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(54) **APPARATUS AND METHOD FOR ESTIMATING BLOOD SUGAR BASED ON HETEROGENEOUS SPECTRUMS**

VORRICHTUNG UND VERFAHREN ZUR SCHÄTZUNG DES BLUTZUCKERSPIEGELS AUF BASIS HETEROGENER SPEKTREN

APPAREIL ET PROCÉDÉ PERMETTANT D'ESTIMER LE TAUX DE SUCRE DANS LE SANG SUR LA BASE DE SPECTRES HÉTÉROGÈNES

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Description

BACKGROUND

1. Field

[0001] An apparatus and a method consistent with exemplary embodiments relate to a blood sugar estimation technology, and more particularly, to an apparatus and a method of estimating blood sugar using heterogeneous spectrums.

2. Description of Related Art

[0002] Nowadays, due to the living environment, adult diseases increased, causing users to be more interested in health than before. Among them, patients who suffer from adult diseases including high blood pressure, diabetes, etc. are increasing. In case of such chronic disease, while the clinic visits are necessary, it is also necessary for the patients to perform follow-up examinations of their conditions by periodically checking blood pressure and blood sugar level and take appropriate actions accordingly. For example, it is necessary for people with diabetes to monitor blood sugar about six times a day to control and maintain an appropriate blood sugar level by periodically measuring the level of sugar in blood.

[0003] Accordingly, the speed at which the use of the portable personal medical devices including blood pressure gauges, blood sugar meters, insulin pumps, etc. spreads is rapidly increasing. According to this trend, standardization of medical devices and medical services such as described above is becoming active, and personal medical devices and services utilizing them are being provided.

[0004] Currently, as one of the medical devices that measure blood sugar, there are the invasive blood sugar meters. In the method of using such an invasive blood sugar meter described above, a needle penetrates the skin and blood is directly collected to check the level of sugar in blood. However, in this method, a patient may feel pain from being pricked with a needle every time during a blood-collecting process, and there is a risk of infection of a part that is pricked with the needle. Since invasive blood sugar meters may make users uncomfortable, as described above, noninvasive blood sugar meters based on a spectroscopic analysis method capable of measuring a blood sugar level of intercellular liquid under the skin without using a needle have been developed.

[0005] However, even when using noninvasive blood sugar meters, a plurality of blood-collecting processes are still necessary to generate calibration, that is, an individualized blood sugar estimation model.

[0006] US 2012/035442 A1 relates to the selection of the specific filter combinations, which can provide sufficient information for multivariate calibration to extract accurate analyte concentrations in complex biological systems. The present invention also describes wavelength interval selection methods that give rise to the miniaturized designs. Finally, this invention presents a plurality of wavelength selection methods and miniaturized spectroscopic apparatus designs and the necessary tools to map from one domain (wavelength selection) to the other (design parameters). Such selection of informative spectral bands has a broad scope in miniaturizing any clinical diagnostic instruments which employ Raman spectroscopy in particular and other spectroscopic techniques in general.

[0007] DANZER K ET AL, "Near-Infrared Diffuse Reflection Spectroscopy for Non-Invasive Blood-Glucose Monitoring", LEOS NEWSLETTER, THE SOCIETY, PISCATAWAY, NJ, US, (19980401), vol. 12, no. 2, ISSN 1060-3301 discusses the use of near-infrared diffuse reflection spectroscopy for non-invasive blood-glucose monitoring.

SUMMARY

[0008] It is the object of the present application to provide a blood sugar model generation apparatus and method, which finally allow accurately estimating the blood sugar of a user in a non-invasive way.

[0009] This object is solved by the subject matter of the independent claims.

[0010] Preferred embodiments are defined by the dependent claims.

[0011] This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description of Exemplary Embodiments. This summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

[0012] The following description relates to an apparatus and a method for determining blood sugar level using heterogeneous spectrums.

[0013] In one general aspect of an exemplary embodiment, a blood sugar model generation apparatus includes a data obtainer configured to obtain blood sugar profile data of a user based on a first type spectrum-blood sugar profile relationship model, a second type spectrum measurer configured to measure training second type spectrum data for the skin of the user, and a processor configured to generate an individualized blood sugar model based on the obtained blood sugar profile data and the measured training second type spectrum data.

[0014] A first type spectrum may be a Raman spectrum, and a second type spectrum may be a near infrared (NIR) spectrum.

[0015] The first type spectrum-blood sugar profile relationship model may be generated through machine learning based on training first type spectrum data and training blood sugar profile data.

[0016] The training blood sugar profile data may be obtained by performing an oral glucose tolerance test

(OGTT) on a subject whose training first type spectrum data has been measured.

[0017] The first type spectrum-blood sugar profile relationship model may be generated through machine learning with the training first type spectrum data as an input and the training blood sugar profile data as a target.

[0018] The first type spectrum-blood sugar profile relationship model may be generated through machine learning with the training first type spectrum data as an input and an area under the curve (AUC) value calculated from the training blood sugar profile data as a target.

[0019] 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.

[0020] The second type spectrum measurer may include a light source configured to emit light to the skin of the user and a spectroscope configured to detect absorbed, scattered, or reflected light from the skin of the user and measures the training second type spectrum data based on the detected light,

[0021] The processor may generate the individualized blood sugar model through machine learning.

[0022] The processor may generate the individualized blood sugar model by calculating a blood sugar value corresponding to the measured training second type spectrum data from the obtained blood sugar profile data and through machine learning with the training second type spectrum data as an input and the calculated blood sugar value as a target.

[0023] In another general aspect of the present disclosure, a blood sugar profile providing apparatus includes a memory configured to store a first type spectrum-blood sugar profile relationship model, a first type spectrum measurer configured to measure first type spectrum data for the skin of a user, and a processor configured to calculate a blood sugar profile of the user based on the first type spectrum-blood sugar profile relationship model and the measured first type spectrum data.

[0024] A first type spectrum may be a Raman spectrum.

[0025] The first type spectrum-blood sugar profile relationship model may be generated through machine learning based on training first type spectrum data and training blood sugar profile data.

[0026] The training blood sugar profile data may be obtained by performing an OGTT on a subject whose training first type spectrum data has been measured.

[0027] The first type spectrum-blood sugar profile relationship model may be generated through machine learning with the training first type spectrum data as an input and the training blood sugar profile data as a target.

[0028] The first type spectrum-blood sugar profile relationship model may be generated through machine learning with the training first type spectrum data as an input and an AUC value calculated from the training blood sugar profile data as a target.

[0029] 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.

[0030] The first type spectrum measurer may include a light source configured to emit light to the skin of the user and a spectroscope configured to detect absorbed, scattered, or reflected light from the skin of the user and measures the first type spectrum data.

[0031] When the first type spectrum-blood sugar profile relationship model is generated through machine learning with training first type spectrum data as an input and training blood sugar profile data as a target, the processor may calculate a blood sugar profile of the user by a blood profile output by inputting the measured first type spectrum data into the first type spectrum-blood sugar profile relationship model.

[0032] When the first type spectrum-blood sugar profile relationship model is generated through machine learning with training first type spectrum data as an input and an AUC valued calculated from training blood sugar profile data as a target, the processor may calculate a blood sugar profile of the user based on an AUC value output by inputting the measured first type spectrum data into the first type spectrum-blood sugar profile relationship model.

[0033] The processor may adjust a reference blood sugar profile to allow an AUC value of the reference blood sugar profile to be the output AUC value and may calculate a blood sugar profile data of the user by the data of the adjusted reference blood sugar profile.

[0034] In still another general aspect of the present disclosure, an apparatus includes a memory configured to store an individualized blood sugar model, a second type spectrum measurer configured to measure second type spectrum data for the skin of a user, and a processor configured to calculate blood sugar of the user based on the measured second type spectrum data and the individualized blood sugar model. Here, the blood sugar model is generated based on blood sugar profile data of the user based on a first type spectrum-blood sugar profile relationship model and training second type spectrum data for the skin of the user.

