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ELECTRONIC DEVICE AND OPERATION METHOD THEREOF

Abstract

An electronic device according to an embodiment includes: at least one sensor, a memory storing one or more instructions, and at least one processor, comprising processing circuitry, individually and/or collectively, configured to execute the one or more instructions and to control the electronic device to: measure, using the at least one sensor, an amount of carbon dioxide generated by a user and a variation in body fat of the user, calculate a calorie burn amount of the user, based on the amount of carbon dioxide generated by the user, calculate a calorie intake amount of the user, based on the variation in the body fat of the user and the calorie burn amount of the user, and output user-customized healthcare information, based on the variation in the body fat of the user, the calorie burn amount of the user, and the calorie intake amount of the user.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a continuation of International Application No. PCT/KR2023/013452 designating the United States, filed on Sep. 7, 2023, in the Korean Intellectual Property Receiving Office and claiming priority to Korean Patent Application No. 10-2022-0135233, filed on Oct. 19, 2022, in the Korean Intellectual Property Office, the disclosures of each of which are incorporated by reference herein in their entireties.

BACKGROUND
Field
[0002] The disclosure relates to an electronic device, and for example, to an electronic device and operation method thereof for recommending user-customized healthcare information.
DESCRIPTION OF RELATED ART
[0003] Recently, as research on wearable electronic devices among electronic devices has been actively conducted, various wearable electronic devices have been released or are expected to be released. Wearable electronic devices that are being currently released or are scheduled to be released include smartwatches, smart glasses, smart bands, and the like.
[0004] Wearable electronic devices are highly accessible because they are attached to a user's body, and are capable of providing users with various healthcare services in conjunction with or independently of mobile devices such as smartphones and tablets.
[0005] However, conventional wearable electronic devices have problems in providing user-customized healthcare services due to the inconvenience of having to receive user data required for healthcare services from the user and measurement errors in user data due to various causes. Therefore, there is a need for an electronic device capable of providing effective user-customized healthcare services using accurately measured user data.
SUMMARY
[0006] An electronic device according to an example embodiment may include at least one sensor, a memory storing one or more instructions, and at least one processor, comprising processing circuitry, individually and/or collectively, configured to execute the one or more instructions and to control the electronic device to: measure, using the at least one sensor, an amount of carbon dioxide generated by a user and a variation in body fat of the user; calculate a calorie burn amount of the user, based on the amount of carbon dioxide; calculate a calorie intake amount of the user based on the variation in the body fat of the user and the calorie burn amount of the user; and output user-customized healthcare information, based on the variation in the body fat of the user, the calorie burn amount of the user, and the calorie intake amount of the user.
[0007] A method of operating an electronic device, according to an example embodiment, may include: [0008] measuring an amount of carbon dioxide generated by a user, a variation in body fat of the user, and a variation in body fat of the user; calculating a calorie burn amount of the user, based on the amount of carbon dioxide; calculating a calorie intake amount of the user based on the variation in the body fat of the user and the calorie burn amount of the user; and outputting user-customized healthcare information, based on the calorie burn amount of the user, the variation in the body fat of the user, and the calorie intake amount of the user.
[0009] According to an example embodiment, there may be provided a non-transitory computer-readable recording medium having recorded thereon a program for executing any one of the methods, performed by an electronic device, of outputting (or recommending) user-customized healthcare information.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0010] The above and other aspects, features and advantages of certain embodiments of the present disclosure will be more apparent from the following detailed description, taken in conjunction with the accompanying drawings, in which:
[0011] FIG. **1** is a diagram illustrating an example in which an electronic device is used, according to various embodiments;
[0012] FIG. **2** is a block diagram illustrating an example configuration of an electronic device according to various embodiments;
[0013] FIGS. **3**A and **3**B are diagrams illustrating examples of an electronic device according to various embodiments;
[0014] FIG. **4** is a block diagram illustrating an example configuration of a sensing module included in an electronic device, according to various embodiments;
[0015] FIG. **5** is a flowchart illustrating an example method of operating an electronic device, according to various embodiments;
[0016] FIG. **6** is a diagram illustrating an example operation in which an electronic device outputs user-customized

diet management information, according to various embodiments;
[0017] FIG. **7** is a diagram illustrating an example operation in which an electronic device calculates a user's calorie intake amount, according to various embodiments;
[0018] FIG. **8** is a flowchart illustrating an example method of operating an electronic device, according to various embodiments;
[0019] FIG. **9** is a flowchart illustrating an example method of operating an electronic device, according to various embodiments;
[0020] FIG. **10** is a flowchart illustrating an example method of operating an electronic device, according to various embodiments;
[0021] FIG. **11** is a flowchart illustrating an example method of operating an electronic device, according to various embodiments;
[0022] FIG. **12** is a block diagram illustrating an example configuration of a system according to various embodiments; and
[0023] FIG. **13** is a block diagram illustrating an example configuration of an electronic device according to various embodiments.

DETAILED DESCRIPTION

[0024] Terms used in the present disclosure will be briefly described, and the present disclosure will be described in greater detail.
[0025] As terms used in the present disclosure, general terms that are currently widely used are selected by taking into account functions in the present disclosure, but these terms may vary according to the intention of one of ordinary skill in the art, precedent cases, advent of new technologies, etc. Furthermore, specific terms may be arbitrarily selected, and in this case, the meaning of the selected terms will be described in detail in the detailed description of a corresponding part of the disclosure. Thus, the terms used herein should be defined not by simple appellations thereof but based on the meaning of the terms together with the overall description of the present disclosure.
[0026] Throughout the disclosure, when a part "includes" or "comprises" an element, unless there is a particular description contrary thereto, it is understood that the part may further include other elements, not excluding the other elements. As used herein, the term "unit" or "module" indicates a unit for processing at least one function or operation and may be implemented using hardware or software or a combination of hardware and software.
[0027] Embodiments will be described more fully hereinafter with reference to the accompanying drawings. However, the present disclosure may be implemented in various different forms and is not limited to the various example embodiments described herein. In addition, parts not related to descriptions of the present disclosure may be omitted to clearly explain the present disclosure in the drawings, and like reference numerals denote like elements throughout.
[0028] In various embodiments of the present disclosure, the term "user" may refer to a person who controls a system, a function or an operation, and may include a developer, an administrator, or an installation technician.
[0029] In various embodiments of this disclosure, the term "electronic device" may refer to an electronic device (or wearable electronic device) that may be worn on a user's body.
[0030] FIG. **1** is a diagram illustrating an example 100 in which an electronic device is used, according to various embodiments.
[0031] Referring to FIG. **1**, an electronic device **10** may be worn on a user's body to measure biometric information of the user and recommend healthcare information based on the measured biometric information.
[0032] In an embodiment, as illustrated in FIG. **1**, the electronic device **10** has the shape of a watch and may be temporarily fixed to the user's wrist by a watch band or the like.
[0033] In an embodiment, the electronic device **10** may be attached to a part of the user's body to sense the biometric information of the user (e.g., the amount of carbon dioxide produced by the user, a user's blood pH, etc.) using at least one sensor included in the electronic device **10**. According to an embodiment of the present disclosure, the electronic device may determine a user's physical condition using the measured biometric information of the user, thereby enabling an accurate determination of the user's physical condition and providing the user with user-customized healthcare information that may effectively improve the user's health accordingly.
[0034] FIG. **2** is a block diagram illustrating an example configuration of an electronic device according to various embodiments.
[0035] Components of an electronic device **300** according to an embodiment of the present disclosure are described in greater detail with reference to FIG. **2**. The electronic device **10** of FIG. **1** may correspond to the electronic device **300** of FIG. **2**.
[0036] According to an embodiment of the present disclosure, the electronic device **300** is a device that may be worn on a user's body and may be an electronic device that measures or provides biometric information of the user.
[0037] As illustrated in FIG. **2**, according to an embodiment of the present disclosure, the electronic device **300** may include a sensing module (e.g., including at least one sensor) **310**, a touch input module (e.g., including touch input

circuitry) **320**, a display module (e.g., including a display) **330**, a communication module (e.g., including communication circuitry) **340**, and a control module (e.g., including at least one processor, comprising various processing circuitry) **350**.

[0038] The sensing module **310** may include one or more sensors and may detect various pieces of information for determining a user's state, a state of the electronic device **300**, and a state of the surrounding environment. For example, the sensing module **310** may sense information about the user's state. The information about the user's state may include at least one of information related to the user's movement, information related to the user's location, and information related to the user's biosignal.

[0039] For example, the sensing module **310** may measure the amount of carbon dioxide produced by the user, a variation in the user's body fat, an electrocardiogram of the user, etc. Various sensors that may be included in the sensing module **310** are described in greater detail below with reference to FIG. **4**.

[0040] The touch input module **320** may include various touch input circuitry and receive a touch input from the user.

[0041] The touch input module **320** may detect an input from the user touching the touch input module **320** using a pointing object. In this case, the pointing object refers to a tool for touching a touch panel via a real-touch or proximity touch. Examples of the pointing object include a stylus pen, a finger, etc.

