the second light emitter **322**.

[0194] According to an embodiment of the disclosure, when viewed from above the surface **331** of the board **330**, the distance between the light source of the second light emitter **322** and the light receiving portion **312***s* of the second photodetector **312** may range from 3 mm to 4 mm.

[0195] According to an embodiment of the disclosure, when viewed from above the surface **331** of the board **330**, the distance dl between the light source of the first light emitter **321** and the light receiving portion **311***s* of the first photodetector **311** may range from 3 mm to 4 mm.

[0196] According to an embodiment of the disclosure, the second light emitter **322** may include a plurality of second light emitters **322** arranged along an edge of the light transmission area **207***t*.

[0197] According to an embodiment of the disclosure, the wearable device **103** may further include the photodetecting module **1311** and **1312** disposed on the surface **331** of the board **330** and configured to detect light having a specific wavelength.

[0198] According to an embodiment of the disclosure, the first photodetector **311**, the second photodetector **312**, the first light emitter **321**, and the second light emitter **322** may be arranged around the photodetecting module **1311** and **1312** to at least partially surround the photodetecting module **1311** and **1312**.

[0199] According to an embodiment of the disclosure, the photodetecting module **1311** and **1312** may include the third photodetector **1311** configured to detect light having a wavelength equal to or longer than the first wavelength.

[0200] According to an embodiment of the disclosure, the photodetecting module **1311** and **1312** may include the fourth photodetector **1312** configured to detect light having a wavelength equal to or longer than the second wavelength.

[0201] According to an embodiment of the disclosure, when viewed from above the surface **331** of the board **330**, the fourth photodetector **1312** may be disposed to be closer to the second light emitter **322** than to the first light emitter **321**.

[0202] According to an embodiment of the disclosure, a method for measuring skin fluorescence in the wearable device **103** may include operation S**1** for emitting at least one of red light, blue light, or green light toward the user's skin through the light emission modules **320** and **323** and obtaining a skin color property signal value through the photodetecting module **310**.

[0203] According to an embodiment of the disclosure, the method for measuring skin fluorescence in the wearable device **103** may include operation S**2** for emitting IR light toward the user's skin through the light emission modules **320** and **323** and obtaining a skin thickness property signal value through the photodetecting module **310**.

[0204] According to an embodiment of the disclosure, the method for measuring skin fluorescence in the wearable device **103** may include setting an illuminance of UV light emitted through the light emission modules **320** and **323** based on the obtained skin color property signal value and the obtained skin thickness property signal value.

[0205] According to an embodiment of the disclosure, the method for measuring skin fluorescence in the wearable device **103** may include emitting UV light with the set illuminance toward the user's skin through the light emission module **320** and obtaining a skin fluorescence signal value through the photodetecting module **310**.

[0206] According to an embodiment of the disclosure, the light emission modules **320** and **323** may include a plurality of first light emission modules **320** including UV light emitters **322**.

[0207] According to an embodiment of the disclosure, operation S**4** for obtaining the skin fluorescence signal value may include emitting UV light through an optimal first light emission module **320** among the plurality of first light emission modules **320**.

[0208] According to an embodiment of the disclosure, operation S**4** for obtaining the skin fluorescence signal value may include operations S**41**, S**42**, S**43**, and S**44** for emitting UV light toward the user's skin by sequentially operating the plurality of first light emission modules **320** and obtaining a signal value corresponding to each of the first light emission modules **320** through the photodetecting module **310**.

[0209] According to an embodiment of the disclosure, operation S**4** for obtaining the skin fluorescence signal value may include operation S**45** for determining the optimal first light emission module **320** among the plurality of first light emission modules **320** by comparing the signal value corresponding to each of the first light emission modules **320** with a preset value.

[0210] According to an embodiment of the disclosure, operation S**2** for obtaining the skin thickness property signal value may include setting an illuminance of the IR light emitted through the light emission module **323** based on the obtained skin color property signal value.

[0211] According to an embodiment of the disclosure, the method for measuring skin fluorescence in the wearable device **103** may further include, before operation S**1** for obtaining the skin color property signal value, emitting UV light toward the user's skin by sequentially operating the plurality of first light emission modules **320** and obtaining a signal value corresponding to each of the first light emission modules **320** through the photodetecting module **310**.

[0212] According to an embodiment of the disclosure, the method for measuring skin fluorescence in the wearable device **103** may further include, before operation S**1** for obtaining the skin color property signal value, when a difference between the signal value corresponding to each of the first light emission modules **320** and a predetermined reference value is greater than a reference deviation, providing wearable device wearing information visually or audibly through the wearable device **103**.

[0213] While the disclosure has been shown and described with reference to various embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the disclosure as defined by the appended claims and their equivalents.

What is claimed is:

1. A wearable device comprising:

a housing including a light transmission area;

a board disposed inside the housing and including a surface directed toward the light transmission area;

a first photodetector disposed on the surface of the board and configured to detect light having a wavelength equal to or longer than a first wavelength;

a second photodetector disposed on the surface of the board and configured to detect light having a wavelength equal to or longer than a second wavelength longer than the first wavelength;

a first light emitter disposed between the first photodetector and the second photodetector and configured to irradiate light having a third wavelength toward the light transmission area; and

a second light emitter disposed between the first light emitter and the second photodetector and configured to emit light having a fourth wavelength shorter than the third wavelength toward the light transmission area.