[0035] A first type spectrum may be a Raman spectrum, and a second type spectrum may be an NIR spectrum.

[0036] The first type spectrum-blood sugar profile relationship model may be generated through machine learning based on training first type spectrum data and training blood sugar profile data.

[0037] The training blood sugar profile data may be obtained by performing an OGTT on a subject whose training first type spectrum data has been measured.

[0038] The first type spectrum-blood sugar profile relationship model may be generated through machine learning with the training first type spectrum data as an input and the training blood sugar profile data as a target.

[0039] The first type spectrum-blood sugar profile relationship model may be generated through machine learning with the training first type spectrum data as an input and an AUC value calculated from the training blood sugar profile data as a target.

[0040] 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.

[0041] The second type spectrum measurer may include a light source configured to emit light to the skin of the user and a spectroscope configured to detect absorbed, scattered, or reflected light from the skin of the user and measures the second type spectrum data based on the detected light.

[0042] The individualized blood sugar model may be generated through machine learning.

[0043] Other features and aspects of exemplary embodiment will become more apparent from the following detailed description of exemplary embodiment, the drawings, and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0044] The above and/or other aspects will be more apparent and more readily appreciated by describing from the following description of exemplary embodiments with reference to the accompanying drawings, in which:

FIG. 1 is a block diagram illustrating a heterogeneous spectrum-based blood sugar estimation apparatus according to an exemplary embodiment.

FIG. 2 is a block diagram illustrating a first type spectrum-blood sugar profile relationship model generation apparatus according to an exemplary embodiment.

FIG. 3 is a block diagram illustrating another example of a first type spectrum-blood sugar profile relationship model generation apparatus according to an exemplary embodiment.

FIG. 4 is a block diagram illustrating a blood sugar profile estimation apparatus according to an exemplary embodiment.

FIG. 5 is a block diagram illustrating another example of a blood sugar profile estimation apparatus according to an exemplary embodiment.

FIG. 6 is a view illustrating a method of estimating blood sugar profile data according to an exemplary embodiment.

FIG. 7 is a block diagram illustrating a blood sugar estimation model generation apparatus according to an exemplary embodiment.

FIG. 8 is a block diagram illustrating another example of a blood sugar estimation model generation apparatus according to an exemplary embodiment.

FIG. 9 is a block diagram illustrating a blood sugar estimation apparatus according to an exemplary embodiment.

FIG. 10 is a block diagram illustrating another example of a blood sugar estimation apparatus according to an exemplary embodiment.

FIG. 11 is a flowchart illustrating a method of estimating blood sugar based on a heterogeneous spectrum according to an exemplary embodiment.

FIG. 12 is a flowchart illustrating a method of generating a first type spectrum-blood sugar profile relationship model according to an exemplary embodiment.

FIG. 13 is a flowchart illustrating a method of estimating a blood sugar profile according to an exemplary embodiment.

FIG. 14 is a flowchart illustrating a method of generating a blood sugar estimation model according to an exemplary embodiment.

FIG. 15 is a flowchart illustrating a method of estimating blood sugar according to an exemplary embodiment.

[0045] 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.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0046] The following description is provided to assist the reader in gaining a comprehensive understanding of the methods, apparatuses, and/or systems described herein. Accordingly, various changes, modifications, and equivalents of the methods, apparatuses, and/or systems described herein will be suggested to those of ordinary skill in the art. Also, descriptions of well-known functions and constructions may be omitted for increased clarity and conciseness.

[0047] FIG. 1 is a block diagram illustrating a heterogeneous spectrum-based blood sugar estimation apparatus according to an exemplary embodiment.

[0048] Referring to FIG. 1, a heterogeneous spectrum-based blood sugar estimation apparatus 100 may include a first type spectrum-blood sugar profile relationship model generator 110, a blood sugar profile estimator 120, a blood sugar estimation model generator 130, and a blood sugar estimator 140.

[0049] The first type spectrum-blood sugar profile relationship model generator 110 may generate a model which defines a relationship between a first type spectrum and a blood sugar profile (hereinafter, a first type spectrum-blood sugar profile relationship model). Here, the first type spectrum may be a Raman spectrum for the skin and the blood sugar profile may be a trend of blood sugar in time.

[0050] According to an exemplary embodiment, the first type spectrum-blood sugar profile relationship model generator 110 may generate the first type spectrum-blood sugar profile relationship model through machine learning based on training first type spectrum data and training blood sugar profile data for skin of a subject. Here, the training blood sugar profile data may be data obtained by performing an oral glucose tolerance test (OGTT) on the subject whose first type spectrum data has been measured. Also, a machine learning algorithm may include 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, deep-learning, etc. However, the learning algorithm is provided by way of an example and is not limited thereto.

[0051] The blood sugar profile estimator 120 may estimate blood sugar profile data of a user.

[0052] According to an exemplary embodiment, the blood sugar profile estimator 120 may estimate blood sugar profile data using a first type spectrum-blood sugar profile relationship model. For example, the blood sugar profile estimator 120 may obtain first type spectrum data for the skin of the user and may estimate blood sugar profile data of the user by inputting the obtained first type spectrum data into the first type spectrum-blood sugar profile relationship model.

[0053] The blood sugar estimation model generator 130 may generate an individualized blood sugar estimation model.

[0054] According to an exemplary embodiment, the blood sugar estimation model generator 130 may generate the individualized blood sugar estimation model through machine learning based on training second type spectrum data for the skin of the user and the blood sugar profile data of the user estimated by the blood sugar profile estimator 120. Here, a second type spectrum may be a near-infrared (NIR) spectrum.

[0055] For example, the blood sugar estimation model generator 130 may generate the individualized blood sugar estimation model through machine learning with the training second type spectrum data for the skin of the user as an input and a blood sugar value corresponding to the training second type spectrum data as a target. Here, the blood sugar value corresponding to the training second type spectrum data may be calculated from the estimated blood sugar profile data of the user.

[0056] The blood sugar estimator 140 may estimate blood sugar of the user.

[0057] According to an exemplary embodiment, the blood sugar estimator 140 may estimate the blood sugar of the user using the individualized blood sugar estimation model. For example, the blood sugar estimator 140 may obtain the second type spectrum data for the skin of the user and may estimate the blood sugar of the user by inputting the obtained second type spectrum into the blood sugar estimation model.

[0058] Meanwhile, the heterogeneous spectrum-based blood sugar estimation apparatus 100 may be embodied as a single software module or manufactured as a single hardware chip to be installed in an electronic apparatus. Otherwise, each of the components that form the heterogeneous spectrum-based blood sugar estimation apparatus 100 such as the first type spectrum-blood sugar profile relationship model generator 110, the blood sugar profile estimator 120, the blood sugar estimation model generator 130, and the blood sugar estimator 140 may be embodied as a separate software module or a separate hardware chip to be installed in a separate electronic apparatus. Here, the electronic apparatus may include a fixed terminal and a mobile terminal. The fixed terminal may include a digital television (TV), a desktop computer, etc. The mobile terminal may include a cellular phone, a smart phone, a tablet personal computer (PC), a notebook PC, personal digital assistants (PDA), a portable multimedia player (PMP), a navigation device, an MP3 player, a digital camera, a wearable device, etc. However, the electronic device is not limited to the above examples and may include various devices.

[0059] FIG. 2 is a block diagram illustrating a first type spectrum-blood sugar profile relationship model generation apparatus according to an exemplary embodiment. A first type spectrum-blood sugar profile relationship model generation apparatus 200 may be an example of the first type spectrum-blood sugar profile relationship model generator 110 of FIG. 1.

[0060] Referring to FIG. 2, the first type spectrum-blood sugar profile relationship model generation apparatus 200 may include a data obtainer 210 and a processor 220.

[0061] The data obtainer 210 may obtain training first type spectrum data and training blood sugar profile data. Here, a first type spectrum may be a Raman spectrum.

[0062] According to an exemplary embodiment, the data obtainer 210 may obtain the training first type spectrum data and the training blood sugar profile data from a certain database or an external apparatus. Here, the training blood sugar profile data may be data obtained by performing an OGTT on a subject whose first type spectrum data has been measured.