[0042] According to an embodiment, the touch input module **320** provided in the electronic device **300** may be configured to detect not only a user's real-touch but also proximity touch on the touch input module **320**.

[0043] According to an embodiment, the touch input module **320** may receive a touch input by a pointing object. The touch input may refer to a motion in which the user touches the touch input module **320** using the pointing object and then does not move for a predetermined period of time. For example, when a touch to the touch input module **320** is continuously detected for several tens to several hundreds of milliseconds (ms), the electronic device **300** may determine that a touch input has been received.

[0044] The control module **350** may include various circuitry (e.g., at least one processor comprising processing circuitry) and control operations of the electronic device **300**.

[0045] According to an embodiment, when a touch input is received from the touch input module **320**, the control module **350** may control the sensing module **310** to measure biometric information of the user.

[0046] According to an embodiment, the control module **350** may determine the user's state based on the biometric information of the user, and control the display module **330** to display user-customized healthcare information or sleep management information based on a result of the determination.

[0047] The display module **330** may include a display and display and output information processed in the electronic device **300**. The display module **320** may display at least one piece of healthcare information or sleep management information about the user transmitted from the control module **350**. Furthermore, the display module **320** may further display a user interface (UI) for receiving a user input for controlling the electronic device **300** and a UI for setting parameters related to an operation of receiving a touch input and an operation of transmitting a message to a receiving device.

[0048] The display module **330** may be configured as a touch screen by forming a layer structure with the touch input module **320**. In this case, the touch screen may be used as an input device as well as an output device by performing functions of both the touch input module **320** and the display module **330**. The display module **330** may include, for example, and without limitation, at least one of a liquid crystal display (LCD), a thin-film transistor LCD (TFT-LCD), an organic light-emitting diode (OLED) display, a flexible display, a three-dimensional (3D) display, and an electrophoretic display. In addition, the display module **330** may be configured as a translucent optical waveguide (e.g., a prism).

[0049] The communication module **340** may include various communication circuitry and communicate with an external electronic device or server. The communication module **340** may receive, from the external electronic device, a control signal for controlling the electronic device **300**, a signal indicating information about a state of the external electronic device, etc. In addition, the communication module **340** may transmit, to the external electronic device, a control signal for controlling the electronic device **300**, a signal indicating information about the state of the electronic device **300**, etc.

[0050] For example, the communication module **340** may include at least one of a Bluetooth Low Energy (BLE) module, a Bluetooth module, a near field communication (NFC) module, a radio frequency (RF) module, and a mobile communication module, or a combination thereof.

[0051] FIGS. **3**A and **3**B are diagrams illustrating examples of an electronic device according to various embodiments.

[0052] According to an embodiment of the present disclosure, as illustrated in FIG. **3**A, an electronic device **300-1** may be implemented in the form of a smartwatch that is fixed to a user's wrist. The electronic device **300** of FIG. **2** may correspond to the electronic device **300-1** of FIG. **3**A or an electronic device **300-2** of FIG. **3**B. In addition, the sensing module **310**, the touch input module **320**, the display module **330**, the communication module **340**, and the control module **350** of FIG. **2** may respectively correspond to a sensing module **310**, a touch input module **320**, a display module **330**, a communication module **340**, and a control module **350** of FIGS. **3**A and **3**B.

[0053] The electronic device **300-1** in the form of the smartwatch illustrated in FIG. **3**A may include the touch input module **320**, the display module **330**, and the control module **350**. However, all of the components shown in FIG. **3**A are not essential components of the electronic device **300-1**. The electronic device **300-1** may be implemented by more components than those shown in FIG. **3**A, or it may be implemented by fewer components than those shown in FIG. **3**A.

[0054] Some of the components included in the electronic device **300-1** may be built into the electronic device **300-1**, and other components thereof may be mounted on outside of the electronic device **300-1**. For example, the control module **350** may be built into the electronic device **300-1**.

[0055] In addition to the control module **350**, the electronic device **300-1** may further include therein the sensing module **310** that detects a state of the user wearing the electronic device **300-1**, a state of the electronic device **300-1**, or an external state. In addition, the electronic device **300-1** may further include therein the communication module **340** for communicating with another electronic device. The touch input module **320** and the display module **330** may be mounted on the outside of the electronic device **300-1**. The components built into the electronic device **300-1** and the components mounted on the outside of the electronic device **300-1** are not limited to those described above.

[0056] A frame that maintains the shape of the electronic device **300-1** may include a material such as plastic and/or metal, and include wiring that connects the components included in the electronic device **300-1** to each other.

[0057] The touch input module **320** may include a touch pad operable by a user's finger. In FIG. **3**A, the touch input module **320** is illustrated as being located on a watch face included in the electronic device **300-1**, but the touch input module **320** may also be located at another position on the electronic device **300-1**. The electronic device **300-1** may receive various user inputs via the touch input module **320**.

[0058] The display module **330** may be located on the watch face of the electronic device **300-1** as illustrated in FIG. **3**A. The display module **330** may be configured as a touch screen by forming a layer structure with a touch pad that receives a touch input. In this case, the display module **330** may perform the function of the touch input module **320** together.

[0059] Referring to FIG. **3**B, according to an embodiment of the present disclosure, the electronic device **300** may be configured in the form of a smart band that is fixed to the user's wrist, forearm, ankle, etc.

[0060] The electronic device **300-2** in the form of the smart band illustrated in FIG. **3**B may include the touch input module **320**, the display module **330**, and the control module **350**. However, all of the components shown in FIG. **3**B are not essential components of the electronic device **300-2**. The electronic device **300-2** may be implemented by more components than those shown in FIG. **3**B, or it may be implemented by fewer components than those shown in FIG. **3**B.

[0061] Some of the components included in the electronic device **300-2** may be built into the electronic device **300-2**, and other components thereof may be mounted on outside of the electronic device **300-2**. For example, the control module **350** may be built into the electronic device **300-2**.

[0062] In addition to the control module **350**, the electronic device **300-2** may further include therein the sensing module **310** that detects a state of the user wearing the electronic device **300-2**, a state of the electronic device **300-2**, or an external state. In addition, the electronic device **300-2** may further include therein the communication module **340** for communicating with another electronic device. The touch input module **320** and the display module **330** may be mounted on the outside of the electronic device **300-2**. The components built into the electronic device **300-2** and the components mounted on the outside of the electronic device **300-1** are not limited to those described above.

[0063] A frame that maintains the shape of the electronic device **300-2** may include a material such as plastic and/or metal, and may include an elastic band so that it may be fixed to the user's body regardless of the user's body size. In addition, the frame that maintains the shape of the electronic device **300-2** may include wiring that connects the components included in the electronic device **300-2** to each other.

[0064] The touch input module **320** may include a touch pad operable by a user's finger. In FIG. **3**B, the touch input module **320** is illustrated as being located on a side on which the display module **330** is located, but the touch input module **320** may also be located at another position on the electronic device **300-2**. The electronic device **300-2** may receive various user inputs via the touch input module **320**.

[0065] The display module **330** may be configured as a touch screen by forming a layer structure with a touch pad that receives a touch input. In this case, the display module **330** may perform the function of the touch input module **320** together.

[0066] As illustrated in FIG. **3**A and FIG. **3**B, an electronic device according to various embodiments of the present disclosure may be implemented in various forms.

[0067] FIG. **4** is a block diagram illustrating an example configuration of a sensing module included in an electronic device, according to various embodiments.

[0068] For example, FIG. **4** is a block diagram of the sensing module **310** included in the electronic device **300** of FIG. **2**.

[0069] Referring to FIG. **4**, according to an embodiment of the present disclosure, the sensing module **310** may include at least one of an illuminance sensor **402**, a biosensor **404**, a tilt sensor **406**, a position sensor **408**, a proximity sensor **410**, a geomagnetic sensor **412**, a gyroscope sensor **414**, a temperature/humidity sensor **416**, an infrared (IR) sensor **418**, and a velocity/acceleration sensor **420**, or any combination thereof. In addition to the types of sensors illustrated in FIG. **4**, various sensors may be included in the sensing module **310**.

[0070] The sensing module **310** may include various combinations of sensors depending on an implemented configuration of the electronic device **300**. For example, the electronic device **300** may sense information related to a user's movement (e.g., information about the user's activity status) as information about the user's state by including at least one or a combination of the tilt sensor **406**, the position sensor **408**, the geomagnetic sensor **412**, the gyroscope sensor **414**, and the velocity/acceleration sensor **420**.

[0071] The biosensor **404** may sense information related to the user's body composition and biosignals. The biosensor **404** may include, for example, at least one of a heart rate sensor, a blood glucose sensor, a blood pressure sensor, a sweat sensor, a body temperature sensor, and an iris sensor.

[0072] For example, the biosensor **404** may measure the calorie burn amount of the user.

[0073] For example, the biosensor **404** may measure a body fat percentage or body fat amount of the user.

[0074] For example, the biosensor **404** may measure a metabolic rate of the user.

[0075] For example, the biosensor **404** may measure the user's sleep cycle or sleep period.