2. The wearable device of claim **1**, further comprising:

a light emission module configured to emit light having a fifth wavelength longer than the third wavelength toward the light transmission area,

wherein the first photodetector, the second photodetector, the first light emitter, and the second light emitter are arranged around the light emission module to at least partially surround the light emission module.

3. The wearable device of claim **2**, wherein the light emission module includes at least one of an infrared (IR) light emitter configured to emit IR light, a red light emitter configured to emit red light, or a green light emitter configured to emit green light.

4. The wearable device of claim **3**, further comprising:

a wall surrounding the light emission module and protruding from the surface of the board toward the light transmission area.

5. The wearable device of claim **4**, wherein the first photodetector, the first light emitter, the second light emitter, and the second photodetector are sequentially arranged along an edge of the light transmission area.

6. The wearable device of claim **5**, further comprising:

a wall disposed between the second photodetector and the second light emitter and protruding from the surface of the board toward the light transmission area.

7. The wearable device of claim **6**,

wherein the first light emitter is configured to emit blue light, and

wherein the second light emitter is configured to emit ultraviolet (UV) light.

8. The wearable device of claim **7**, further comprising:

a third light emitter configured to emit light having a wavelength equal to or longer than the third wavelength toward the light transmission area.

9. The wearable device of claim **8**, further comprising:

a wall disposed between the third light emitter and the first photodetector and protruding from the surface of the board toward the light transmission area.

10. The wearable device of claim **9**, wherein a distance between a light receiving portion of the first photodetector and a light source of the third light emitter is greater than a distance between a light receiving portion of the second photodetector and a light source of the second light emitter.

11. The wearable device of claim **10**, wherein when viewed from above the surface of the board, a distance between a light source of the second light emitter and a light receiving portion of the second photodetector ranges from 3 mm to 4 mm.

12. The wearable device of claim **11**, wherein when viewed from above the surface of the board, a distance between a light source of the first light emitter and a light receiving portion of the first photodetector ranges from 3 mm to 4 mm.

13. The wearable device of claim **12**, wherein the second light emitter includes a plurality of second light emitters arranged along an edge of the light transmission area.

14. The wearable device of claim **13**, further comprising:

a third photodetector disposed on the surface of the board and configured to detect light having a wavelength equal to or longer than the first wavelength; and

a fourth photodetector disposed on the surface of the board and configured to detect light having a wavelength equal to or longer than the second wavelength,

wherein the first photodetector, the second photodetector, the first light emitter, and the second light emitter are arranged around the third photodetector and the fourth photodetector to at least partially surround the third photodetector and the fourth photodetector.

15. The wearable device of claim **14**, wherein when viewed from above the surface of the board, the fourth photodetector is disposed to be closer to the second light emitter than to the first photodetector.

16. A method performed by a wearable device for measuring skin fluorescence including a light emission module configured to emit light toward a user's skin and a photodetecting module configured to detect light emitted from the user's skin, the method comprising:

emitting, by the wearable device, at least one of red light, blue light, or green light toward the user's skin through the light emission module and obtaining a skin color property signal value through the photodetecting module;

emitting, by the wearable device, infrared (IR) light toward the user's skin through the light emission module and obtaining a skin thickness property signal value through the photodetecting module;

setting, by the wearable device, an illuminance of ultraviolet (UV) light emitted through the light emission module based on the obtained skin color property signal value and the obtained skin thickness property signal value; and

emitting, by the wearable device, UV light with the set illuminance toward the user's skin through the light emission module and obtaining a skin fluorescence signal value through the photodetecting module.

17. The method of claim **16**,

wherein the light emission module includes a plurality of first light emission modules including UV light emitters, and

wherein obtaining the skin fluorescence signal value includes emitting UV light through an optimal first light emission module among the plurality of first light emission modules.

18. The method of claim **17**, wherein obtaining the skin fluorescence signal value includes:

emitting UV light toward the user's skin by sequentially operating the plurality of first light emission modules and obtaining a signal value corresponding to each of the first light emission modules through the photodetecting module; and

determining the optimal first light emission module among the plurality of first light emission modules by comparing the signal value corresponding to each of the first light emission modules with a preset value.

19. The method of claim **16**, wherein obtaining the skin thickness property signal value includes setting an illuminance of the IR light emitted through the light emission module based on the obtained skin color property signal value.

20. The method of claim **17**, further comprising, performed before obtaining the skin color property signal value:

emitting UV light toward the user's skin by sequentially operating the plurality of first light emission modules and obtaining a signal value corresponding to each of the first light emission modules through the photodetecting module; and

when a difference between the signal value corresponding to each of the first light emission modules and a predetermined reference value is greater than a reference deviation, providing wearable device wearing information through the wearable device.

* * * * *