[0063] The processor 220 may generate the first type spectrum-blood sugar profile relationship model through machine learning based on the training first type spectrum data and the training blood sugar profile data which are obtained. Here, a machine learning algorithm may include 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, deep-learning, etc. but is not limited thereto.

[0064] According to an exemplary embodiment, the processor 220 may generate the first type spectrum-blood sugar profile relationship model through machine learning with the obtained training first type spectrum data as an input and training blood sugar profile data as a target.

[0065] According to another exemplary embodiment, the processor 220 may generate the first type spectrum-blood sugar profile relationship model by calculating an area under the curve (AUC) value of a training blood sugar profile from the training blood sugar profile data and through machine learning with the training first type spectrum data as an input and the calculated AUC value as a target.

[0066] FIG. 3 is a block diagram illustrating another example of a first type spectrum-blood sugar profile relationship model generation apparatus according to an exemplary embodiment.

[0067] Referring to FIG. 3, compared with the first type spectrum-blood sugar profile relationship model generation apparatus 200 of FIG. 2, a first type spectrum-blood sugar profile relationship model generation apparatus 300 may selectively further include an inputter 310, a storage or a memory 320, a communicator 330, and an outputter 340.

[0068] The inputter or an input interface 310 may receive various operation signals from a user. According to an exemplary embodiment, the inputter 310 may include a key pad, a dome switch, a touch pad (static pressure/static electricity), a jog wheel, a jog switch, a hardware (H/W) button, etc. Particularly, when a touch pad and a display together form a layer structure, it may be called a touch screen.

[0069] The storage 320 may store programs or commands for operations of the first type spectrum-blood sugar profile relationship model generation apparatus 300 and may store data which are input or output. Also, the storage 320 may store a generated first type spectrum-blood sugar profile relationship model.

[0070] The storage 320 may include a flash memory type memory, a hard disk type memory, a multimedia card micro type memory, a card type memory such as a secure digital (SD) memory, an extreme digital (XD) memory, etc., a random access memory (RAM), a static random access memory (SRAM), a read only memory (ROM), an electrically erasable programmable read only memory (EEPROM), a programmable read only memory (PROM), a magnetic memory, a magnetic disk, an optical disk, etc. Also, the first type spectrum-blood sugar profile relationship model generation apparatus 300 may operate an external storage medium such as a web storage which performs a storage function of the storage 320 on the Internet.

[0071] The communicator 330 may perform communication with an external apparatus. For example, the communicator 330 may transmit data input through the inputter 310, the first type spectrum-blood sugar profile relationship model generated by the processor 220, etc. to the external apparatus or may receive data for generating the first type spectrum-blood sugar profile relationship model from the external apparatus.

[0072] Here, the external apparatus may be a medical apparatus which uses the generated first type spectrum-blood sugar profile relationship model, a printer for outputting a result, or a display apparatus which displays data related to the generated first type spectrum-blood sugar profile relationship model. In addition, the external apparatus may be a digital TV, a desktop computer, a cellular phone, a smart phone, a tablet PC, a notebook PC, PDA, a PMP, a navigation device, an MP3 player, a digital camera, a wearable device, etc. but is not limited thereto.

[0073] The outputter 340 may output data related to generating the first type spectrum-blood sugar profile relationship model and data related to the generated first type spectrum-blood sugar profile relationship model. According to an exemplary embodiment, the outputter 340 may output the data related to generating the first type spectrum-blood sugar profile relationship model and the data related to the generated first type spectrum-blood sugar profile relationship model using at least one of an acoustic method, a visual method, and a tactile method. For example, the outputter 340 may output the data related to generating the first type spectrum-blood sugar profile relationship model and the data related to the generated first type spectrum-blood sugar profile relationship model using a voice, a text, vibrations, etc. For this, the outputter 340 may include a display, a speaker, a vibrator, etc.

[0074] FIG. 4 is a block diagram illustrating a blood sugar profile estimation apparatus according to an exemplary embodiment. A blood sugar profile estimation apparatus 400 may be an example of the blood sugar profile estimator 120 of FIG. 1.

[0075] Referring to FIG. 4, the blood sugar profile estimation apparatus 400 may include a first type spectrum measurer 410, a storage 420, and a processor 430.

[0076] The first type spectrum measurer 410 may measure first type spectrum data, for example, Raman spectrum data for the skin of the user. For this, the first type spectrum measurer 410 may include a light source 411 which emits light to the skin of the user and a spectroscope 412 which detects absorbed, scattered, or reflected light from the skin of the user and measures the first type spectrum data. Here, the light source 411 may include a light emitting diode (LED), a laser diode, etc. The spectroscope 412 may include a photo diode, a photo transistor (PTr), a charge-coupled device (CCD), etc.

[0077] The storage 420 may store a first type spectrum-blood sugar profile relationship model. Here, the first type spectrum-blood sugar profile relationship model may be generated through machine learning with training first type spectrum data as an input and training blood sugar profile data as a target or with training first type spectrum data as an input and an AUC value of a training blood sugar profile calculated from the training blood sugar profile data as a target.

[0078] Also, the storage 420 may store programs or commands for operating the blood sugar profile estimation apparatus 400 and may store data which are input or output.

[0079] The storage 420 may include a flash memory type memory, a hard disk type memory, a multimedia card micro type memory, a card type memory such as an SD memory, an XD memory, etc., an RAM, an SRAM, an ROM, an EEPROM, a PROM, a magnetic memory, a magnetic disk, an optical disk, etc. Also, the blood sugar profile estimation apparatus 400 may operate an external storage medium such as a web storage which performs a storage function of the storage 420 on the Internet.

[0080] The processor 430 may estimate blood sugar profile data of the user based on the measured first type spectrum data and the stored first type spectrum-blood sugar profile relationship model.

[0081] According to an exemplary embodiment, when the first type spectrum-blood sugar profile relationship model is generated through machine learning with the training first type spectrum data as the input and the training blood sugar profile data as the target, an output of the first type spectrum-blood sugar profile relationship model is provided as the blood sugar profile data. In this case, the processor 430 may estimate the blood sugar profile data output by inputting the measured first type spectrum data into the first type spectrum-blood sugar profile relationship model as the blood sugar profile data of the user.

[0082] According to another exemplary embodiment, when the first type spectrum-blood sugar profile relationship model may be generated through machine learning with the training first type spectrum data as the input and the AUC value of the training blood sugar profile calculated from the training blood sugar profile data as the target, an output of the first type spectrum-blood sugar profile relationship model is provided in the form of AUC, that is, the AUC value of the blood sugar profile of the user to be estimated. In this case, the processor 430 may estimate the blood sugar profile data of the user based on the AUC value output by inputting the measured first type spectrum data into the first type spectrum-blood sugar profile relationship model. For example, the processor 430 may adjust a reference blood sugar profile to allow an AUC value of the reference blood sugar profile to be the output AUC value, for example, adjustment of the height of a graph, and may estimate the adjusted reference blood sugar profile as the blood sugar profile of the user. Here, the reference blood sugar profile may be experimentally derived as a blood sugar profile capable of expressing blood sugar profiles of a plurality of subjects.

[0083] FIG. 5 is a block diagram illustrating another example of a blood sugar profile estimation apparatus according to an exemplary embodiment.

[0084] Referring to FIG. 5, compared with the blood sugar profile estimation apparatus 400 of FIG. 4, a blood sugar profile estimation apparatus 500 may further include an inputter 510, a communicator 520, and an outputter 530 selectively.

[0085] The inputter or an input interface 510 may receive various operation signals from a user. According to an exemplary embodiment, the inputter 510 may include a key pad, a dome switch, a touch pad (static pressure/static electricity), a jog wheel, a jog switch, an hardware button, etc. Particularly, when a touch pad and a display together form a layer structure, it may be called a touch screen.

