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(54) **APPARATUS AND METHOD FOR GENERATING WEIGHT ESTIMATION MODEL, AND APPARATUS AND METHOD FOR ESTIMATING WEIGHT**

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(57) **ABSTRACT**

An apparatus for generating the weight estimation model includes a training data collection unit that collects training data, the training data including skin spectrum information and weight information of a plurality of objects, and a model generation unit that generates the weight estimation model, used for a spectrum-based weight estimation, through machine learning based on the collected training data.

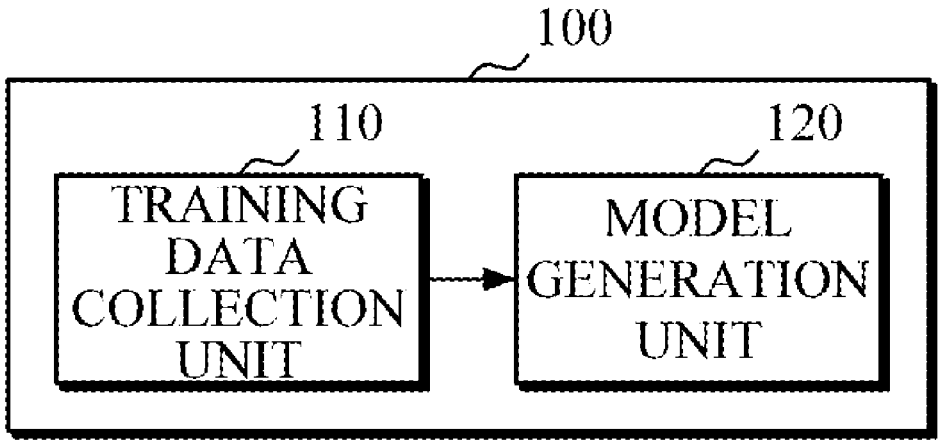


FIG. 1

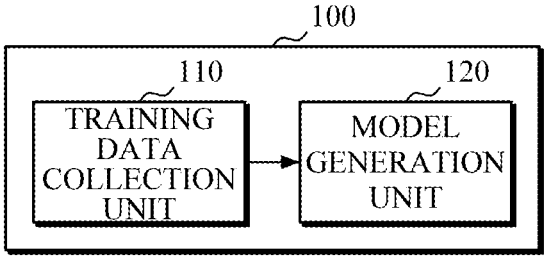

100
110
120
TRAINING DATA COLLECTION UNIT
MODEL GENERATION UNIT

FIG. 2

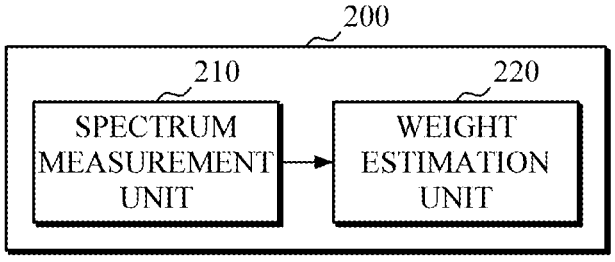

200
210
220
SPECTRUM MEASUREMENT UNIT
WEIGHT ESTIMATION UNIT

FIG. 3

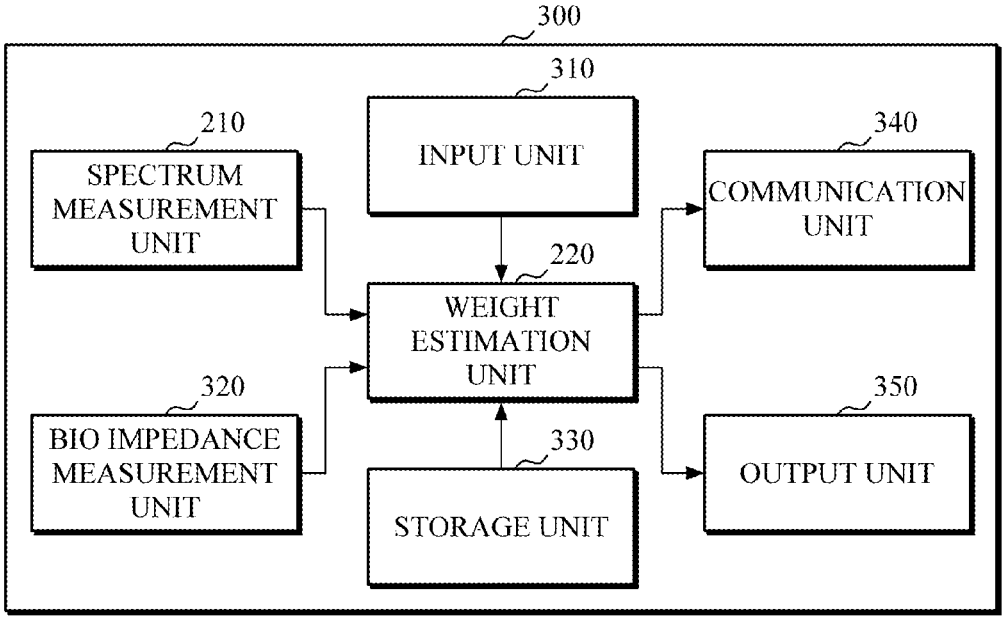

300
310
INPUT UNIT
210
SPECTRUM MEASUREMENT UNIT
340
COMMUNICATION UNIT
220
WEIGHT ESTIMATION UNIT
320
BIO IMPEDANCE MEASUREMENT UNIT
350
OUTPUT UNIT
330
STORAGE UNIT