[0076] For example, the biosensor **404** may measure a maximum oxygen partial pressure (VO.sub.2MAX) within the user's body.

[0077] For example, the biosensor **404** may measure a partial pressure of carbon dioxide in the user's body.

[0078] For example, the biosensor **404** may measure a pH level in the user's blood using the amount of carbon dioxide produced by the user.

[0079] The position sensor **408** may include a global positioning system (GPS) module, a Wi-Fi Protected Setup (WPS) module, a BLE module, etc. For example, the position sensor **408** may include a GPS module and sense a position of the electronic device **300** using a GPS. The position sensor **408** may include a WPS module and sense the position of the electronic device **300** using a Wi-Fi map.

[0080] For example, the position sensor **408** may sense contextual information of the user based on the user's location.

[0081] The temperature/humidity sensor **416** may sense at least one of a temperature and a humidity of the surrounding environment of the electronic device **300**.

[0082] For example, the velocity/acceleration sensor **420** may obtain information related to a movement of the user wearing the electronic device **300** by sensing at least one of a velocity and an acceleration of the electronic device **300**.

[0083] The IR sensor **418** includes a nondispersive IR (NDIR) sensor and may perform real-time transcutaneous measurement of the amount of carbon dioxide produced by the user. For example, the NDIR sensor may measure the amount of carbon dioxide produced by the user using the characteristic of carbon dioxide absorbing only specific light in the infrared spectrum (e.g., carbon dioxide absorption spectrum characteristics).

[0084] FIG. **5** is a flowchart illustrating an example method of operating an electronic device, according to various embodiments.

[0085] For example, FIG. **5** illustrates a method, performed by a processor of the electronic device **300** of FIG. **2**, of outputting user-customized healthcare information by measuring the amount of carbon dioxide produced by a user.

[0086] Referring to FIG. **5**, operations for outputting the user-customized healthcare information may include operations **510**, **520**, **530**, and **540**.

[0087] In operation **510**, the processor may control the electronic device **300** to measure the amount of carbon dioxide produced by the user and a variation in the user's body fat.

[0088] According to an embodiment, the processor may transcutaneously measure the amount of carbon dioxide produced by the user using at least one sensor (e.g., an NDIR sensor).

[0089] In an embodiment, the processor may measure the amount of carbon dioxide produced by the user based on Equation 1 below.

[00001] [Equation1] $\text{volumeofCO}_2\,\text{producedbyuser}(VCO_2) = (PaCO_2 * VA) / 0.863$

[0090] A volume VCO.sub.2 of carbon dioxide produced by the user may correspond to the amount of carbon dioxide produced by the user, PaCO.sub.2 may denote a partial pressure of carbon dioxide in the user's arterial blood, VA may denote the amount of gas exchange in the user's alveoli and may be calculated based on, VA=VE−VD, VE may denote the amount of air inhaled into the user's lungs per minute (or the amount of air exhaled from the user's lungs per minute), and VD may denote a volume of air that does not take part in the gas exchange in the user's lungs.

[0091] According to an embodiment, the processor may measure a variation in the user's body fat using at least one sensor (e.g., a bioelectrical impedance analysis (BIA) sensor).

[0092] According to an embodiment, when a variation in the user's body fat (or a variation in total calories according to a change in the user's body fat) is negative, the processor may determine that the user's body fat amount has increased.

[0093] According to an embodiment, when a variation in the user's body fat (or a variation in total calories according to a change in the user's body fat) is positive, the processor may determine that the user's body fat amount has decreased.

[0094] The variation in the user's body fat may be calculated according to Equation 2 below, and the variation in calories according to the variation in the user's body fat may be calculated based on Equation 3 below (in this case, the user's body fat amount may be calculated based on ‘ ’, and it is assumed that calorie (user's body fat percentage)*(user's Weight) Put 9 calories (cal)).

[00002] [Equation2]

$$\text{variation in user's body fat} = (\text{user's body fat amount in previous state}) - (\text{user's body fat amount in current state})$$

[Equation3]

$$\text{variation in calories according to change in user's body fat} = \{(\text{variation in user's body fat}) * (\text{calories corresponding to } 1g \text{ of body fat})$$

[0095] For example, when the user's weight is 75 kilograms (kg), the user's body fat percentage in a previous state is 24.345%, and the user's body fat percentage in a current state is 24.50% (assuming that the calories corresponding to 1 gram of body fat amount are about 9 cal), a variation in calories according to a change in the user's body fat amount may be calculated as ‘{((24.345+24.50)/100)*75 (kg)*9 (cal/g)}=−116.3 (g)*9 (cal/g)=1046.7 cal’. In other words, based on a result of the calculation, the processor may determine that the body fat amount in the user's body has increased by an amount corresponding to ‘1046.7 cal’.

[0096] For example, when the user's weight is 75 kg, the user's body fat percentage in a previous state is 24.345%, and the user's body fat percentage in a current state is 18.1875% (assuming that the calories corresponding to 1 gram of body fat amount are about 9 cal), a variation in calories according to a change in the user's body fat amount may be calculated as ‘{((24.345+18.1875)/100)*75 (kg)*9 (cal/g)}=71.2 (g)*9 (cal/g)=640.8 cal’. In other words, based on a result of the calculation, the processor may determine that body fat amount in the user's body has decreased by an amount corresponding to ‘640.8 cal’.

[0097] In operation **520**, the processor may calculate the calorie burn amount of the user. In an embodiment, the processor may calculate the calorie burn amount of the user (kcal/minute) based on the amount of carbon dioxide produced by the user.

[0098] According to an embodiment, the processor may calculate the calorie burn amount of the user according to Equation 4 or Equation 5 based on the Weir formula (Equation 5 is an equation derived from Equation 4).

[00003] [Equation4] $\text{calorie burn amount (kcal per minute)} = 3.94VO_2 + 1.11VCO_2$ [Equation5]

$$\text{calorie burn amount (kcal per minute)} = 3.94(VCO_2 / RQ) + 1.11VCO_2$$

[0099] Here, VO.sub.2 represents a volume of oxygen consumed in liter per unit time (e.g., 1 minute), VCO.sub.2 represents a volume of carbon dioxide produced in liter by the user per unit time (e.g., 1 minute), and RQ is a respiratory quotient, which may be a constant value of ‘0.86’ or indicate a food quotient (the food quotient may refer, for example, to ‘total RQ/total calorie intake amount’).

[0100] In operation **530**, the processor may calculate calorie intake amount of the user, based on the calorie burn amount of the user and the variation in the body fat. For example, the processor may autonomously calculate the user's calorie intake amount using the calorie burn amount of the user and the variation in the body fat without a manual input from the user.

[0101] According to an embodiment, the processor may calculate the user's calorie intake amount according to Equation 6 below. In other words, the processor may autonomously calculate the user's calorie intake amount without the manual input from the user.

[00004] [Equation6]

$$\text{user's calorie intake amount (cal)} = \{(\text{user's calorie burn amount}) - (\text{variation in calories according to change in user's body fat})\}$$

[0102] For example, when the user's weight is 75 kg, the calorie burn amount of the user is ‘2000 cal’, and the variation in calories according to the change in the user's body fat amount is ‘−1046.7 cal’ (in this case, calories corresponding to 1 gram of body fat amount are assumed to be about 9 cal), the user's calorie intake amount may be ‘{2000−(−1046.7)}={2000+1046.7}=3046.7 cal’.

[0103] For example, when the user's weight is 75 kg, the calorie burn amount of the user is ‘2000 cal’, and the variation in calories according to the change in the user's body fat amount is ‘+640.8 cal’ (in this case, the calories corresponding to 1 gram of body fat amount are assumed to be about 9 cal), the user's calorie intake amount may be ‘{2000−(640.8)}=1359.2 cal’.

[0104] In operation **540**, the processor may output user-customized healthcare information.

[0105] According to an embodiment, the processor may output user-customized healthcare information on a display of the electronic device based on the user's calorie intake amount calculated by the processor itself and user information (e.g., the user's diet and/or information about exercise preference, and information about the user's state or situation).

[0106] According to an embodiment, the user-customized healthcare information may include at least one of information about a diet recommended for the user and information about a type of exercise, an exercise time, or an exercise intensity recommended for the user.

[0107] In an embodiment, the processor may control the electronic device **300** to measure a metabolic rate of the user according to the user-customized healthcare information and store feedback information including the metabolic rate of the user. The processor may output user-customized healthcare information for a next cycle, based on the feedback information.

[0108] The electronic device according to various embodiments of the present disclosure may autonomously calculate the user's calorie intake amount and provide customized healthcare information, thereby improving a data error and user inconvenience caused by a manual input of biometric data by the user and providing an efficient user-customized healthcare system based on accurate biometric data.

[0109] FIG. **6** is a diagram illustrating an example operation in which an electronic device outputs user-customized diet management information, according to various embodiments.

[0110] For example, FIG. **6** illustrates an operation in which the electronic device **300** of FIG. **2** outputs user-customized diet management information to a user.