[0086] The communicator 520 may perform communication with an external apparatus. For example, the communicator 520 may transmit data input through the inputter 510, blood sugar profile data of the user estimated by the processor 430, etc. to the external apparatus or may receive data for estimating the blood sugar profile data of the user from the external apparatus.

[0087] Here, the external apparatus may be a medical apparatus which uses the estimated blood sugar profile data, a printer for outputting results, or a display apparatus which displays the estimated blood sugar profile data. In addition, the external apparatus may be a digital TV, a desktop computer, a cellular phone, a smart phone, a tablet PC, a notebook PC, PDA, a PMP, a navigation device, an MP3 player, a digital camera, a wearable device, etc. but is not limited thereto.

[0088] The outputter 530 may output data related to estimation of the blood sugar profile data of the user and estimation result data. According to an exemplary embodiment, the outputter 530 may output the data related to estimation of the blood sugar profile of the user and the estimation result data using at least one of an acoustic method, a visual method, and a tactile method. For example, the outputter 530 may output the data related to estimation of the blood sugar profile data of the user and the estimation result data using a voice, a text, vibrations, etc. For this, the outputter 530 may include a display, a speaker, a vibrator, etc.

[0089] FIG. 6 is a view illustrating a method of estimating blood sugar profile data according to an exemplary embodiment.

[0090] As described above, when a first type spectrum-blood sugar profile relationship model may be generated through machine learning with training first type spectrum data as an input and an AUC value of a training blood sugar profile calculated from training blood sugar profile data as a target, an output of the first type spectrum-blood sugar profile relationship model is provided in the form of AUC; that is, an AUC value of a blood sugar profile of a user to be estimated. In this case, the blood sugar profile estimation apparatus 400 may adjust a reference blood sugar profile to allow an AUC value of the reference blood sugar profile to be an AUC value which is output and may estimate data of the adjusted reference blood sugar profile as blood sugar profile data of the user. Here, the adjustment of the reference blood sugar profile may be performed by adjusting the height of a graph while maintaining a graph shape of the reference blood sugar profile.

[0091] In the example of FIG. 6, as a result of inputting measured first type spectrum data of the user into the first type spectrum-blood sugar profile relationship model, Case 1 indicates that the output of the first type spectrum-blood sugar profile relationship model is AUC = 90, and Case 2 indicates that the output of the first type spectrum-blood sugar profile relationship model is AUC = 110.

[0092] In Case 1, since the output AUC value of the first type spectrum-blood sugar profile relationship model is 90, the blood sugar profile estimation apparatus 400 adjusts a reference blood sugar profile 610 to allow an AUC value of the reference blood sugar profile 610 to be 90 and estimates data of an adjusted reference blood sugar profile 620 as the blood sugar profile data of the user.

[0093] In Case 2, since the output AUC value of the first type spectrum-blood sugar profile relationship model is 110, the blood sugar profile estimation apparatus 400 adjusts the reference blood sugar profile 610 to allow the AUC value of the reference blood sugar profile 610 to be 110 and estimates data of the adjusted reference blood sugar profile as the blood sugar profile data of the user.

[0094] FIG. 7 is a block diagram illustrating a blood sugar estimation model generation apparatus according to an exemplary embodiment. A blood sugar estimation model generation apparatus 700 may be an example of the blood sugar estimation model generator 130 of FIG. 1.

[0095] Referring to FIG. 7, the blood sugar estimation model generation apparatus 700 may include a data obtainer 710, a second type spectrum measurer 720, and a processor 730.

[0096] The data obtainer 710 may obtain blood sugar profile data of a user. Here, the blood sugar profile data of the user is estimated based on a first type spectrum-blood sugar profile relationship model and first type spectrum data for the skin of the user and may be obtained from a certain database or an external apparatus. Here, a first type spectrum may be a Raman spectrum.

[0097] Meanwhile, the first type spectrum-blood sugar profile relationship model may be generated through machine learning with training first type spectrum data as an input and training blood sugar profile data as a target or with training first type spectrum data as an input and an AUC value calculated from the training blood sugar profile data as a target. The training blood sugar profile data may be obtained by performing an OGTT on a subject whose training first type spectrum data has been measured.

[0098] The second type spectrum measurer 720 may measure training second type spectrum data for the skin of the user. Here, a second type spectrum may be an NIR spectrum. For this, the second type spectrum measurer 720 may include a light source 721 which emits light to the skin of the user and a spectroscope 722 which detects absorbed, scattered, or reflected light from the skin of the user and measures second type spectrum data. Here, the light source 721 may include an LED, a laser diode, etc. The spectroscope 722 may include a photo diode, a PTr, a CCD, etc.

[0099] The processor 730 may generate an individualized blood sugar estimation model based on the obtained blood sugar profile data of the user and the measured training second type spectrum data.

[0100] According to an exemplary embodiment, the processor 730 may generate the individualized blood sugar estimation model by calculating a blood sugar value corresponding to the training second type spectrum data from the blood sugar profile data of the user and through machine learning with the training second type spectrum as an input and the calculated blood sugar value as a target. For example, as described above, since the blood sugar profile data indicates a trend of blood sugar according to time, the processor 730 may calculate a blood sugar value corresponding to a time of measuring the training second type spectrum data from the blood sugar profile data of the user.

[0101] Meanwhile, as described above, a machine learning algorithm may include 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, deep-learning, etc. but is not limited thereto.

[0102] FIG. 8 is a block diagram illustrating another example of a blood sugar estimation model generation apparatus according to an exemplary embodiment.

[0103] Referring to FIG. 8, compared with the blood sugar estimation model generation apparatus 700 of FIG. 7, a blood sugar estimation model generation apparatus 800 may further include an inputter 810, a storage 820, a communicator 830, and an outputter 840 selectively.

[0104] The inputter 810 may receive various operation signals from a user. According to an exemplary embodiment, the inputter 810 may include a key pad, a dome switch, a touch pad (static pressure/static electricity), a jog wheel, a jog switch, a hardware button, etc. Particularly, when a touch pad and a display together form a layer structure, it may be called a touch screen.

[0105] The storage 820 may store programs or commands for operating the blood sugar estimation model generation apparatus 800 and may store data which are input or output. Also, the storage 820 may store a generated individualized blood sugar estimation model.

[0106] The storage 820 may include a flash memory type memory, a hard disk type memory, a multimedia card micro type memory, a card type memory such as an SD memory, an XD memory, etc., an RAM, an SRAM, an ROM, an EEPROM, a PROM, a magnetic memory, a magnetic disk, an optical disk, etc. Also, the blood sugar estimation model generation apparatus 800 may operate an external storage medium such as a web storage which performs a storage function of the storage 820 on the Internet.

[0107] The communicator 830 may perform communication with an external apparatus. For example, the communicator 830 may transmit data input through the inputter 810, an individualized blood sugar estimation model generated by the processor 730, etc. to the external apparatus or may receive data for generating the individualized blood sugar estimation model from the external apparatus.

[0108] Here, the external apparatus may be a medical apparatus which uses the individualized blood sugar estimation mode, a printer for outputting results, or a display apparatus which displays the generated individualized blood sugar estimation model. In addition, the external apparatus may be a digital TV, a desktop computer, a cellular phone, a smart phone, a tablet PC, a notebook PC, PDA, a PMP, a navigation device, an MP3 player, a digital camera, a wearable device, etc. but is not limited thereto.

[0109] The outputter 840 may output data related to generation of the individualized blood sugar estimation model and data related to the generated individualized blood sugar estimation model. According to an exemplary embodiment, the outputter 840 may output the data related to generation of the individualized blood sugar estimation model and the data related to the generated individualized blood sugar estimation model using at least one of an acoustic method, a visual method, and a tactile method. For example, the outputter 840 may output the data related to generation of the individualized blood sugar estimation model and data related to the generated individualized blood sugar estimation model using a voice, a text, vibrations, etc. For this, the outputter 840 may include a display, a speaker, a vibrator, etc.