FIG. 4

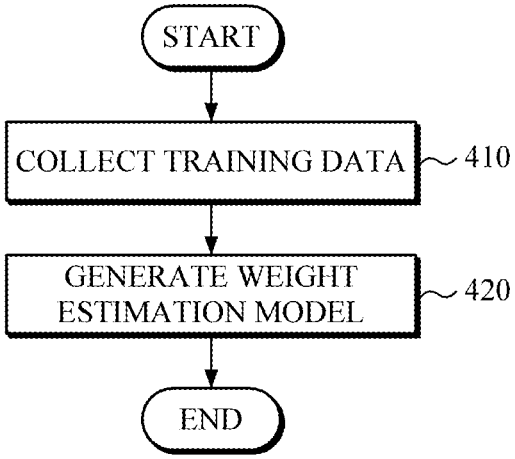

START
COLLECT TRAINING DATA
410
GENERATE WEIGHT ESTIMATION MODEL
420
END

FIG. 5

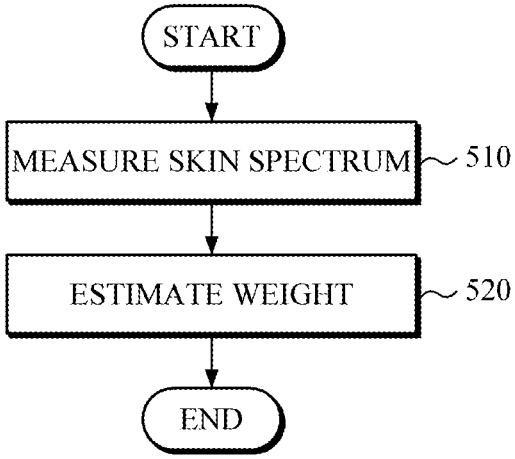


FIG. 6

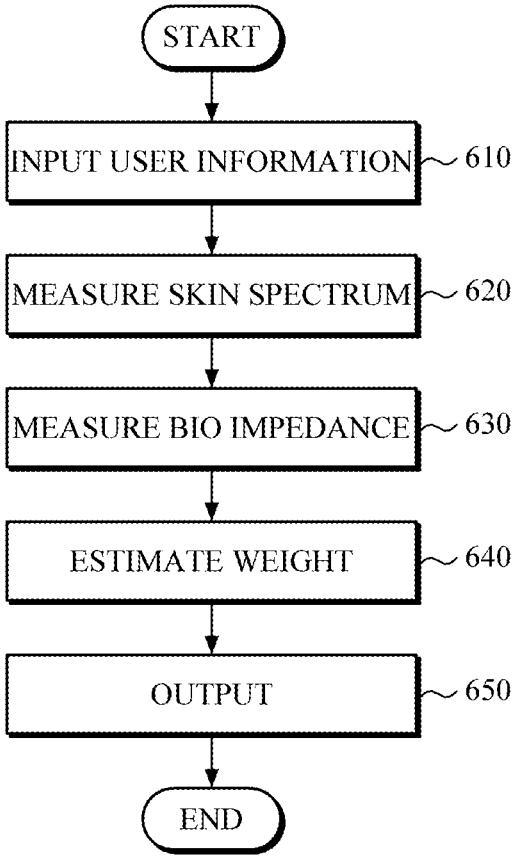

START
INPUT USER INFORMATION
610
MEASURE SKIN SPECTRUM
620
MEASURE BIO IMPEDANCE
630
ESTIMATE WEIGHT
640
OUTPUT
650
END

FIG. 7

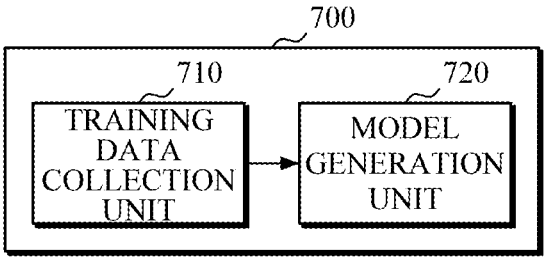

700
710
720
TRAINING DATA COLLECTION UNIT
MODEL GENERATION UNIT

FIG. 8

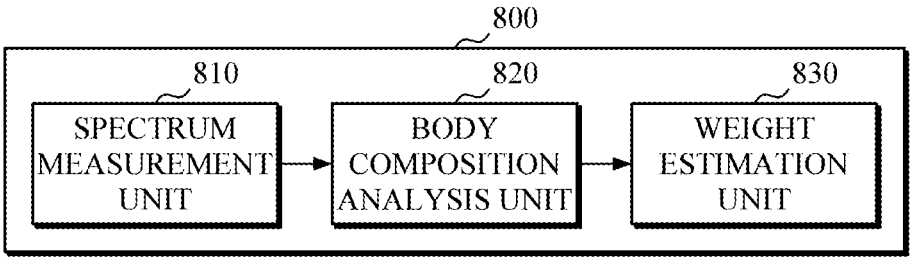

800
810
820
830
SPECTRUM MEASUREMENT UNIT
BODY COMPOSITION ANALYSIS UNIT
WEIGHT ESTIMATION UNIT

FIG. 9

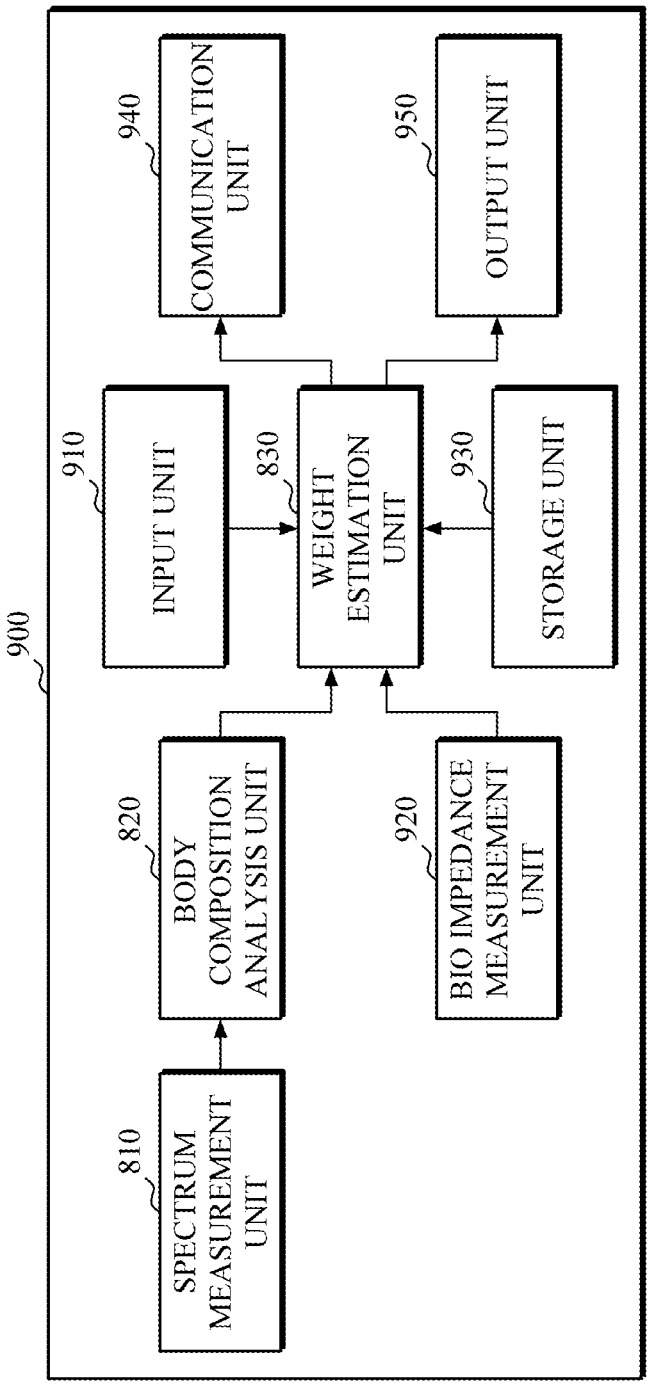

900
810
SPECTRUM MEASUREMENT UNIT
820
BODY COMPOSITION ANALYSIS UNIT
920
BIO IMPEDANCE MEASUREMENT UNIT
910
INPUT UNIT
830
WEIGHT ESTIMATION UNIT
930
STORAGE UNIT
940
COMMUNICATION UNIT
950
OUTPUT UNIT

FIG. 10

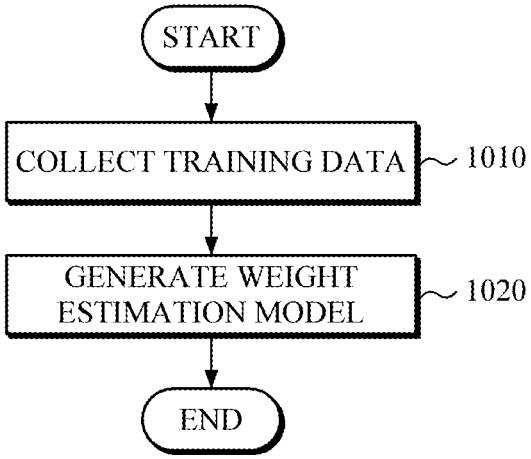

START
COLLECT TRAINING DATA
1010
GENERATE WEIGHT ESTIMATION MODEL
1020
END

FIG. 11

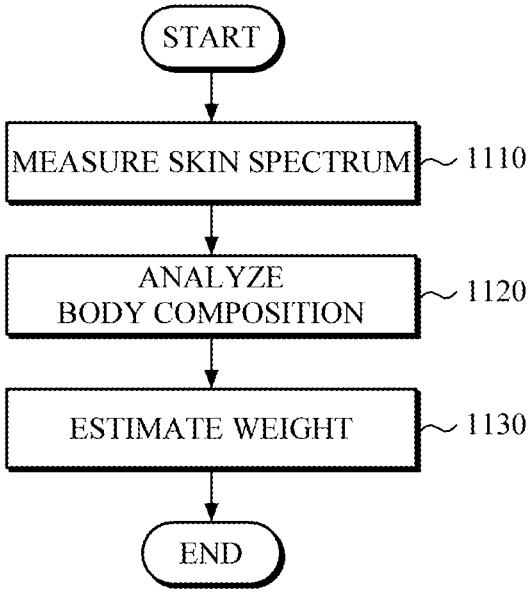
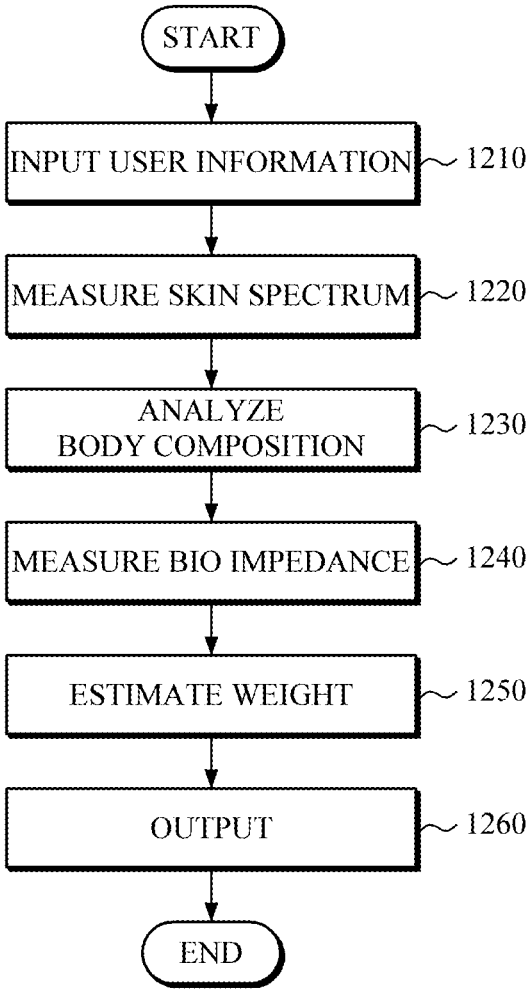

START
MEASURE SKIN SPECTRUM
1110
ANALYZE BODY COMPOSITION
1120
ESTIMATE WEIGHT
1130
END

FIG. 12


START
INPUT USER INFORMATION
1210
MEASURE SKIN SPECTRUM
1220
ANALYZE BODY COMPOSITION
1230
MEASURE BIO IMPEDANCE
1240
ESTIMATE WEIGHT
1250
OUTPUT
1260
END

APPARATUS AND METHOD FOR GENERATING WEIGHT ESTIMATION MODEL, AND APPARATUS AND METHOD FOR ESTIMATING WEIGHT

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application claims priority from Korean Patent Application No. 10-2016-0018687, filed on Feb. 17, 2016, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] 1. Field

[0003] Apparatuses and methods consistent with exemplary embodiments relate to an apparatus and a method for generating a weight estimation model and an apparatus and a method for estimating a weight.

[0004] 2. Description of Related Art

[0005] Modern days, people who are highly concerned about their health want to increase or decrease body weight. However, it is very difficult to measure body weight on a daily basis in a busy schedule. Therefore, it is common that people may experience a rapid increase in body weight within a few days if they forget to measure the body weight.