[0111] In FIG. **6**, it is assumed that the user is a 24-year-old female, weighs 75 kg, is 5 feet (ft) 5 inches tall, does not prefer high-intensity activity, is currently in a resting state, has recently been on a ketogenic (keto) diet, and has set a goal of burning 500 cal for weight loss. It is also assumed that the user burns 600 cal in a low-intensity exercise state and 1200 cal in a resting state.

[0112] Referring to FIG. **6**, a system A **610** may calculate an overall calorie burn amount of the user as 1800 cal, which is a sum of the calories (600 cal) burned in the low-intensity exercise state and the calories (1200 cal) burned in a resting state.

[0113] Therefore, the system A **610** may output (or recommend), to the user, information about a ‘1300-calorie’ diet (a diet of 100 grams of rice, 150 grams of chicken, and 100 grams of vegetables) to achieve a target calorie burn amount (500 cal) of the user for weight loss.

[0114] According to an embodiment of the present disclosure, a system B **650** may calculate the overall calorie burn amount of the user as ‘2300 cal’, which is a sum of calories (600 cal) burned in a low-intensity exercise state and calories (1700 cal) burned in a resting state. In this case, the system B **650** may calculate the calorie burn amount of the user in a resting state as 1700 cal by taking into account a basal metabolic rate (BMR) increased due to the user's recent keto diet.

[0115] Therefore, the system B **610** may output (or recommend) to the user information about a ‘1800-calorie’ diet (a diet of 150 grams of rice, 250 grams of chicken, and 150 grams of vegetables) to achieve the target calorie burn amount (500 cal) of the user for weight loss.

[0116] According to an example embodiment of the present disclosure, the electronic device (e.g., the system B **650**) may recommend user-customized healthcare information to the user by taking into account not only basic information input by the user, but also a specific current situation or state of the user (e.g., the user being on a keto diet for weight loss).

[0117] FIG. **7** is a diagram illustrating an example operation in which an electronic device calculates a user's calorie intake amount, according to various embodiments.

[0118] For example, FIG. **7** illustrates an operation in which the electronic device **300** of FIG. **2** outputs user-customized diet management information to the user by autonomously calculating calorie intake amount of a user.

[0119] In FIG. **7**, it is assumed that the user is a 24-year-old female, the user's weight is 75 kg, the user's height is 5 ft 5 inches, a target calorie burn amount of the user per day is 1500 cal, and the user's dinner menu is recommended based on the target calorie burn amount per day.

[0120] Referring to FIG. **7**, a system A **710** is a system that manually receives the user's calorie intake amount for each meal from the user and outputs (or recommends) healthcare information to the user. The user may store calorie intake amount for breakfast (600 cal) in the system A **710**, and forget to store calorie intake amount for lunch in the system A **710**.

[0121] The system A **710** may determine calories to be consumed for dinner (900 cal) by subtracting only the user's breakfast calories (600 cal) from the target calorie burn amount per day (1500 cal). Accordingly, the system A **710** may output or recommend to the user information about a recommended dinner intake for consuming ‘900 cal’ (e.g., a diet of 60 grams of rice, 100 grams of chicken, and 70 grams of vegetables).

[0122] A system B **750** is a system that autonomously calculates the user's calorie intake amount and outputs or recommends healthcare information to the user. The system B **750** may autonomously determine calories to be consumed for dinner (500 cal), based on a variation in calories (45 cal) due to burning of the user's body fat and the overall calorie burn amount of the user (1045 cal). Accordingly, the system B **750** may output or recommend to the user information about a recommended dinner intake for consuming ‘500 cal’ (e.g., a diet of 30 grams of rice, 60 grams of chicken, and 40 grams of vegetables).

[0123] According to various embodiments of the present disclosure, the electronic device (e.g., the system B **750**) may recommend user-customized healthcare information to the user by autonomously calculating a user's calorie intake amount based on the calorie burn amount of the user and a variation in the user's body fat (or a variation in calories according to a change in the user's body fat).

[0124] FIG. **8** is a flowchart illustrating an example method of operating an electronic device, according to various embodiments.
[0125] For example, FIG. **8** illustrates an example method, performed by the processor controlling the electronic device **300** of FIG. **2**, of outputting user-customized healthcare information based on information about a heart rate for burning the user's body fat.
[0126] Referring to FIG. **8**, operations for outputting the user-customized healthcare information may include operations **810**, **830**, **850**, and **870**.
[0127] In operation **810**, the processor may calculate a body fat burn heart rate of the user. In this disclosure, the body fat burn heart rate of the user may refer to the user's heart rate required to burn the user's body fat.
[0128] According to an embodiment, the processor may measure the calorie burn amount of the user, a maximum oxygen partial pressure within the user's body, and the user's current heart rate using at least one sensor. In this case, the calorie burn amount of the user may be calculated based on the amount of carbon dioxide produced by the user, and the amount of carbon dioxide produced by the user may be measured based on Equation 1 in FIG. **5**.
[0129] According to an embodiment, the processor may calculate the body fat burn heart rate of the user, based on the calorie burn amount of the user and the maximum oxygen partial pressure in the user's body.
[0130] In operation **830**, the processor may identify (e.g., determine) whether the user's current heart rate is greater than or equal to the user's body fat burn heart rate.
[0131] According to an embodiment, when the user's current heart rate is greater than or equal to the heart rate for burning the user's body fat, the processor may perform operation **850**.
[0132] According to an embodiment, when the user's current heart rate is less than the heart rate for burning the user's body fat, the processor may perform operation **870**.
[0133] In operation **850**, the processor may output information for maintaining the user's exercise intensity.
[0134] According to an embodiment, when the user's current heart rate is greater than or equal to the heart rate for burning the user's body fat, the processor may determine that a current exercise intensity is suitable for burning the user's body fat and output information for maintaining the user's current exercise intensity.
[0135] In operation **870**, the processor may output information for increasing the user's exercise intensity.
[0136] According to an embodiment, when the user's current heart rate is less than the heart rate for burning the user's body fat, the processor may determine that the current exercise intensity is not suitable for burning the user's body fat, and output information for increasing the user's exercise intensity (e.g., information about the user's exercise speed, exercise duration, and the number of exercises.
[0137] For example, when the maximum oxygen partial pressure VO.sub.2MAX in the user's body is 185 beats per minute (bpm), and the user's body fat-burning heart rate calculated based on the user's current heart rate of 110 bpm is 130 bpm, the processor may determine that the user's current exercise intensity is insufficient to burn body fat, and output, onto the display of the electronic device, a message for recommending an increase in the exercise intensity to the user.
[0138] According to various embodiments of the present disclosure, the electronic device may recommend or output healthcare information to the user to maximize/increase the burning of the user's body fat using biometric information of the user (e.g., information about the calorie burn amount of the user and the maximum oxygen partial pressure in the user's body).
[0139] FIG. **9** is a flowchart illustrating an example method of operating an electronic device, according to various embodiments.
[0140] In detail, FIG. **9** illustrates an example method, performed by the processor controlling the electronic device **300** of FIG. **2**, of outputting user-customized healthcare information by measuring a pH level in a user's blood based on the amount of carbon dioxide produced by the user. In an embodiment of the present disclosure, a ‘pH level’ may refer to the concentration of hydrogen ions in the user's blood.
[0141] Referring to FIG. **9**, operations for outputting the user-customized healthcare information may include operations **910**, **930**, **950**, and **970**.
[0142] In operation **910**, the processor may determine a pH level in the user's blood based on the amount of carbon dioxide produced by the user.
[0143] According to an embodiment, the processor may measure an amount of carbon dioxide generated by the user using at least one sensor. For example, the processor may measure the amount of carbon dioxide generated by the user based on Equation 1 in FIG. **5** described above.
[0144] According to an embodiment, the processor may determine a pH level in the user's blood based on Equation 7 below. The following Equation 7 is based on the Henderson-Hasselbalch equation.
[00005] [Equation7] $\text{pHlevelinuser'}s\text{blood} = 6.1 + \log_{10}(HCO_3 \;/ (0.0308 * PaCO_2))$
[0145] Here, HCO.sub.3[mEq/L] may denote the concentration of bicarbonate ions in the user's body, and PaCO.sub.20 [mmHg] may denote a partial pressure of carbon dioxide in the user's arterial blood (e.g., a carbon dioxide partial pressure in the arterial blood) (in this case, the partial pressure of carbon dioxide in the user's body may be proportional to the amount of carbon dioxide generated by the user).

[0146] According to an embodiment, the processor may calculate HCO.sub.3[mEq/L] based on Equation 8 below. The following Equation 8 is based on the Winters equation.

[00006] $HCO_3\,[\mathrm{mEq}/L] = (PCO_2\,[\mathrm{mmHg}] - 8{+}/{-}2) / 1.5$ [Equation8]

[0147] Here, HCO.sub.3 [mEq/L] may denote the concentration of bicarbonate ions in the user's body, and PCO.sub.2 [mmHg] may denote a partial pressure of carbon dioxide in the user's body (in this case, the partial pressure of carbon dioxide in the user's body may be proportional to the amount of carbon dioxide generated by the user).