[0110] FIG. 9 is a block diagram illustrating a blood sugar estimation apparatus according to an exemplary embodiment. A blood sugar estimation apparatus 900 may be an example of the blood sugar estimator 140 of FIG. 1.

[0111] Referring to FIG. 9, the blood sugar estimation apparatus 900 may include a second type spectrum measurer 910, a storage 920, and a processor 930.

[0112] The second type spectrum measurer 910 may measure second type spectrum data, for example, NIR spectrum data for the skin of the user. For this, the second type spectrum measurer 910 may include a light source 911 which emits light to the skin of the user and a spectroscope 912 which detects absorbed, scattered, or reflected light from the skin of the user and measures the second type spectrum data. Here, the light source 911 may include an LED, a laser diode, etc. The spectroscope 912 may include a photo diode, a PTr, a CCD, etc.

[0113] The storage 920 may store an individualized blood sugar estimation model. Here, the individualized blood sugar estimation model may be generated based on blood sugar profile data of the user estimated by a first type spectrum-blood sugar profile relationship model and first type spectrum data for the skin of the user and training second type spectrum data. For example, the individualized blood sugar estimation model may be generated by calculating a blood sugar value corresponding to the training second type spectrum data from the estimated blood sugar profile data of the user and through machine learning with the training second type spectrum as an input and the calculated blood sugar value as a target.

[0114] Meanwhile, the first type spectrum-blood sugar profile relationship model may be generated through machine learning with training first type spectrum data as an input and training blood sugar profile data as a target or with training first type spectrum data as an input and an AUC value of a training blood sugar profile calculated from the training blood sugar profile data as a target.

[0115] Also, the storage 920 may store programs or commands for operating the blood sugar estimation apparatus 900 and may store data which are input or output.

[0116] The storage 920 may include a flash memory type memory, a hard disk type memory, a multimedia card micro type memory, a card type memory such as an SD memory, an XD memory, etc., an RAM, an SRAM, an ROM, an EEPROM, a PROM, a magnetic memory, a magnetic disk, an optical disk, etc. Also, the blood sugar estimation apparatus 900 may operate an external storage medium such as a web storage which performs a storage function of the storage 920 on the Internet.

[0117] The processor 930 may estimate blood sugar of the user based on the measured second type spectrum data and the stored individualized blood sugar estimation model.

[0118] FIG. 10 is a block diagram illustrating another example of a blood sugar estimation apparatus according to an exemplary embodiment.

[0119] Referring to FIG. 10, compared with the blood sugar estimation apparatus 900, a blood sugar estimation apparatus 1000 may selectively further include an inputter 1010, a communicator 1020, and an outputter 1030.

[0120] The inputter 1010 may receive various operation signals from a user. According to an exemplary embodiment, the inputter 1010 may include a key pad, a dome switch, a touch pad (static pressure/static electricity), a jog wheel, a jog switch, a hardware button, etc. Particularly, when a touch pad and a display together form a layer structure, it may be called a touch screen.

[0121] The communicator 1020 may perform communication with an external apparatus. For example, the communicator 1020 may transmit data input through the inputter 1010, blood sugar of the user estimated by the processor 930, etc. to the external apparatus or may receive data for estimating the blood sugar of the user from the external apparatus.

[0122] Here, the external apparatus may be a medical apparatus which uses estimated blood sugar data of the user, a printer for outputting results, or a display apparatus which displays the estimated blood sugar data. In addition, the external apparatus may be a digital TV, a desktop computer, a cellular phone, a smart phone, a tablet PC, a notebook PC, PDA, a PMP, a navigation device, an MP3 player, a digital camera, a wearable device, etc. but is not limited thereto.

[0123] The outputter 1030 may output data related to estimation of the blood sugar of the user and estimation result data. According to an exemplary embodiment, the outputter 1030 may output the data related to estimation of the blood sugar of the user and the estimation result data using at least one of an acoustic method, a visual method, and a tactile method. For example, the outputter 1030 may output the data related to estimation of the blood sugar of the user and the estimation result data using a voice, a text, vibrations, etc. For this, the outputter 1030 may include a display, a speaker, a vibrator, etc. By way of an example, based on the estimation of the blood sugar level of the user, an alarm may be output when the estimation of the blood sugar level of the user exceeds a predetermined threshold. In an exemplary embodiment, the apparatus which detects the blood sugar level 1000 may be a specialized medical device which measures light reflected from the skin of the user to detect the user's sugar blood level, as described above by way of an example.

[0124] FIG. 11 is a flowchart illustrating a method of estimating blood sugar based on a heterogeneous spectrum according to an exemplary embodiment.

[0125] Referring to FIGS. 1 and 11, the heterogeneous spectrum-based blood sugar estimation apparatus 100 may generate a first type spectrum-blood sugar profile relationship model through machine learning based on training first type spectrum data and training blood sugar profile data (in operation 1110). Here, a first type spectrum may be a Raman spectrum for the skin and a blood sugar profile may be a trend of blood sugar level at predetermined times or a trend of blood sugar over time.

[0126] The heterogeneous spectrum-based blood sugar estimation apparatus 100 may estimate blood sugar profile data of a user using the generated first type spectrum-blood sugar profile relationship model (in operation 1120). For example, the heterogeneous spectrum-based blood sugar estimation apparatus 100 may obtain first type spectrum data for the skin of the user and may estimate blood sugar profile data of the user by inputting the obtained first type spectrum data into the first type spectrum-blood sugar profile relationship model.

[0127] The heterogeneous spectrum-based blood sugar estimation apparatus 100 may generate an individualized blood sugar estimation model through machine learning based on training second type spectrum data for the skin of the user and the estimated blood sugar profile data of the user (in operation 1130). Here, a second type spectrum may be an NIR spectrum.

[0128] For example, the heterogeneous spectrum-based blood sugar estimation apparatus 100 may generate the individualized blood sugar estimation model through machine learning with the training second type spectrum data for the skin of the user as an input and a blood sugar value corresponding to the training second type spectrum data as a target. Here, the blood sugar value corresponding to the training second type spectrum data may be calculated from the estimated blood sugar profile data of the user.

[0129] The heterogeneous spectrum-based blood sugar estimation apparatus 100 may estimate blood sugar of the user using the individualized blood sugar estimation model (in operation 1140). For example, the heterogeneous spectrum-based blood sugar estimation apparatus 100 may obtain the second type spectrum data for the skin of the user and may estimate the blood sugar of the user by inputting the obtained second type spectrum into the blood sugar estimation model.

[0130] FIG. 12 is a flowchart illustrating a method of generating a first type spectrum-based blood sugar profile relationship model according to an exemplary embodiment.

[0131] Referring to FIGS. 2 and 12, according to an exemplary embodiment, the first type spectrum-blood sugar profile relationship model generation apparatus 200 may obtain training first type spectrum data and training blood sugar profile data (in operation 1210). Here, a first type spectrum may be a Raman spectrum.

[0132] For example, the first type spectrum-blood sugar profile relationship model generation apparatus 200 may obtain training first type spectrum data and the training blood sugar profile data from a certain database or an external apparatus. Here, the training blood sugar profile data may be data obtained by performing an OGTT on a subject whose first type spectrum data has been measured.

[0133] The first type spectrum-blood sugar profile relationship model generation apparatus 200 may generate a first type spectrum-blood sugar profile relationship model through machine learning based on the obtained training first type spectrum data and training blood sugar profile data (in operation 1220). For example, the first type spectrum-blood sugar profile relationship model generation apparatus 200 may generate the first type spectrum-blood sugar profile relationship model through machine learning with the training first type spectrum data as an input and the training blood sugar profile data as a target or with the training first type spectrum data as an input and an AUC value calculated from the training blood sugar profile data as a target.

[0134] FIG. 13 is a flowchart illustrating a method of estimating a blood sugar profile according to an exemplary embodiment.

[0135] Referring to FIGS. 4 and 13, the blood sugar profile estimation apparatus 400 may estimate first type spectrum data for the skin of a user (in operation 1310). Here, a first type spectrum may be a Raman spectrum.