[0006] In addition, considering that obesity may lead to various kinds of diseases, it is important to maintain proper weight. Particularly, with the emergence of an aging society, maintaining proper weight is becoming more important to lead a healthy life.

[0007] Therefore, there is a need for a technology that can conveniently and simply measure and monitor weight.

SUMMARY

[0008] One or more exemplary embodiments provide an apparatus and a method for generating a weight estimation model which are used in estimating a weight based on a skin spectrum, and an apparatus and a method for estimating a weight based on a skin spectrum.

[0009] In one general aspect, there is provided an apparatus for generating a weight estimation model including: a training data collection unit that collects training data, the training data comprising skin spectrum information and weight information of a plurality of objects; and a model generation unit that generates the weight estimation model, used for spectrum-based weight estimation, through machine learning based on the collected training data.

[0010] Here, the model generation unit may generate the weight estimation model through the machine learning, in which the skin spectrum information is used as an input and the weight information is used as an output.

[0011] Also, the training data may further contain at least one of age information, height information, gender information, and bio impedance information of an object.

[0012] Also, the model generation unit may generate the weight estimation model through the machine learning, in which the skin spectrum information and the at least one of the age information, the height information, the gender information, and the bio impedance information are used as inputs and the weight information is used as an output.

[0013] Also, an algorithm used to perform the machine learning may include at least one of partial least squares regression, linear regression, neural network, decision tree, genetic algorithm, genetic programming, K-nearest neighbor, radial basis function network, random forest, support vector machine, and deep-learning.

[0014] In another general aspect, there is provided a method for generating a weight estimation model including: collecting training data, the training data comprising skin spectrum information and weight information of a plurality of objects; and generating the weight estimation model, used for spectrum-based weight estimation, through machine learning based on the collected training data.

[0015] Here, the generating of the weight estimation model may include generating the weight estimation model through the machine learning, in which the skin spectrum information is used as an input and the weight information is used as an output.

[0016] Also, the training data may further contain at least one of age information, height information, gender information, and bio impedance information of an object.

[0017] Also, the generating of the weight estimation model may include generating the weight estimation model through the machine learning, in which the skin spectrum information and the at least one of the age information, the height information, the gender information, and the bio impedance information are used as inputs and the weight information is used as an output.

[0018] Also, an algorithm used to perform the machine learning may include at least one of partial least squares regression, linear regression, neural network, decision tree, genetic algorithm, genetic programming, K-nearest neighbor, radial basis function network, random forest, support vector machine, and deep-learning.

[0019] In still another general aspect, there is provided an apparatus for estimating a weight including: a spectrum measurement unit that measures a skin spectrum of a user; and a weight estimation unit that estimates a weight of the user using a weight estimation model based on the measured skin spectrum.

[0020] Here, the weight estimation model may be generated through machine learning based on training data, the training comprising skin spectrum information and weight information of a plurality of objects.

[0021] Also, the training data may further contain at least one of age information, height information, gender information, and bio impedance information of the plurality objects.

[0022] Also, the weight estimation unit may estimate the weight of the user further based on at least one of age information, height information, gender information, and bio impedance information of the user.

[0023] Also, an algorithm to perform the machine learning may include at least one of partial least squares regression, linear regression, neural network, decision tree, genetic algorithm, genetic programming, K-nearest neighbor, radial basis function network, random forest, support vector machine, and deep-learning.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The above and/or other aspects will be more apparent by describing certain example embodiments with reference to the accompanying drawings.

[0025] FIG. **1** is a block diagram illustrating an exemplary embodiment of an apparatus for generating a weight estimation model.

[0026] FIG. **2** is a block diagram illustrating an exemplary embodiment of an apparatus for estimating a weight.

[0027] FIG. **3** is a block diagram illustrating another exemplary embodiment of an apparatus for estimating a weight.

[0028] FIG. **4** is a flowchart illustrating an exemplary embodiment of a method for generating a weight estimation model.

[0029] FIG. **5** is a flowchart illustrating an exemplary embodiment of a method for estimating a weight.

[0030] FIG. **6** is a flowchart illustrating another exemplary embodiment of a method for estimating a weight.

[0031] FIG. **7** is a block diagram illustrating another exemplary embodiment of an apparatus for generating a weight estimation model.

[0032] FIG. **8** is a block diagram illustrating still another exemplary embodiment of an apparatus for estimating a weight.

[0033] FIG. **9** is a block diagram illustrating yet another exemplary embodiment of an apparatus **200** for estimating a weight.

[0034] FIG. **10** is a block diagram illustrating another exemplary embodiment of a method for generating a weight estimation model.

[0035] FIG. **11** is a flowchart illustrating still another exemplary embodiment of a method for estimating a weight.

[0036] FIG. **12** is a flowchart illustrating yet another exemplary embodiment of a method for estimating a weight.

DETAILED DESCRIPTION

[0037] Hereinafter, the exemplary embodiments will be described in detail with reference to the accompanying drawings. In the following descriptions of possible embodiments operable from the invention, when some of the components and features of the exemplary embodiments are known and description thereof obscures the subject matter of the disclosure, the corresponding detailed description will be omitted. In addition, the terminology described below is defined considering functions in the disclosure and may vary according to a user's or operator's intention or usual practice. Thus, the meanings of the terminology should be interpreted based on the overall context of the present specification.

[0038] Throughout the drawings and the detailed description, unless otherwise described, the same drawing reference numerals will be understood to refer to the same elements, features, and structures. The relative size and depiction of these elements may be exaggerated for clarity, illustration, and convenience.

[0039] FIG. **1** is a block diagram illustrating an exemplary embodiment of an apparatus for generating a weight estimation model. The apparatus **100** for generating the weight estimation model according to an exemplary embodiment may be an apparatus for generating the weight estimation model which is used in estimating a user's weight based on a skin spectrum of the user.

[0040] Referring to FIG. **1**, the apparatus **100** for generating the weight estimation model may include a training data collection unit **110** and a model generation unit **120**.

[0041] The training data collection unit **110** may collect training data comprising skin spectrum information and weight information of a plurality of objects.

[0042] There is no particular limitation in a method in which the training data collection unit **110** collects the training data. That is, the training data collection unit **110** may simply receive and collect the skin spectrum information and weight information of the plurality of objects from an external device or collect the skin spectrum information by directly irradiating the plurality of objects with light and collect the weight information by directly measuring the weights of the plurality of objects.