[0148] In operation **930**, the processor may identify whether the pH level in the user's blood exceeds a threshold range.

[0149] According to an embodiment, when the pH level in the user's blood exceeds the threshold range, the processor may perform operation **950**.

[0150] According to an embodiment, when the pH level in the user's blood does not exceed the threshold range, the processor may perform operation **970**.

[0151] In operation **950**, the processor may output a warning message to the user.

[0152] According to an embodiment, when the pH level in the user's blood exceeds the threshold range, the processor may output, to the user, a warning message recommending examination or treatment by determining that functions of the user's body (e.g., the lungs or kidneys) have been impaired.

[0153] According to an embodiment, the processor may calculate an average pH level of the user by repeatedly measuring a pH level in the user's blood over a specific period of time, and when there is a change in the average pH level in the user's blood, the processor may output a warning message to the user.

[0154] For example, when a pH level in the user's blood on day 1 is 7.38, a pH level in the user's blood on day 180 is 7.35, and a pH level in the user's blood on day 180 is 7.36, the processor may output a warning message to the user according to a decrease in an average pH level in the user's blood over a year.

[0155] In operation **970**, the processor may output metabolic state information based on the pH level in the blood.

[0156] According to an embodiment, when the pH level in the user's blood does not exceed the threshold range, the processor may output, to the user, information about a metabolic state (e.g., an acidic state, an alkaline state, a normal state, etc.) according to the pH level in the user's blood.

[0157] According to an embodiment of the present disclosure, the electronic device may recommend or output healthcare information according to an internal state of the user's body based on the pH level in the user's blood measured noninvasively using the user's biometric information (e.g., the amount of carbon dioxide produced by the user).

[0158] FIG. **10** is a flowchart illustrating an example method of operating an electronic device, according to an embodiment.

[0159] For example, FIG. **10** illustrates an example method, performed by the processor controlling the electronic device **300** of FIG. **2**, of outputting user-customized sleep management information by measuring the amount of carbon dioxide produced by a user.

[0160] According to an embodiment of the present disclosure, a sleep apnea state of the user may refer to a state in which a partial pressure of carbon dioxide in the user's blood increases due to the user stopping breathing or slowing down breathing for a certain period of time while sleeping.

[0161] Referring to FIG. **10**, operations for outputting the user-customized healthcare information may include operations **1010**, **1030**, **1050**, and **1070**.

[0162] In operation **1010**, the processor may measure the amount of carbon dioxide produced by the user. According to an embodiment, the processor may transcutaneously measure the amount of carbon dioxide produced by the user using at least one sensor (e.g., an NDIR sensor).

[0163] In an embodiment, the processor may measure the amount of carbon dioxide produced by the user based on Equation 1 in FIG. **5** described above.

[0164] In operation **1030**, the processor may identify whether the user is in a sleeping state. In an embodiment, because the amount of carbon dioxide generated by the user in a sleeping state tends to increase, the processor may identify whether the user is in a sleeping state based on the amount of carbon dioxide generated by the user.

[0165] According to an embodiment, when the amount of carbon dioxide generated by the user is below a target range, the processor may identify that the user is in a non-sleeping state (e.g., an active state).

[0166] According to an embodiment, when the amount of carbon dioxide generated by the user is above the target range, the processor may identify that the user is in a sleeping state and perform operation **1050**.

[0167] In operation **1050**, the processor may output user-customized sleep management information according to the user's sleeping stage. According to an embodiment of the present disclosure, the user-customized sleep management information may include at least one of sleep duration information, sleep period information, and sleeping posture information for the user to get better sleep.

[0168] For example, the processor may output sleeping posture information to the user to prevent and/or reduce the occurrence of sleep apnea in the user.

[0169] According to an embodiment, when the user is identified as being in a sleeping state, the processor may apply a weight to the amount of carbon dioxide generated by the user in the sleeping state (or the amount of carbon dioxide generated by the user in a non-sleeping state) in order to distinguish between the amounts of carbon dioxide respectively generated by the user while in the sleeping state and the non-sleeping state.
[0170] For example, there may be cases where the amount of carbon dioxide generated by the user increases not only when the user is in a sleeping state but also when the user is in a non-sleeping state (e.g., in an active state) due to an increase in the amount of metabolism in the body. Therefore, the processor may learn the user's biometric data (e.g., sleep cycle, the amount of carbon dioxide produced while the user is in each state, etc.), distinguish the user's sleeping state from the user's non-sleeping state based on the learned user's biometric data, and apply a weight to the amount of carbon dioxide produced according to each state.
[0171] According to an embodiment, the processor may output user-customized sleep management information for preventing/reducing sleep apnea based on a duration of the user's sleep apnea state measured while the user is in the sleeping state, the frequency of the user's sleep interruptions, and the user's current situation.
[0172] According to an embodiment, the user's sleeping stage may include a deep sleeping stage and a non-deep sleeping stage, and the deep sleeping stage and the non-deep sleeping stage may be distinguished based on the user's sleep cycle and the amount of carbon dioxide generated by the user in the sleeping state.
[0173] The operation in which the processor outputs user-customized sleep management information according to the user's sleeping stage is described in greater detail below with reference to FIG. **11**.
[0174] Although not shown, in an embodiment, the processor may output (or recommend) user-customized sleep management information for a next cycle by taking into account user feedback information (e.g., the user's sleep state improvement, the user's preferences, or information about the user's context) on the output sleep management information.
[0175] FIG. **11** is a flowchart illustrating an example method of operating an electronic device, according to various embodiments.
[0176] For example, FIG. **11** illustrates an operation in which the processor controls the electronic device **300** of FIG. **2** to output user-customized sleep management information according to a user's sleeping stage.
[0177] Referring to FIG. **11**, operations for outputting user-customized sleep management information for each sleeping stage may include operations **1110**, **1130**, **1150**, **1170**, and **1190**.
[0178] In operation **1110**, the processor may identify whether the user is in a deep sleeping stage.
[0179] According to an embodiment, the processor may measure, via at least one sensor, the user's sleep cycle, sleep period, or the amount of carbon dioxide generated by the user in a sleeping state.
[0180] According to an embodiment, the processor may determine that the user is in a sleep apnea state when the amount of carbon dioxide produced by the user in the sleeping state is greater than or equal to a threshold value. In this case, the sleep apnea state may refer to a state in which a partial pressure of carbon dioxide in the user's blood increases due to the user stopping breathing or slowing down breathing for a certain period of time while in the sleeping state.
[0181] According to an embodiment, the processor may identify whether the user is in a deep sleeping stage based on the user's sleep cycle and the amount of carbon dioxide generated by the user in the sleeping state.
[0182] According to an embodiment, if the user is identified as being in the deep sleeping stage, the processor may perform operation **1130**.
[0183] According to an embodiment, when the user is in a non-deep sleeping stage, the processor may perform operation **1190**.
[0184] In operation **1130**, the processor may deactivate an alarm function for the user until the user enters the non-deep sleeping stage.
[0185] According to an embodiment, the processor may deactivate the alarm function for the user so as not to disturb the user's sleep until the user's sleeping stage changes to the non-deep sleeping stage.
[0186] In operation **1150**, the processor may predict the user's wake-up time.
[0187] According to an embodiment, the processor may predict the user's wake-up time based on the user's sleep cycle, the user's sleep history information, and user profile information.
[0188] In operation **1170**, the processor may activate a notification function or an alarm function for the user at the predicted user's wake-up time.
[0189] In operation **1190**, the processor may activate an alarm function for the user before the user reaches a sleep apnea state.
[0190] According to an embodiment, the processor may store, for each sleep cycle, the amount of carbon dioxide produced by the user in a sleep apnea state.
[0191] In an embodiment, the processor may identify whether the user has reached a sleep apnea state, based on a result of comparison between the amount of carbon dioxide produced by the user in the sleeping state and the stored amount of carbon dioxide produced by the user in the sleep apnea state. Therefore, the processor may activate a notification function or an alarm function for the user before the user reaches a sleep apnea state according to the