[0136] The blood sugar profile estimation apparatus 400 may estimate blood sugar profile data of the user based on the measured first type spectrum data and a stored first type spectrum-blood sugar profile relationship model (in operation 1320). Here, the first type spectrum-blood sugar profile relationship model may be generated through machine learning with training first type spectrum data as an input and training blood sugar profile data as a target or with training first type spectrum data as an input and an AUC value of a training blood sugar profile calculated from the training blood sugar profile data as a target.

[0137] According to an exemplary embodiment, when the first type spectrum-blood sugar profile relationship model may be generated through machine learning with the training first type spectrum data as the input and the training blood sugar profile data as the target, the blood sugar profile estimation apparatus 400 may estimate blood sugar profile data output by inputting the first type spectrum data into the first type spectrum-blood sugar profile relationship model as the blood sugar profile data of the user.

[0138] According to another exemplary embodiment, when the first type spectrum-blood sugar profile relationship model is generated through machine learning with the training first type spectrum data as the input and the AUC value of the blood sugar profile calculated from the training blood sugar profile data as the target, the blood sugar profile estimation apparatus 400 may estimate the blood sugar profile data of the user based on the AUC value output by inputting the measured first type spectrum data into the first type spectrum-blood sugar profile relationship model.

[0139] FIG. 14 is a flowchart illustrating a method of generating a blood sugar estimation model according to an exemplary embodiment.

[0140] Referring to FIGS. 7 and 14, the blood sugar estimation model generation apparatus 700 may obtain blood sugar profile data of a user (in operation 1410). Here, the blood sugar profile data of the user is estimated based on a first type spectrum-blood sugar profile relationship model and first type spectrum data for the skin of the user and may be obtained from a certain database or an external apparatus. Here, a first type spectrum may be a Raman spectrum.

[0141] Meanwhile, the first type spectrum-blood sugar profile relationship model may be generated through machine learning with training first type spectrum data as an input and training blood sugar profile data as a target or with training first type spectrum data as an input and an AUC value calculated from the training blood sugar profile data as a target. The training blood sugar profile data may be obtained by performing an OGTT on a subject whose training first type spectrum data has been measured.

[0142] The blood sugar estimation model generation apparatus 700 may measure training second type spectrum data for the skin of the user (in operation 1420). Here, a second type spectrum may be an NIR spectrum.

[0143] The blood sugar estimation model generation apparatus 700 may generate an individualized blood sugar estimation model based on the obtained blood sugar profile data of the user and the measured training second type spectrum data (in operation 1430). For example, the blood sugar estimation model generation apparatus 700 may generate the individualized blood sugar estimation model by calculating a blood sugar value corresponding to the training second type spectrum data from the blood sugar profile data of the user and through machine learning with the training second type spectrum as an input and the calculated blood sugar value as a target.

[0144] FIG. 15 is a flowchart illustrating a method of estimating blood sugar according to an exemplary embodiment.

[0145] Referring to FIGS. 9 and 15, the blood sugar estimation apparatus 900 may estimate second type spectrum data for the skin of a user (in operation 1510). Here, a second type spectrum may be an NIR spectrum.

[0146] The blood sugar estimation apparatus 900 may estimate blood sugar of the user based on the measured second type spectrum data and a stored individualized blood sugar estimation model (in operation 1520). Here, the individualized blood sugar estimation model may be generated based on blood sugar profile data of the user estimated by a first type spectrum-blood sugar profile relationship model and first type spectrum data for the skin of the user and training second type spectrum data. For example, the individualized blood sugar estimation model may be generated by calculating a blood sugar value corresponding to the training second type spectrum data from the estimated blood sugar profile data of the user and through machine learning with the training second type spectrum as an input and the calculated blood sugar value as a target.

[0147] Meanwhile, the first type spectrum-blood sugar profile relationship model may be generated through machine learning with training first type spectrum data as an input and training blood sugar profile data as a target or with training first type spectrum data as an input and an AUC value of a training blood sugar profile calculated from the training blood sugar profile data as a target.

[0148] Some aspects of the present disclosure can be implemented as computer readable codes in a computer readable record medium. Codes and code segments constituting the computer program can be easily inferred by a skilled computer programmer in the art. The computer readable record medium includes all types of record media in which computer readable data are stored. Examples of the computer readable record medium include a ROM, a RAM, a CD-ROM, a magnetic tape, a floppy disk, and an optical data storage. Further, the record medium may be implemented in the form of a carrier wave such as Internet transmission. In addition, the computer readable record medium may be distributed to computer systems over a network, in which computer readable codes may be stored and executed in a distributed manner.

[0149] A number of examples have been described above. Nevertheless, it will be understood that various modifications may be made. For example, suitable results may be achieved if the described techniques are performed in 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.

[0150] The scope of protection is defined by the appended claims.

Claims

1. A blood sugar model generation apparatus (800) comprising:

   a data obtainer (710) configured to calculate blood sugar profile data of a user based on a first type spectrum-blood sugar profile relationship model and a first type spectrum data for a skin of the user;
   a second type spectrum measurer (720) configured to measure training second type spectrum data for the skin of the user;
   a processor (730) configured to generate an individualized blood sugar model based on the calculated blood sugar profile data and the measured training second type spectrum data; and
   an outputter (840) configured to output the generated individualized blood sugar model.

2. The blood sugar model generation apparatus (800) of claim 1, wherein a first type spectrum is a Raman spectrum, and a second type spectrum is a near infrared, NIR, spectrum.

3. The blood sugar model generation apparatus (800) of claim 1 or 2, further comprising a first type spectrum-blood sugar profile relationship model generator (110) configured to generate the first type spectrum-blood sugar profile relationship model through machine learning based on training first type spectrum data and training blood sugar profile data.

4. The blood sugar model generation apparatus (800) of claim 3,
   wherein the training blood sugar profile data is oral glucose tolerance test, OGTT, data obtained from a subject whose said training first type spectrum data has been measured, or
   wherein the first type spectrum-blood sugar profile relationship model generator (110) is configured to generate the first type spectrum-blood sugar profile relationship model through machine learning with the training of first type spectrum data as an input and the training blood sugar profile data as a target, or
   wherein the first type spectrum-blood sugar profile relationship model generator (110) is configured to generate the first type spectrum-blood sugar profile relationship model
   through machine learning with the training first type spectrum data as an input and an area under the curve, AUC, value calculated from the training blood sugar profile data as a target, or
   wherein the machine learning comprises a machine learning algorithm selected from among 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.

5. The blood sugar model generation apparatus (800) of one of claims 1 to 4, wherein the second type spectrum measurer (720) comprises:

   a light source (721) configured to emit light to the skin of the user; and
   a spectroscope (722) configured to detect absorbed, scattered, or reflected light from the skin of the user and measure the training second type spectrum data based on the detected light.

6. The blood sugar model generation apparatus (800) of one of claims 1 to 5, wherein the processor (730) is further configured to generate the individualized blood sugar model through machine learning, and
   wherein the processor (730) is further configured to generate the individualized blood sugar model by calculating a blood sugar value corresponding to the measured training second type spectrum data from the calculated blood sugar profile data and through the machine learning with the training second type spectrum data as an input and the calculated blood sugar value as a target.

7. Method of providing a blood sugar model comprising the steps of:

   obtaining (1210) training first type spectrum data and training blood sugar profile data;
   generating (1220) a first type spectrum-blood sugar profile relationship model based on the obtained training first type spectrum data and the training blood sugar profile data;
   measuring (1310) first type spectrum data for a skin of a user;
   calculating (1320) a blood sugar profile data of the user based on the first type spectrum-blood sugar profile relationship model and the measured first type spectrum data;
   measuring (1420) training second type spectrum data for the skin of the user;
   generating (1430) an individualized blood sugar model based on the calculated blood sugar profile data and the measured training second type spectrum data; and
   outputting the generated individualized blood sugar model.

8. The method of claim 7, further comprising generating (1220) the first type spectrum-blood sugar profile re-

lationship model through machine learning based on training the first type spectrum data and the training blood sugar profile data.