[0043] The model generation unit **120** may generate the weight estimation model through machine learning based on the collected training data. For example, the model generation unit **120** may generate the weight estimation model through the machine learning using the skin spectrum information as an input and the weight information corresponding to the skin spectrum information, which is weight information of an object whose skin spectrum information is acquired, as a target (or as an output).

[0044] A machine learning algorithm may be one of partial least squares regression, linear regression, neural network, decision tree, genetic algorithm, genetic programming, K-nearest neighbor, radial basis function network, random forest, support vector machine, and deep-learning.

[0045] For example, when the weight estimation model is generated using the partial least squares regression, the generated weight estimation model may be expressed as Equation 1.

$$b_0+b_1A_1+b_2A_2+\ldots+b_nA_n=W \quad \text{[Equation 1]}$$

[0046] Here, W denotes a weight, A_n denotes absorbance in a wavelength n, and b_n denotes a coefficient of A_n.

[0047] In addition, when generating the weight estimation model using the neural network, the model generation unit **120** may generate the weight estimation model using a typical back propagation method (for example, gradient descent algorithm, stochastic gradient descent algorithm, etc.).

[0048] According to an exemplary embodiment, to increase the accuracy of weight estimation, the apparatus **100** for generating the weight estimation model may generate the weight estimation model by further using additional information including age, height, gender, bio impedance, etc. of the object in addition to the skin spectrum information and the weight information. In this case, the training data collection unit **110** may collect the training data further comprising at least one of age information, height information, gender information, and bio impedance information of the object in addition to the skin spectrum information and the weight information, and the model generation unit **120** may generate the weight estimation model through the machine learning using, as inputs, the at least one of age information, height information, gender information, and bio impedance information of the object as well as the skin spectrum information and using the weight information of the object as a target.

[0049] FIG. **2** is a block diagram illustrating an exemplary embodiment of an apparatus for estimating a weight. The apparatus **200** for estimating the weight is an apparatus that may estimate a weight of a user based on a skin spectrum of the user and estimates the user's weight using the weight estimation model generated by the apparatus **100** for generating the weight estimation model of FIG. **1**. The apparatus **200** for estimating the weight may be implemented as a software module, a hardware module (e.g., manufactured in the form of a hardware chip), or a combination thereof, and mounted in an electronic device. The electronic device may

include a mobile phone, a smart phone, a tablet, a laptop, a PDA (personal digital assistant), a PMP (portable multimedia player), a navigation, an MP3 player, a digital camera, a wearable device, etc. However, the electronic device is not limited to the above-described examples and may include a variety of devices.

[0050] Referring to FIG. **2**, the apparatus **200** for estimating the weight may include a spectrum estimation unit **210** and a weight estimation unit **220**.

[0051] The spectrum estimation unit **210** may estimate a user's skin spectrum. For example, the spectrum estimation unit **210** may irradiate the user's skin with light and detect light scattered by or reflected from the skin, thereby measuring the user's skin spectrum. To this end, the spectrum estimation unit **210** may include a spectroscope.

[0052] The weight estimation unit **220** may estimate a user's weight based on the measured user's skin spectrum using the weight estimation model generated in advance.

[0053] The weight estimation model may be generated through machine learning based on training data comprising skin spectrum information and weight information of a plurality of objects. Here, a machine learning algorithm may be one of partial least squares regression, linear regression, neural network, decision tree, genetic algorithm, genetic programming, K-nearest neighbor, radial basis function network, random forest, support vector machine, and deep-learning.

[0054] FIG. **3** is a block diagram illustrating another exemplary embodiment of an apparatus for estimating a weight.

[0055] Referring to FIGS. **2** and **3**, compared to the apparatus **200** for estimating the weight of FIG. **2**, the apparatus **300** for estimating the weight of FIG. **3** may further selectively include an input unit **310**, a bio impedance measurement unit **320**, a storage unit **330**, a communication unit **340**, and an output unit **350**.

[0056] The input unit **310** may receive a variety of operation signals and a variety of user information used for the weight estimation from a user. The user information may be user related information which can be used in the weight estimation, and contain age, gender, height, and the like.

[0057] According to an exemplary embodiment, the input unit **310** may include a key pad, a dome switch, a touch pad (e.g., static pressure/power failure), a jog wheel, a jog switch, H/W bottoms, and the like. In particular, when a layer structure is formed with the touch pad and a display, this may be referred to as a touch screen.

[0058] The bio impedance estimation unit **320** may estimate a user's bio impedance. For example, the bio impedance estimation unit **320** may estimate the user's bio impedance using a BIA (bio impedance analyzer) method that applies a current to a user's body and measures electrical impedance of the user.

[0059] The storage unit **330** may store programs or commands for operations of the apparatus **200** for estimating the weight, and also store input/output data. In addition, the storage unit **330** may store the weight estimation model generated in advance. As described above in FIG. **1**, the weight estimation model may be generated based on the training data comprising the skin spectrum information and weight information of the plurality of objects or generated based on the training data further comprising additional information including age, height, gender, bio impedance, etc. of the object in addition to the skin spectrum information and weight information of the plurality of objects.

[0060] The storage unit **330** may include a flash memory type memory, a hard disk type memory, a multimedia card micro type memory, a card type memory (e.g., SD or XD memory), a RAM (random access memory), an SRAM (static random access memory), a ROM (read only memory), an EEPROM (electrically erasable programmable read only memory), a PROM (programmable read only memory), a magnetic memory, a magnetic disk, an optical disk, and the like. In addition, the apparatus **300** for estimating the weight may operate an external storage medium such as a web storage or the like which performs a storage function of the storage unit **330** on the Internet.

[0061] The communication unit **340** may perform communication with an external device. For example, the communication unit **340** may transmit the information received from a user through the input unit **310**, the user's bio impedance information measured by the bio impedance measurement unit **320**, the skin spectrum information measured by the spectrum measurement unit **210**, the user's weight information estimated by the weight measurement unit **220**, and the like to the external device, or receive a variety of information which can be used in the user's weight estimation from the external device.

[0062] The external device may be a medical device using the estimated weight information, a printer for outputting the result, or a display device for displaying the estimated weight information. In addition to these, the external device may be a smartphone, a mobile phone, a PDA (personal digital assistant), a laptop, a PC, and other mobile or non-mobile computing devices and is not limited thereto.