result of comparison.
[0192] According to an embodiment of the present disclosure, the electronic device may measure a sleeping stage based on the amount of carbon dioxide produced by the user in the sleeping state and recommend user-customized sleep management information to the user according to the user's sleeping stage, thereby improving the user's sleeping state and preventing/reducing risks (e.g., sleep apnea) that may occur while the user is in the sleeping state.
[0193] FIG. **12** is a block diagram illustrating an example configuration of a system according to various embodiments.
[0194] For example, FIG. **12** illustrates a system **1200** that outputs user-customized healthcare information or sleep management information using biometric data of a user.
[0195] Referring to FIG. **12**, according to an embodiment of the present disclosure, a processor **1230** of the system **1200** may output user-customized care information (e.g., user-customized healthcare information or user-customized sleep management information) **1280** using various biometric data **1210**, **1220**, **1221**, **1223**, **1225**, **1240**, **1250**, and **1270** of the user.
[0196] In an embodiment, the processor **1230** may include various processing circuitry and receive user information (e.g., profile information, recent user context information, etc.) from the user and store the user information.
[0197] In an embodiment, the processor **1230** may measure the amount **1220** of carbon dioxide generated by the user using at least one sensor (e.g., an NDIR sensor).
[0198] In an embodiment, based on the amount **1220** of carbon dioxide generated by the user, the processor **1230** may measure a calorie burn amount **1221** of the user and a pH level **1223** in the user's blood and determine a sleeping stage **1225** of the user.
[0199] In an embodiment, the processor **1230** may autonomously measure a calorie intake amount **1250** of the user without a user input, based on a body fat amount **1240** of the user (or a variation in the user's body fat) and the user's calorie burn amount **1221**.
[0200] In an embodiment, the processor **1230** may measure a body fat burn heart rate **1270** of the user based on information about a maximum oxygen partial pressure VO.sub.2max in the user's body.
[0201] In an embodiment, the processor **1230** may recommend or output the user-customized care information **1280** (e.g., user-customized healthcare information or user-customized sleep management information) to the user using the user information **1210** and information about the user's calorie burn amount **1221**, the pH level **1223** in the user's blood, the user's sleeping stage **1225**, the user's calorie intake amount **1250**, the user's body fat burn heart rate **1250**, and the user's activity.
[0202] In an embodiment, the processor **1230** may recommend or output user-customized care information for a next cycle by taking into account user feedback on the user-customized care information (e.g., user-customized healthcare information or user-customized sleep management information) **1280**.
[0203] FIG. **13** is a block diagram illustrating an example configuration of an electronic device according to various embodiments.
[0204] For example, FIG. **13** illustrates a detailed configuration of the electronic device **300** of FIG. **2** according to an example embodiment. The sensing module **310**, the touch input module **320**, the display module **330**, the communication module **340**, and the control module **350** of FIG. **2** may respectively correspond to a sensing module **1360**, a user input module **1330**, a display module **1310**, a communication module **1340**, and a control module **1620** of FIG. **13**. In addition, although not shown, the sensing module **1360** of FIG. **13** may be a module corresponding to the sensing module **310** and include at least one or a combination of the illuminance sensor **402**, the biosensor **404**, the tilt sensor **406**, the position sensor **408**, the proximity sensor **410**, the geomagnetic sensor **412**, the gyroscope sensor **414**, the temperature/humidity sensor **416**, the IR sensor **418**, and the velocity/acceleration sensor **420** of FIG. **4**.
[0205] Referring to FIG. **13**, the electronic device according to an embodiment of the present disclosure may include the display module (e.g., including a display) **1310**, the control module (e.g., including at least one processor, comprising processing circuitry) **1320**, the user input module (e.g., including user input circuitry) **1330**, the communication module (e.g., including communication circuitry) **1340**, an output module (e.g., including output circuitry) **1350**, the sensing module (e.g., including at least one sensor) **1360**, an audio/video (A/V) input module (e.g., including A/V input circuitry) **1370**, and a memory **1380** of FIG. **13**.
[0206] The display module **1310** may include a display and display and output information processed by the electronic device under the control of the control module **1320**. In addition, the display module **1310** may display a graphical UI (GUI) on a screen.
[0207] According to an embodiment, the display module **1310** may output a notification signal related to control of the amount of a user's exercise.
[0208] According to an embodiment, according to control by the control module **1320**, the display module **1310** may display a message related to whether a value contained in the past exercise record information has exceeded a value contained in current exercise record information.
[0209] Moreover, when the display **1310** and a touch pad form a layered structure to construct a touch screen, the

display **1310** may be used as an input device as well as an output device. The display module **1310** may include, for example, and without limitation, at least one of an LCD, a TFT-LCD, an OLED display, a flexible display, a 3D display, and an electrophoretic display. In addition, the electronic device may include two or more display modules **1310** depending on a form of implementation of the electronic device. In this case, the two or more display modules **1310** may be arranged to face each other using a hinge.

[0210] The control module **1320** may include at least one processor including various processing circuitry and generally controls all operations of the electronic device. For example, the control module **1320** may control all operations of the display module **1310**, the user input module **1330**, the communication module **1340**, the output module **1350**, the A/V input module **1370**, etc. by executing programs stored in the memory **1380**.

[0211] In addition, the control module **1320** may execute an operating system (OS) and various applications stored in the memory **1380**.

[0212] The control module **1320** may include at least one processor including various processing circuitry and may be implemented as a system on chip (SoC) that integrates a core (not shown) and a graphics processing unit (GPU) (not shown). In addition, the control module **1320** may include a single core, a dual core, a triple core, a quad core, and a number of cores equal to multiples thereof. The processor of the control module **1320** 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.

[0213] In an embodiment, the control module **1320** may calculate the calorie burn amount and the body fat amount of the user based on the measured amount of carbon dioxide generated by the user, and autonomously calculate the user's calorie intake amount using the calorie burn amount and the body fat amount of the user.

[0214] In an embodiment, the control module **1320** may output user-customized healthcare information to the user based on the user's calorie burn amount, the user's body fat amount, and the user's calorie intake amount.

[0215] In an embodiment, the control module **1320** may output user-customized healthcare information according to a pH level in the user's blood.

[0216] In an embodiment, the control module **1320** may output user-customized healthcare information according to a body fat burn heart rate of the user.

[0217] In an embodiment, the control module **1320** may output user-customized sleep management information based on the user's sleeping stage.

[0218] The user input interface **1330** may include various user input circuitry and refers to a device via which the user inputs data for controlling the electronic device. For example, the user input interface **1330** may include, but is not limited to, a keypad, a dome switch, a touch pad (a capacitive overlay type, a resistive overlay type, an infrared beam type, a surface acoustic wave type, an integral strain gauge type, a piezoelectric type, etc.), a jog wheel, and a jog switch.

[0219] According to an embodiment, the user input module **1330** may receive, from the user, an input regarding user information (e.g., the user's profile, the user's recent context, the user's preferences, etc.).

[0220] According to an embodiment, the user input module **1330** may receive, from the user, an input for selecting one from a list including at least one piece of past exercise record information.

[0221] According to an embodiment, the user input module **1330** may receive, from the user, an input for starting, stopping, and ending exercise provision information.

[0222] The sound output module **1351** may include various sound output circuitry and output audio data received from the communication interface **1340** or stored in the memory **1380**. The sound output module **1351** also outputs sound signals associated with functions performed by the electronic device (e.g., a call signal reception sound, a message reception sound, and a notification sound). The sound output module **1351** may include a speaker, a buzzer, and the like.

[0223] A vibration motor **1352** may output a vibration signal. For example, the vibration motor **123** may output a vibration signal corresponding to an output of audio data or video data (e.g., a call signal reception sound, a message reception sound, etc.). In addition, the vibration motor **123** may also output a vibration signal when a touch is input to the touch screen.

[0224] The communication module **1340** may include one or more components include various communication circuitry that enable communication between the electronic device and an external server (e.g., an exercise record management server), between the electronic device and an external electronic device (e.g., a mobile phone, a smartphone, a PC, a laptop, etc.), or between external servers. For example, the communication module **1340** may include a short-range communication module **1341**, a mobile communication module **1342**, and a broadcast receiving module **1343**.

[0225] The short-range communication module **1341** may include, but is not limited to, a Bluetooth communication unit, a BLE communication unit, an NFC module, a wireless local area network (WLAN) (or Wi-Fi) communication unit, a ZigBee communication unit, an Infrared Data Association (IrDA) communication unit, a Wi-Fi Direct (WFD) communication unit, an ultra-wideband (UWB) communication unit, an Ant+ communication unit, etc.

[0226] The mobile communication module **1342** transmits and receives a wireless signal to and from at least one of a base station, an external terminal, and a server on a mobile communication network. In this case, the wireless signal may be a voice call signal, a video call signal, or data in any one of various formats according to transmission and reception of a text/multimedia message.

[0227] The broadcast receiving module **1343** receives broadcast signals and/or broadcast-related information from the outside via a broadcast channel. The broadcasting channel may include a satellite channel and/or a terrestrial channel. Depending on an implementation example, the electronic device may not include the broadcast receiving module **1343**.

[0228] The sensing module **1360** may include at least one or a combination of sensors, including, for example, and without limitation, an illuminance sensor, a biosensor, a tilt sensor, a position sensor, a proximity sensor, a geomagnetic sensor, a gyroscope sensor, a temperature/humidity sensor, an IR sensor, and a velocity/acceleration sensor. In addition to the stated types of sensors, various sensors may be included in the sensing module **1360**.

[0229] In an embodiment, the biosensor may sense information related to the user's body composition and biosignals. The biosensor may include, for example, at least one of a heart rate sensor, a blood glucose sensor, a blood pressure sensor, a sweat sensor, a body temperature sensor, and an iris sensor.

[0230] For example, the biosensor may measure the calorie burn amount of the user, the user's body fat percentage, the user's body fat amount, the user's metabolic rate, the user's sleep cycle or sleep period.

[0231] For example, the biosensor may measure a partial pressure of oxygen in the user's body (e.g., a maximum oxygen partial pressure VO.sub.2MAX) or a partial pressure of carbon dioxide in the user's body.