9. The method of claim 8, wherein the training blood sugar profile data is obtained by performing an oral glucose tolerance test, OGTT, on a subject whose said training of the first type spectrum data has been measured, or
generating (1220) the first type spectrum-blood sugar profile relationship model through machine learning with the training first type spectrum data as an input and the training blood sugar profile data as a target, or
generating (1220) the first type spectrum-blood sugar profile relationship model through machine learning with the training first type spectrum data as an input and an area under the curve, AUC, value calculated from the training blood sugar profile data as a target, or
wherein the machine learning comprises a machine learning algorithm selected from among 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.

10. The method of claim 7, wherein the step of measuring (1310) first type spectrum comprises:

placing a light source configured to emit light to the skin of the user; and
detecting absorbed, scattered, or reflected light from the skin of the user and measuring (1310) the first type spectrum data based on the detected light.

11. The method of claim 10, further comprising: generating (1220) the first type spectrum-blood sugar profile relationship model through machine learning with the training first type spectrum data as an input and training blood sugar profile data as a target,
wherein a processor (730) is further configured to calculate (1320) the blood sugar profile of the user by a blood sugar profile output by inputting the measured first type spectrum data into the first type spectrum-blood sugar profile relationship model, or
generating (1220) the first type spectrum-blood sugar profile relationship model through machine learning with training first type spectrum data as an input and an area under the curve, AUC, value calculated from training blood sugar profile data as a target, and
wherein the processor (730) is further configured to calculate (1320) the blood sugar profile of the user based on the AUC value output by inputting the measured first type spectrum data into the first type spectrum-blood sugar profile relationship model,
wherein the processor (730) is further configured to adjust a reference blood sugar profile to allow the AUC value of the reference blood sugar profile to be the output AUC value and to calculate (1320) a blood sugar profile data of the user by the data of the adjusted reference blood sugar profile.

12. The method of any of claims 7 to 11, further comprising the steps of:

measuring (1510) second type spectrum data for the skin of the user; and
calculating (1520) blood sugar of the user based on the measured second type spectrum data and the individualized blood sugar model.

Patentansprüche

1. Vorrichtung zur Erzeugung eines Blutzuckerspiegelmodells (800), mit:

einer Datenermittlungseinheit (710), die ausgebildet ist, Blutzuckerspiegelprofildaten eines Benutzers auf der Grundlage eines Modells der Beziehung zwischen einem ersten Spektrumstyp und dem Blutzuckerspiegelprofil und Daten des ersten Spektrumstyps für eine Haut des Benutzers zu berechnen;
einer Messeinheit für einen zweiten Spektrumstyp (720), die ausgebildet ist, Trainingsdaten für den zweiten Spektrumstyp für die Haut des Benutzers zu messen;
einem Prozessor (730), der ausgebildet ist, ein individualisiertes Blutzuckerspiegelmodell auf der Grundlage der berechneten Blutzuckerspiegelprofildaten und der gemessenen Trainingsdaten für den zweiten Spektrumstyp zu erzeugen; und
eine Ausgabeeinheit (840), die ausgebildet ist, das erzeugte individualisierte Blutzuckerspiegelmodell auszugeben.

2. Vorrichtung zur Erzeugung eines Blutzuckerspiegelmodells (800) nach Anspruch 1, wobei ein erster Spektrumstyp ein Rahman-Spektrum und ein zweiter Spektrumstyp ein Spektrum im nahen Infrarotbereich, NIR, ist.

3. Vorrichtung zur Erzeugung eines Blutzuckerspiegelmodells (800) nach Anspruch 1 oder 2, die ferner aufweist: eine Erzeugungseinheit für ein Modell der Beziehung zwischen einem ersten Spektrumstyp und einem Blutzuckerspiegelprofil (110), die ausgebildet ist, das Modell der Beziehung zwischen dem ersten Spektrumstyp und dem Blutzuckerspiegelprofil durch Maschinenlernen auf der Grundlage von Trainingsdaten des ersten Spektrumstyps und Trainingsdaten für das Blutzuckerspiegelprofil zu erzeugen.

4. Vorrichtung zur Erzeugung eines Blutzuckerspiegelmodells (800) nach Anspruch 3, wobei die Trainingsdaten für das Blutzuckerspiegelprofil Daten aus einem oralen Glukosetoleranztest, OGTT, sind, die von einem Objekt erhalten werden, dessen Trainingsdaten für den ersten Spektrumstyp gemessen worden sind, oder
wobei die Erzeugungseinheit für ein Modell der Beziehung zwischen dem ersten Spektrumstyp und dem Blutzuckerspiegelprofil (110) ausgebildet ist, das Modell der Beziehung zwischen dem ersten Spektrumstyp und dem Blutzuckerspiegelprofil durch Maschinenlernen zu erzeugen, wobei die Trainingsdaten des ersten Spektrumstyps als Eingangsdaten dienen und die Trainingsdaten für das Blutzuckerspiegelprofil als Sollwert dienen, oder
wobei die Erzeugungseinheit für ein Modell der Beziehung zwischen dem ersten Spektrumstyp und dem Blutzuckerspiegelprofil (110) ausgebildet ist, das Modell der Beziehung zwischen dem ersten Spektrumstyp und dem Blutzuckerspiegelprofil durch ein Maschinenlernen zu erzeugen, wobei die Trainingsdaten für den ersten Spektrumstyp Eingangsdaten sind und ein Wert für die Fläche unter der Kurve, AUC, aus den Trainingsdaten für das Blutzuckerspiegelprofil ein Sollwert ist, oder
wobei das Maschinenlernen umfasst: einen Maschinenlern-Algorithmus, der ausgewählt ist aus: Regression der teilweise kleinsten Quadrate, lineare Regression, neuronales Netzwerk, Entscheidungsbaum, genetischer Algorithmus, genetische Programmierung, K-nächster Nachbar, Netzwerk aus radialen Basisfunktionen, zufälliges Lernen, Forest-Lernen, Unterstützungsvektormaschine und tiefes Lernen.

5. Vorrichtung zur Erzeugung eines Blutzuckerspiegelmodells (800) nach einem der Ansprüche 1 bis 4, wobei die Messeinheit für den zweiten Spektrumstyp (720) umfasst:

   eine Lichtquelle (721), die zum Aussenden von Licht auf die Haut des Benutzers ausgebildet ist; und
   ein Spektroskop (722), das ausgebildet ist, absorbiertes, gestreutes oder reflektiertes Licht von der Haut des Benutzers zu erfassen und die Trainingsdaten für den zweiten Spektrumstyp auf der Grundlage des erfassten Lichts zu messen.

6. Vorrichtung zur Erzeugung eines Blutzuckerspiegelmodells (800) nach einem der Ansprüche 1 bis 5, wobei der Prozessor (730) ferner ausgebildet ist, das individualisierte Blutzuckerspiegelmodell durch Maschinenlernen zu erzeugen, und
wobei der Prozessor (730) ferner ausgebildet ist, das individualisierte Blutzuckerspiegelmodell zu erzeugen durch Berechnung eines Blutzuckerspiegelwerts, der den gemessenen Trainingsdaten des zweiten Spektrumstyps entspricht, aus den berechneten Blutzuckerspiegelprofildaten, und durch Maschinenlernen, in welchem die Trainingsdaten für den zweiten Spektrumstyp als Eingangsdaten dienen und der berechnete Blutzuckerspiegelwert als ein Sollwert dient.