[0063] The communication unit **340** may communicate with the external device using Bluetooth communication, BLE (Bluetooth low energy) communication, NFC (near field communication), WLAN (wireless local area network) communication, Zigbee communication, IrDA (infrared data association) communication, WFD (Wi-Fi direct) communication, UWB (ultra-wideband) communication, Ant+ communication, Wi-Fi communication, RFID (radio frequency Identification) communication, or the like. However, this is merely an example, and the exemplary embodiments are not limited thereto.

[0064] The output unit **350** may output a weight estimation result. According to an exemplary embodiment, the output unit **350** may output the weight estimation result in at least one of audible, visual, and tactile methods. For example, the output unit **340** may output the weight estimation result using voice, text, vibration, and the like. To this end, the output unit **340** may include a display, a speaker, a vibrator, and the like.

[0065] The weight estimation unit **220** may estimate the user's weight using the weight estimation model based on the user's skin spectrum information estimated by the spectrum estimation unit **210**, the user's bio impedance information estimated by the bio impedance estimation unit **320**, and the user information input through the input unit **310**. That is, the weight estimation unit **220** may estimate the user's weight further using the bio impedance information, the user information (e.g., height, age, gender, and the like) in addition to the user's skin spectrum information.

[0066] FIG. **4** is a flowchart illustrating an exemplary embodiment of a method for generating a weight estimation model.

[0067] Referring to FIGS. **1** and **4**, in operation **410**, the apparatus **100** for generating the weight estimation model may collect training data comprising skin spectrum information and weight information of a plurality of objects.

[0068] In operation **420**, the apparatus **100** for generating the weight estimation model may generate a weight estimation model through machine learning based on the collected training data. For example, the apparatus **100** for generating the weight estimation model may generate the weight estimation model through the machine learning using the skin spectrum information as an input and the weight information corresponding to the skin spectrum information, that is, weight information of an object whose skin spectrum information is acquired, as a target.

[0069] A machine learning algorithm may be one of partial least squares regression, linear regression, neural network, decision tree, genetic algorithm, genetic programming, K-nearest neighbor, radial basis function network, random forest, support vector machine, and deep-learning.

[0070] According to an exemplary embodiment, the apparatus **100** for generating the weight estimation model may generate the weight estimation model further using additional information including age, height, gender, bio impedance, etc. of the object in addition to the skin spectrum information and the weight information. In this case, the apparatus **100** for generating the weight estimation model may collect the training data further comprising at least one of age information, height information, gender information, and bio impedance information of the object in addition to the skin spectrum information and the weight information, and generate the weight estimation model through machine learning using, as inputs, the at least one of the age information, height information, gender information, and bio impedance information of the object as well as the skin spectrum information and using the weight information as a target.

[0071] FIG. **5** is a flowchart illustrating an exemplary embodiment of a method for estimating a weight.

[0072] Referring to FIGS. **2** and **5**, in operation **510**, the apparatus **200** for estimating a weight may estimate a user's skin spectrum. For example, the apparatus **200** for estimating the weight may irradiate the user's skin with light and detect light scattered by or reflected from the skin, thereby measuring the user's skin spectrum.

[0073] In operation **520**, the apparatus **200** for estimating the weight may measure a user's weight based on the measured user's skin spectrum using a weight estimation model generated in advance.

[0074] The weight estimation model may be generated through machine learning based on training data comprising skin spectrum information and weight information of a plurality of objects. Here, a machine learning algorithm may be one of partial least squares regression, linear regression, neural network, decision tree, genetic algorithm, genetic programming, K-nearest neighbor, radial basis function network, random forest, support vector machine, and deep-learning.

[0075] FIG. **6** is a flowchart illustrating another exemplary embodiment of a method for estimating a weight.

[0076] Referring to FIGS. **3** and **6**, in operation **610**, the apparatus **300** for estimating the weight may receive a variety of user information used in weight estimation. The user information is user related information which can be used in weight estimation and contain age, gender, height, and the like.

[0077] In operation **620**, the apparatus **300** for estimating the weight may measure a user's skin spectrum.

[0078] In operation **630**, the apparatus **300** for estimating the weight may measure a user's bio impedance. For example, the apparatus **300** for estimating the weight may measure the user's bio impedance using a BIA method that applies a current to a user's body and measures electrical impedance of the user.

[0079] In operation **640**, the apparatus **300** for estimating the weight may estimate a user's weight using a weight estimation model based on the measured user's skin spectrum information, the measured user's bio impedance information, and the received user information. As described in FIG. **1**, the weight estimation model may be generated based on training data comprising the skin spectrum information and weight information of the plurality of objects or generated based on the training data further comprising additional information including age, height, gender, bio impedance, etc. of the object in addition to the skin spectrum information and weight information of the plurality of objects.

[0080] In operation **650**, the apparatus **300** for estimating the weight may output a weight estimation result. According to an exemplary embodiment, the apparatus **300** for estimating the weight may output the weight estimation result in at least one of audible, visual, and tactile methods. For example, the apparatus **300** for estimating the weight may output the weight estimation result using voice, text, vibration, and the like.

[0081] FIG. **7** is a block diagram illustrating another exemplary embodiment of an apparatus for generating a weight estimation model.

[0082] Referring to FIG. **7**, an apparatus **700** for generating a weight estimation model may include a training data collection unit **710** and a model generation unit **720**.

[0083] The training data collection unit **710** may collect training data comprising body composition analysis result information and weight information of a plurality of objects. The body composition analysis result information may contain an amount of protein, an amount of fat, an amount of water, and the like.

[0084] Here, there is no limitation to a method in which the training data collection unit **710** collects the training data. That is, the training data collection unit **110** may simply receive and collect the body composition analysis result information and weight information of the plurality of objects from an external device. Alternatively, the training data collection unit **110** may acquire a skin spectrum by directly irradiating the plurality of objects with light and then collect the body composition analysis result information by analyzing the skin spectrum as well as also collect the weight information by directly measuring weights of the plurality of objects.

[0085] The model generation unit **720** may generate the weight estimation model through machine learning based on the collected training data. For example, the model generation unit **720** may generate the weight estimation model through the machine learning using the body composition analysis result information as an input and the weight information corresponding to the body composition analysis result information as a target.