[0232] For example, the biosensor may measure a pH level in the user's blood using the amount of carbon dioxide produced by the user.

[0233] For example, the position sensor may sense contextual information of the user based on the user's location.

[0234] For example, the IR sensor includes an NDIR sensor and may perform real-time transcutaneous measurement of the amount of carbon dioxide produced by the user.

[0235] The A/V input module **1370** may include various A/V input circuitry for inputting audio signals or video signals, and may include a camera **1371** and a microphone **1372**. The camera **1371** may obtain image frames such as still images or moving images via an image sensor in a video call mode or shooting mode. An image captured via the image sensor may be processed by the control module **1320** or a separate image processing module (not shown).

[0236] The image frames processed by the camera **1371** may be stored in the memory **1380** or transmitted to the outside via the communication module **1340**. The camera **1371** may be two or more cameras depending on a configuration of the terminal.

[0237] The microphone **1372** receives an external sound signal and process the external sound signal into electrical audio data. For example, the microphone **1372** may receive a sound signal from an external device or a speaker. The microphone **1372** may use various noise removal algorithms to remove noise that occurs in the process of receiving an external sound signal.

[0238] The memory **1380** may store a program for processing and controlling the control module **1320**, and store input/output data (e.g., a plurality of menus, a plurality of first-layer sub-menus corresponding to each of the plurality of menus, a plurality of second-layer sub-menus corresponding to each of the plurality of first-layer sub-menus, etc.).

[0239] The memory **1380** may include at least one type of storage medium among a hard disk-type memory, a multimedia card micro-type memory, a card-type memory (e.g., a Secure Digital (SD) card or an eXtreme Digital (XD) memory), random access memory (RAM), static RAM (SRAM), read-only memory (ROM), electrically erasable programmable ROM (EEPROM), PROM, a magnetic memory, a magnetic disc, and an optical disc. In addition, the electronic device may operate a web storage or cloud server that performs a storage function of the memory **1380** on the Internet.

[0240] Programs stored in the memory **1380** may be categorized into a plurality of modules according to their functions, for example, a UI module (e.g., including instructions for user interface operations) **1381**, a touch screen module (e.g., including instructions for touch screen operations) **1382**, a notification module (e.g., including instructions for notification operations)**1383**, etc.

[0241] The UI module **1381** may provide specialized UI, GUI, etc. that are linked to the electronic device for each application. The touch screen module **1382** may detect a touch gesture on the user's touch screen and transmit information about the touch gesture to the control module **1320**. According to an embodiment, the touch screen module **1382** may recognize and analyze a touch code. The touch screen module **1382** may also be configured as

separate hardware including a controller.
[0242] Various sensors may be provided inside or near the touch screen to detect a touch or proximity touch on the touch screen. A tactile sensor is an example of a sensor for detecting a touch on the touch screen. The tactile sensor is a sensor that detects a contact with a specific object to a degree or greater than that felt by a human. The tactile sensor may detect various types of information such as the roughness of a contact surface, the hardness of an object in contact, and the temperature of a contact point.
[0243] In addition, a proximity sensor is an example of a sensor for detecting a touch on a touch screen.
[0244] The proximity sensor is a sensor that detects the presence or absence of an object approaching a predetermined detection surface or nearby objects without mechanical contact using a force from an electromagnetic field or IR light. Examples of proximity sensors include a transmission-type photoelectric sensor, a direct reflection-type photoelectric sensor, a mirror reflection-type photoelectric sensor, a high-frequency oscillation-type proximity sensor, a capacitive proximity sensor, a magnetic proximity sensor, and an IR proximity sensor. User touch gestures may include tap, touch & hold, double tap, drag, flick, swipe, etc.
[0245] The notification (e.g., alarm) module **1383** may generate a signal for notifying the occurrence of an event in the electronic device. Examples of events occurring in the electronic device include reception of a call signal, reception of a message, input of a key signal, and notification of a schedule. The notification module **1383** may output a notification signal in the form of a video signal via the display module **1310**, output a notification signal in the form of an audio signal via the sound output module **1351**, and output a notification signal in the form of a vibration signal via the vibration motor **1352**.
[0246] In an embodiment, the notification module **1383** may output a notification, warning, or alarm signal to the user according to user-customized care information. For example, when a pH level in the user's blood exceeds a threshold range, the notification module **1383** may output a warning signal to the user. For example, when a sleeping user is identified as being in a sleep apnea state (e.g., when the amount of carbon dioxide generated by the user is greater than or equal to a threshold value), the notification module **1383** may output an alarm signal to the user.
[0247] The names of the components of the electronic device may vary. In addition, the electronic device according to the present disclosure may be configured with at least one of the components, and may not include some of the components but further include other components.
[0248] A method according to an example embodiment of the present disclosure may be implemented in the form of program commands that may be performed by various types of computers, and may be recorded on computer-readable recording media. The computer-readable recording media may include program commands, data files, data structures, etc. either alone or in combination. The program commands recorded on the media may be designed and configured specially for the present disclosure or may be known to and be usable by those of ordinary skill in the art of computer software. Examples of the computer-readable recording media include magnetic media such as hard disks, floppy disks, and magnetic tapes, optical media such as compact disk ROM (CD-ROM) and digital versatile disks (DVDs), magneto-optical media such as floptical disks, and hardware devices that are specially configured to store and perform program commands, such as ROM, RAM, flash memory, etc. Examples of program commands include not only machine code such as that created by a compiler but also high-level language code that may be executed by a computer using an interpreter or the like.
[0249] An embodiment of the disclosure and all functional operations described herein may be implemented within a digital electronic circuit, or in computer software, firmware, or hardware, including the structures disclosed herein and their equivalent structures, or in any combination of one or more of these.
[0250] An electronic device according to an example embodiment includes at least one sensor, a memory storing one or more instructions, and at least one processor, comprising processing circuitry, wherein at least one processor, individually and/or collectively, may be configured to execute the one or more instructions and to control the electronic device to: measure, using the at least one sensor, an amount of carbon dioxide generated by a user and a variation in body fat of the user, calculate a calorie burn amount of the user, based on the amount of carbon dioxide generated by the user, calculate a calorie intake amount of the user based on the variation in the body fat of the user and the calorie burn amount of the user, and output user-customized healthcare information, based on the variation in the body fat of the user, the calorie burn amount of the user, and the calorie intake amount of the user.
[0251] According to an example embodiment, at least one processor, individually and/or collectively, may be configured to measure a metabolic rate of the user according to the user-customized healthcare information, store feedback information including the metabolic rate of the user, and output user-customized healthcare information, based on the feedback information.
[0252] According to an example embodiment, the electronic device may be configured to output user-customized healthcare information to the user in real time as information including at least one of information about a diet recommended for the user and information about a type of exercise, an exercise time, or an exercise intensity recommended for the user.
[0253] According to an example embodiment, at least one processor, individually and/or collectively, may be configured to identify, using the at least one sensor, whether a state of the user is a sleeping state, and apply a weight

to the measured amount of carbon dioxide when the state of the user is a sleeping state.

[0254] According to an example embodiment, at least one processor, individually and/or collectively, may be configured to: identify whether the amount of carbon dioxide is above a target range, determine the state of the user as being a sleeping state based on the amount of carbon dioxide being above the target range, and provide an alarm to the user according to a sleeping stage of the user.

[0255] According to an example embodiment, at least one processor, individually and/or collectively, may be configured to: based on the sleeping stage being a non-deep sleeping stage, activate an alarm function for the user before the user reaches a sleep apnea state, and based on the sleeping stage being a deep sleeping stage, deactivate the alarm function for the user before the user enters the non-deep sleeping stage.

[0256] In an example embodiment, at least one processor, individually and/or collectively, may be configured to identify a pH level in the user's blood based on the measured amount of carbon dioxide.

[0257] According to an example embodiment, at least one processor, individually and/or collectively, may be configured to: provide a warning to the user based on the pH level in the user's blood exceeding a threshold range, and output to the user a metabolic state of the user according to the pH level in the user's blood based on the pH level in the user's blood not exceeding the threshold range.

[0258] According to an example embodiment, the at least one sensor further comprises a non-dispersive infrared (NDIR) sensor, and at least one processor, individually and/or collectively, may be configured to transcutaneously measure an amount of carbon dioxide generated by the user using the NDIR sensor.

[0259] In an example embodiment, at least one processor, individually and/or collectively, may be configured to: calculate a heart rate of the user required to reach a maximum amount of oxygen consumed by the user per unit time, and output the user-customized healthcare information based on the heart rate of the user.

[0260] A method of operating an electronic device, according to an example embodiment, may include: measuring an amount of carbon dioxide generated by a user and a variation in body fat of the user, calculating a calorie burn amount of the user, based on the amount of carbon dioxide, calculating a calorie intake amount of the user based on the variation in the body fat of the user and the calorie burn amount of the user, and outputting user-customized healthcare information, based on the calorie burn amount of the user, the variation in the body fat of the user, and the calorie intake amount of the user.

[0261] According to an example embodiment, the method of operating the electronic device may include: measuring a metabolic rate of the user according to the user-customized healthcare information, storing feedback information including the metabolic rate of the user, and outputting subsequent user-customized healthcare information, based on the feedback information.

[0262] According to an example embodiment, in the method of operating the electronic device, the electronic device may be configured to output the user-customized healthcare information to the user in real time as information including at least one of information about a diet recommended for the user and information about a type of exercise, an exercise time, or an exercise intensity recommended for the user.

[0263] According to an example embodiment, the method of operating the electronic device may further include: identifying whether a state of the user is a sleeping state, and based on the state of the user being a sleeping state, applying a weight to the measured amount of carbon dioxide.

[0264] According to an example embodiment, the method of operating the electronic device may further include: identifying whether the amount of carbon dioxide is above a target range, determining the state of the user as being a sleeping state based on the amount of carbon dioxide being above the target range, and providing an alarm to the user according to a sleeping stage of the user.

[0265] According to an example embodiment, the method of operating the electronic device may further include: based on the sleeping stage of the user being a non-deep sleeping stage, activating an alarm function for the user before the user reaches a sleep apnea state, and based on the sleeping stage of the user being a deep sleeping stage, deactivating the alarm function for the user before the user enters the non-deep sleeping stage.

[0266] According to an example embodiment, the method of operating the electronic device may further include identifying a pH level in the user's blood based on the measured amount of carbon dioxide.

[0267] According to an example embodiment, the method of operating the electronic device may further include providing a warning to the user based on the pH level in the user's blood exceeding a threshold range, and outputting a metabolic state of the user according to the pH level in the user's blood to the user based on the pH level in the user's blood not exceeding the threshold range.

[0268] According to an example embodiment, the method of operating the electronic device may further include: calculating a heart rate of the user required to reach a maximum amount of oxygen consumed by the user per unit time, and outputting the user-customized healthcare information based on the heart rate of the user.

[0269] The method of operating the electronic device, according to an embodiment, may be implemented in the form of program commands that may be performed by various types of computers, and may be recorded on computer-readable recording media. Furthermore, various embodiments of the present disclosure may be implemented in the form of recording media including instructions executable by a computer, such as program modules executed by the computer. The computer-readable recording media may be any available media that are accessible by the computer, and examples thereof may include both volatile and non-volatile media and both detachable and non-detachable media. Furthermore, the computer-readable recording media may include computer storage media and communication media. The computer storage media include both volatile and nonvolatile, removable and non-removable media implemented using any method or technology for storage of information such as computer-readable instructions, data structures, program modules, or other data. The communication media may typically include computer-readable instructions, data structures, program modules, or other data in a modulated data signal, such as program modules.

[0270] The computer-readable recording media may include program commands, data files, data structures, etc. either alone or in combination. The program commands recorded on the computer-readable recording media may be designed and configured specially for the present disclosure or may be known to and be usable by those of ordinary skill in the art of computer software. Examples of the computer-readable recording media include magnetic media such as hard disks, floppy disks, and magnetic tapes, optical media such as compact disk ROM (CD-ROM) and digital versatile disks (DVDs), magneto-optical media such as floptical disks, and hardware devices that are specially configured to store and perform program commands, such as ROM, RAM, flash memory, etc. Examples of program commands include not only machine code such as that created by a compiler but also high-level language code that may be executed by a computer using an interpreter or the like.

[0271] In addition, at least one of a method of operating a display device and a method of operating an electronic device according to various disclosed embodiments may be included in a computer program product when provided. The computer program product may be traded, as a product, between a seller and a buyer.

[0272] The computer program product may include a software program and a computer-readable storage medium having the software program stored thereon. For example, the computer program product may include a product (e.g., a downloadable application) in the form of a software program electronically distributed by a manufacturer of an electronic device or through an electronic market (e.g., Google Play Store™, and App Store™). For such electronic distribution, at least a part of the software program may be stored on the storage medium or may be temporarily generated. In this case, the storage medium may be a storage medium of a server of the manufacturer, a server of the electronic market, or a relay server for temporarily storing the software program.

[0273] The above description of the present disclosure is provided for illustration, and it will be understood by one of ordinary skill in the art that changes in form and details may be readily made therein without departing from technical idea or essential features of the present disclosure. Therefore, the above-described embodiments and all aspects thereof are merely examples and are not limiting.

[0274] The scope of the present disclosure is limited the detailed description thereof and includes the following claims, and all the changes or modifications within the true spirit and full scope of the disclosure, including the appended claims and their equivalents should be understood as being included in the scope of the present disclosure. It will also be understood that any of the embodiment(s) described herein may be used in conjunction with any other embodiment(s) described herein.

Claims

1. An electronic device comprising: at least one sensor; a memory storing one or more instructions; and at least one processor, comprising processing circuitry, wherein at least one processor, individually and/or collectively, is configured to execute the one or more instructions and to control the electronic device to: measure, using the at least one sensor, an amount of carbon dioxide generated by a user and a variation in body fat of the user, calculate a calorie burn amount of the user, based on the amount of carbon dioxide generated by the user, calculate a calorie intake amount of the user, based on the variation in the body fat of the user and the calorie burn amount of the user, and output user-customized healthcare information, based on the variation in the body fat of the user, the calorie burn amount of the user, and the calorie intake amount of the user.

2. The electronic device of claim 1, wherein at least one processor, individually and/or collectively, is configured to: measure a metabolic rate of the user according to the user-customized healthcare information, store feedback information including the metabolic rate of the user, and output user-customized healthcare information, based on the feedback information.

3. The electronic device of claim 1, wherein at least one processor, individually and/or collectively, is configured to: identify, using the at least one sensor, whether a state of the user is a sleeping state, and apply a weight to the measured amount of carbon dioxide based on the state of the user being a sleeping state.

4. The electronic device of claim 3, wherein at least one processor, individually and/or collectively, is configured to: identify whether the amount of carbon dioxide is above a target range, determine the state of the user as being a sleeping state based on the amount of carbon dioxide being above the target range, and provide an alarm to the user according to a sleeping stage of the user.

5. The electronic device of claim 4, wherein at least one processor, individually and/or collectively, is configured to:

based on the sleeping stage being a non-deep sleeping stage, activate an alarm function for the user before the user reaches a sleep apnea state, and based on the sleeping stage being a deep sleeping stage, deactivate the alarm function for the user before the user enters the non-deep sleeping stage.

6. The electronic device of claim 1, wherein at least one processor, individually and/or collectively, is configured to: identify a pH level in the user's blood, based on the measured amount of carbon dioxide, provide a warning to the user based on the pH level in the user's blood exceeding a threshold range, and output, to the user, a metabolic state of the user according to the pH level in the user's blood based on the pH level in the user's blood not exceeding the threshold range.

7. The electronic device of claim 1, wherein at least one processor, individually and/or collectively, is configured to: calculate a heart rate of the user required to reach a maximum amount of oxygen consumed by the user per unit time, and output the user-customized healthcare information, based on the heart rate of the user.

8. A method of operating an electronic device, the method comprising: measuring an amount of carbon dioxide generated by a user and a variation in body fat of the user; calculating a calorie burn amount of the user, based on the amount of carbon dioxide; calculating a calorie intake amount of the user, based on the variation in the body fat of the user and the calorie burn amount of the user; and outputting user-customized healthcare information, based on the calorie burn amount of the user, the variation in the body fat of the user, and the calorie intake amount of the user.

9. The method of claim 8, further comprising: measuring a metabolic rate of the user according to the user-customized healthcare information; storing feedback information including the metabolic rate of the user; and outputting subsequent user-customized healthcare information, based on the feedback information.

10. The method of claim 8, further comprising: identifying whether a state of the user is a sleeping state; and based on the state of the user being a sleeping state, applying a weight to the measured amount of carbon dioxide.

11. The method of claim 10, further comprising: identifying whether the amount of carbon dioxide is above a target range; determining the state of the user as being a sleeping state based on the amount of carbon dioxide being above the target range; and providing an alarm to the user according to a sleeping stage of the user.

12. The method of claim 11, further comprising: based on the sleeping stage of the user being a non-deep sleeping stage, activating an alarm function for the user before the user reaches a sleep apnea state; and based on the sleeping stage of the user being a deep sleeping stage, deactivating the alarm function for the user before the user enters the non-deep sleeping stage.

13. The method of claim 8, further comprising: identifying a pH level in the user's blood based on the measured amount of carbon dioxide; providing a warning to the user based on the pH level in the user's blood exceeding a threshold range; and outputting, to the user, a metabolic state of the user according to the pH level in the user's blood based on the pH level in the user's blood not exceeding the threshold range.

14. The method of claim 8, further comprising: calculating a heart rate of the user required to reach a maximum amount of oxygen consumed by the user per unit time; and outputting the user-customized healthcare information, based on the heart rate of the user.

15. A non-transitory computer-readable storage medium having recorded thereon a program which, when executed by at least one processor of an electronic device causes the electronic device to perform the operation method of claim 8.