[0086] A machine learning algorithm may be one of partial least squares regression, linear regression, neural network, decision tree, genetic algorithm, genetic programming, K-nearest neighbor, radial basis function network, random forest, support vector machine, and deep-learning.

[0087] According to an exemplary embodiment, the apparatus **700** for generating the weight estimation model may generate the weight estimation model further using additional information including age, height, gender, bio impedance, etc. of the object in addition to the body composition analysis result information and the weight information. In this case, the training data collection unit **710** may collect the training data further comprising at least one of age information, height information, gender information, and bio impedance information of the object in addition to the body composition analysis result information and the weight information, and the model generation unit **720** may generate the weight estimation model through the machine learning using, as inputs, the at least one of the age information, the height information, the gender information, and the bio impedance information as well as the body composition analysis result information and using the weight information as a target.

[0088] FIG. **8** is a block diagram illustrating still another exemplary embodiment of an apparatus for estimating a weight. An apparatus **800** for estimating a weight may be an apparatus that may estimate a user's weight using the weight estimation model generated by the apparatus **700** for generating the weight estimation model of FIG. **7**.

[0089] Referring to FIG. **8**, the apparatus **800** for estimating the weight may include a spectrum estimation unit **810**, a body composition analysis unit **820**, and a weight estimation unit **830**.

[0090] The spectrum estimation unit **810** may measure a user's skin spectrum.

[0091] The body composition analysis unit **820** may analyze a user's body composition (for example, water, protein, fat, etc.) through the measured skin spectrum.

[0092] The weight estimation unit **830** may estimate the user's weight based on the body composition analysis result using the weight estimation model generated in advance.

[0093] The weight estimation model may be generated through machine learning based on training data comprising body composition analysis result information and weight information of a plurality of objects. Here, a machine learning algorithm may be one of partial least squares regression, linear regression, neural network, decision tree, genetic algorithm, genetic programming, K-nearest neighbor, radial basis function network, random forest, support vector machine, and deep-learning.

[0094] FIG. **9** is a block diagram illustrating yet another exemplary embodiment of the apparatus for estimating the weight.

[0095] Referring to FIGS. **8** and **9**, compared to the apparatus **800** for estimating the weight of FIG. **8**, an apparatus **900** for estimating a weight of FIG. **9** may further selectively include an input unit **910**, a bio impedance measurement unit **920**, a storage unit **930**, a communication unit **940**, and an output unit **950**.

[0096] The input unit **910** may receive a variety of operation signals and a variety of user information used for the weight estimation from a user. The user information may be user related information which can be used in the weight estimation and contain age, gender, height, and the like.

[0097] The bio impedance measurement unit **920** may measure a user's bio impedance. For example, the bio impedance measurement unit **920** may measure the user's bio impedance using a BIA method that applies a current to a user's body and measures electrical impedance of the user.

[0098] The storage unit **930** may store programs or commands for operations of the apparatus **900** for estimating the weight and also store input/output data. In addition, the storage unit **930** may store the weight estimation model generated in advance. Here, as described above in FIG. **7**, the weight estimation model may be generated based on the training data comprising the body composition analysis result information and weight information of the plurality of objects or generated based on the training data further comprising additional information including age, height, gender, bio impedance, etc. of the object in addition to the body composition analysis result information and weight information of the plurality of objects.

[0099] The communication unit **940** may perform communication with an external device. For example, the communication unit **940** may transmit the information received from the user through the input unit **901**, the user's bio impedance information measured by the bio impedance measurement unit **920**, the skin spectrum information measured by the spectrum measurement unit **810**, the body composition analysis result information analyzed by the body composition analysis unit **820**, the user's weight information estimated by the weight estimation unit **830**, and the like to the external device or receive a variety of information which can be used in the user's weight estimation from the external device.

[0100] The output unit **950** may output a weight estimation result. According to an exemplary embodiment, the output unit **950** may output the weight estimation result in at least one of audible, visual, and tactile methods.

[0101] The weight estimation unit **830** may estimate the user's weight using the weight estimation model based on the body composition analysis result information of the body composition analysis unit **820**, the user's bio impedance information measured by the bio impedance measurement unit **920**, and the user information received through the input unit **910**.

[0102] FIG. **10** is a block diagram illustrating another exemplary embodiment of a method for generating a weight estimation model.

[0103] Referring to FIGS. **7** and **10**, in operation **1010**, the apparatus **700** for generating the weight estimation model may collect the training data comprising the body composition analysis result information and weight information of the plurality of objects. The body composition analysis result information may contain an amount of protein, an amount of fat, an amount of water, and the like.

[0104] In operation **1020**, the apparatus **700** for generating the weight estimation model may generate the weight estimation model through machine learning based on the collected training data. For example, the apparatus **700** for generating the weight estimation model may generate the weight estimation model through the machine learning using the body composition analysis result information as an input and the weight information corresponding to the body composition analysis result information as a target.

[0105] According to an exemplary embodiment, the apparatus **700** for generating the weight estimation model may generate the weight estimation model further using addi-

tional information including age, height, gender, bio impedance, etc. of the object in addition to the body composition analysis result information and the weight information. In this case, the apparatus **700** for generating the weight estimation model may collect the training data further comprising at least one of age information, height information, gender information, and bio impedance information of the object in addition to the body composition analysis result and the weight information, and generate the weight estimation model through the machine learning using, as inputs, the at least one of the age information, the height information, the gender information, and the bio impedance information as well as the body composition analysis result information and using the weight information as a target.

[0106] FIG. **11** is a flowchart illustrating still another exemplary embodiment of a method for estimating a weight.

[0107] Referring to FIGS. **8** and **11**, in operation **1110**, the apparatus **800** for estimating the weight may measure a user's skin spectrum.

[0108] In operation **1120**, the apparatus **800** for estimating the weight may analyze a user's body composition (for example, water, protein, fat, etc.) through the measured skin spectrum.

[0109] In operation **1130**, the apparatus **800** for estimating the weight may estimate a user's weight based on the body composition analysis result using the weight estimation model generated in advance.

[0110] FIG. **12** is a flowchart illustrating yet another exemplary embodiment of a method for estimating a weight.

[0111] Referring to FIGS. **9** and **12**, the apparatus **900** for estimating the weight may receive a variety of user information used in the weight estimation. The user information may be user related information which can be used in the weight estimation and contain age, gender, height, and the like.

[0112] The apparatus **900** for estimating the weight may measure a user's skin spectrum in operation **1220** and analyze a body composition based on the measured skin spectrum in operation **1230**.

[0113] In operation **1240**, the apparatus **900** for estimating the weight may measure a user's bio impedance. For example, the apparatus **900** for estimating the weight may measure the user's bio impedance using a BIA method that applies a current to a user's body and measures electrical impedance of the user.

[0114] In operation **1250**, the apparatus **900** for estimating the weight may estimate the user's weight using the weight estimation model based on body composition analysis result information, the measured user's bio impedance information, and the received user information. The weight estimation model may be generated based on the training data comprising the body composition analysis result information and weight information of the plurality of objects as described in FIG. **7** or generated based on the training data further comprising additional information including age, height, gender, bio impedance, etc. of the object in addition to the body composition analysis result information and weight information of the plurality of objects.

[0115] In operation **1260**, the apparatus **900** for estimating the weight may output a weight estimation result. According to an exemplary embodiment, the apparatus **900** for estimating the weight may output the weight estimation result in at least one of audible, visual, and tactile methods.

[0116] The computer-readable recording media include all kinds of recording devices in which data that are readable by a computer system are being stored. Examples of the computer-readable recording media include a read-only memory (ROM), a random access memory (RAM), a compact-disc ROM (CD-ROM), a magnetic tape, a floppy disk, an optical data storage device, etc. In addition, the computer-readable recording media may be distributed into the computer system that is connected through the networks to store and implement the computer-readable codes in a distributed computing mechanism.

[0117] At least one of the components, elements, modules or units represented by a block as illustrated in the drawings may be embodied as various numbers of hardware, software and/or firmware structures that execute respective functions described above, according to an exemplary embodiment. For example, at least one of these components, elements or units may use a direct circuit structure, such as a memory, a processor, a logic circuit, a look-up table, etc. that may execute the respective functions through controls of one or more microprocessors or other control apparatuses. Also, at least one of these components, elements or units may be specifically embodied by a module, a program, or a part of code, which contains one or more executable instructions for performing specified logic functions, and executed by one or more microprocessors or other control apparatuses. Also, at least one of these components, elements or units may further include or implemented by a processor such as a central processing unit (CPU) that performs the respective functions, a microprocessor, or the like. Two or more of these components, elements or units may be combined into one single component, element or unit which performs all operations or functions of the combined two or more components, elements of units. Also, at least part of functions of at least one of these components, elements or units may be performed by another of these components, element or units. Further, although a bus is not illustrated in the above block diagrams, communication between the components, elements or units may be performed through the bus. Functional aspects of the above exemplary embodiments may be implemented in algorithms that execute on one or more processors. Furthermore, the components, elements or units represented by a block or processing steps may employ any number of related art techniques for electronics configuration, signal processing and/or control, data processing and the like.

[0118] A number of examples have been described above. Nevertheless, it should be understood that various modifications may be made. For example, suitable results may be achieved if the described techniques are performed in a different order and/or if components in a described system, architecture, device, or circuit are combined in a different manner and/or replaced or supplemented by other components or their equivalents. Accordingly, other implementations are within the scope of the following claims.

What is claimed is:

1. An apparatus for generating a weight estimation model, the apparatus comprising:

a training data collection unit configured to collect training data, the training data comprising skin spectrum information and weight information of a plurality of objects; and

a model generation unit configured to generate the weight estimation model, used for spectrum-based weight estimation, through machine learning based on the collected training data.

2. The apparatus of claim **1**, wherein the model generation unit generates the weight estimation model through the machine learning, in which the skin spectrum information is used as an input and the weight information is used as an output.

3. The apparatus of claim **1**, wherein the training data further comprises at least one of age information, height information, gender information, and bio impedance information of an object.

4. The apparatus of claim **3**, wherein the model generation unit generates the weight estimation model through the machine learning in which the skin spectrum information and the at least one of the age information, the height information, the gender information, and the bio impedance information are used as inputs and the weight information is used as an output.

5. The apparatus of claim **1**, wherein an algorithm used to perform the machine learning comprises at least one of partial least squares regression, linear regression, neural network, decision tree, genetic algorithm, genetic programming, K-nearest neighbor, radial basis function network, random forest, support vector machine, and deep-learning.

6. A method for generating a weight estimation model, the method comprising:

collecting training data, the training data comprising skin spectrum information and weight information of a plurality of objects; and

generating the weight estimation model, used for spectrum-based weight estimation, through machine learning based on the collected training data.

7. The method of claim **6**, wherein the generating of the weight estimation model comprises generating the weight estimation model through the machine learning, in which the skin spectrum information is used as an input and the weight information is used as an output.

8. The method for generating the weight estimation model of claim **6**, wherein the training data further comprises at least one of age information, height information, gender information, and bio impedance information of an object.

9. The method of claim **8**, wherein the generating of the weight estimation model comprises generating the weight estimation model through the machine learning in which the skin spectrum information and the at least one of the age information, the height information, the gender information, and the bio impedance information are used as inputs and the weight information is used as an output.

10. The method of claim **6**, wherein an algorithm used to perform the machine learning comprises at least one of partial least squares regression, linear regression, neural network, decision tree, genetic algorithm, genetic programming, K-nearest neighbor, radial basis function network, random forest, support vector machine, and deep-learning.

11. An apparatus for estimating a weight, the apparatus comprising:

a spectrum measurement unit configured to measure a skin spectrum of a user; and

a weight estimation unit configured to estimate a weight of the user using a weight estimation model based on the measured skin spectrum.

12. The apparatus of claim **11**, wherein the weight estimation model is generated through machine learning based on training data, the training data comprising skin spectrum information and weight information of a plurality of objects.

13. The apparatus of claim **12**, wherein the training data further comprises at least one of age information, height information, gender information, and bio impedance information of the plurality objects.

14. The apparatus of claim **13**, wherein the weight estimation unit estimates the weight of the user further based on at least one of age information, height information, gender information, and bio impedance information of the user.

15. The apparatus of claim **11**, wherein an algorithm used to perform the machine learning comprises at least one of partial least squares regression, linear regression, neural network, decision tree, genetic algorithm, genetic programming, K-nearest neighbor, radial basis function network, random forest, support vector machine, and deep-learning.

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