7. Verfahren zur Bereitstellung eines Blutzuckerspiegelmodells mit den Schritten:

   Erhalten (1210) von Trainingsdaten eines ersten Spektrumstyps und von Trainingsdaten eines Blutzuckerspiegelprofils;
   Erzeugen (1220) eines Modells der Beziehung zwischen dem ersten Spektrumstyp und dem Blutzuckerspiegelprofil auf der Grundlage der erhaltenen Trainingsdaten für den ersten Spektrumstyp und der Trainingsdaten für das Blutzuckerspiegelprofil;
   Messen (1310) von Daten des ersten Spektrumstyps für eine Haut eines Benutzers;
   Berechnen (1320) von Blutzuckerspiegelprofildaten des Benutzers auf der Grundlage des Modells der Beziehung zwischen dem ersten Spektrumstyp und dem Blutzuckerspiegelprofil und auf der Grundlage der gemessenen Daten für den ersten Spektrumstyp;
   Messen (1420) von Trainingsdaten für einen zweiten Spektrumstyp für die Haut des Benutzers;
   Erzeugen (1430) eines individualisierten Blutzuckerspiegelmodells auf der Grundlage der berechneten Blutzuckerspiegelprofildaten und der gemessenen Trainingsdaten für den zweiten Spektrumstyp; und
   Ausgeben des erzeugten individualisierten Blutzuckerspiegelmodells.

8. Verfahren nach Anspruch 7, das ferner umfasst: Erzeugen (1220) des Modells der Beziehung zwischen dem ersten Spektrumstyp und dem Blutzuckerspiegelprofil durch Maschinenlernen auf der Grundlage des Trainierens der Daten für den ersten Spektrumstyp und des Trainierens der Daten für das Blutzuckerspiegelprofil.

9. Verfahren nach Anspruch 8, wobei die Trainingsdaten für das Blutzuckerspiegelprofil erhalten werden durch Ausführen eines oralen Glukosetoleranztest, OGTT, an einem Objekt, dessen Trainingsdaten für den ersten Spektrumstyp gemessen worden sind, oder
Erzeugen (1220) des Modells der Beziehung zwi-

schen dem ersten Spektrumstyp und dem Blutzuckerspiegelprofil durch Maschinenlernen mit den Trainingsdaten für den ersten Spektrumstyp als Eingangswerte und den Trainingsdaten für das Blutzuckerspiegelprofil als Sollwert, oder
Erzeugen (1220) des Modells der Beziehung zwischen dem ersten Spektrumstyp und dem Blutzuckerspiegelprofil durch Maschinenlernen, wobei die Trainingsdaten für den ersten Spektrumstyp als Eingangsdaten dienen und ein Wert der Fläche unter der Kurve, AUT, der aus den Trainingsdaten für das Blutzuckerspiegelprofil berechnet wird, als ein Sollwert dient, oder
wobei das Maschinenlernen umfasst: einen Maschinenlern-Algorithmus, der ausgewählt ist aus: Regression der teilweise kleinsten Quadrate, lineare Regression, neuronales Netzwerk, Entscheidungsbaum, genetischer Algorithmus, genetische Programmierung, K-nächster Nachbar, Netzwerk aus radialen Basisfunktionen, zufälliges Lernen, Forest-Lernen, Unterstützungsvektormaschine und tiefes Lernen.

10. Verfahren nach Anspruch 7, wobei der Schritt des Messens (1310) des ersten Spektrumstyps umfasst:

Positionieren einer Lichtquelle, die ausgebildet ist, Licht auf die Haut des Benutzers auszusenden; und
Erfassen von absorbiertem, gestreutem oder reflektiertem Licht aus der Haut des Benutzers und Messen (1310) der Daten des ersten Spektrumstyps auf der Grundlage des erfassten Lichts.

11. Verfahren nach Anspruch 10, das ferner umfasst: Erzeugen (1220) des Modells der Beziehung zwischen dem ersten Spektrumstyp und dem Blutzuckerspiegelprofil durch Maschinenlernen, wobei die Trainingsdaten des ersten Spektrumstyps als Eingangswerte und die Trainingsdaten für das Blutzuckerspiegelprofil als ein Sollwert dienen,
wobei ein Prozessor (730) ferner ausgebildet ist, das Blutzuckerspiegelprofil des Benutzers durch ein Blutzuckerspiegelprofil zu berechnen durch Eingeben der gemessenen Daten für den ersten Spektrumstyp in das Modell der Beziehung zwischen dem ersten Spektrumstyp und dem Blutzuckerspiegelprofil, oder
Erzeugen (1220) des Modells der Beziehung zwischen dem ersten Spektrumstyp und dem Blutzuckerspiegelprofil durch Maschinenlernen mit Trainingsdaten für den ersten Spektrumstyp als Eingangswerte und einem Wert für eine Fläche unter der Kurve, AUC, der aus den Trainingsdaten für das Blutzuckerspiegelprofil berechnet wird, als ein Sollwert, und wobei der Prozessor (730) ferner ausgebildet ist, das Blutzuckerspiegelprofil des Benutzers auf der Grundlage des ausgegebenen AUC-Werts zu berechnen durch Eingeben der gemessenen Daten für den ersten Spektrumstyp in das Modell der Beziehung zwischen dem ersten Spektrumstyp und dem Blutzuckerspiegelprofil,
wobei der Prozessor (730) ferner ausgebildet ist, ein Referenzblutzuckerspiegelprofil derart einzustellen, dass es möglich ist, dass der AUC-Wert des Referenzblutzuckerspiegelprofils der ausgegebene AUC-Wert ist, und Blutzuckerspiegelprofildaten des Benutzers durch die Daten des eingestellten Referenzblutzuckerspiegelprofils zu berechnen (1320).

12. Verfahren nach einem der Ansprüche 7 bis 11, das ferner die Schritte umfasst:

Messen (1510) von Daten eines zweiten Spektrumstyps für die Haut des Benutzers; und
Berechnen (1520) des Blutzuckerspiegels des Benutzers auf der Grundlage der gemessenen Daten für den zweiten Spektrumstyp und des individualisierten Blutzuckerspiegelmodells.

Revendications

1. Appareil de génération de modèle de glycémie (800) comprenant :

un obtenteur de données (710) configuré pour calculer des données du profil glycémique d'un utilisateur sur base d'un modèle de relation de profil glycémique de spectre de premier type et de données de spectre de premier type pour la peau de l'utilisateur ;
un dispositif de mesure de spectre de deuxième type (720) configuré pour mesurer des données de spectre de deuxième type d'apprentissage pour la peau de l'utilisateur ;
un processeur (730) configuré pour générer un modèle de glycémie individualisé sur base des données de profil glycémique calculées et des données de spectre de deuxième type d'apprentissage mesurées ; et
un dispositif de sortie (840) configuré pour sortir le modèle de glycémie individualisé généré.

2. Appareil de génération de modèle de glycémie (800) selon la revendication 1, dans lequel un spectre de premier type est un spectre de Raman, et un spectre de deuxième type est un spectre dans l'infrarouge proche NIR, soit Near InfraRed.

3. Appareil de génération de modèle de glycémie (800) selon la revendication 1 ou 2, comprenant en outre un générateur de modèle de relation de profil glycémique de spectre de premier type (110) configuré pour générer le modèle de relation de profil glycémique de spectre de premier type via apprentissage automatique sur base de données de spectre de premier type d'apprentissage et de données de profil glycémique d'apprentissage.

4. Appareil de génération de modèle de glycémie (800) selon la revendication 3,
dans lequel les données de profil glycémique d'apprentissage sont des données de test oral de tolérance au glucose OGTT, soit Oral Glucose Tolerance Test, obtenues sur un sujet dont lesdites données de spectre de premier type d'apprentissage ont été mesurées, ou
dans lequel le générateur de modèle de relation de profil glycémique de spectre de premier type (110) est configuré pour générer le modèle de relation de profil glycémique de spectre de premier type via apprentissage automatique avec l'apprentissage de données de spectre de premier type comme entrée et les données de profil glycémique d'apprentissage comme cible, ou
dans lequel le générateur de modèle de relation de profil glycémique de spectre de premier type (110) est configuré pour générer le modèle de relation de profil glycémique de spectre de premier type via apprentissage automatique avec les données de spectre de premier type d'apprentissage comme entrée et une valeur de l'aire sous la courbe AUC, soit Area Under the Curve, calculée à partir des données de profil glycémique d'apprentissage comme cible, ou
dans lequel l'apprentissage automatique comprend un algorithme d'apprentissage automatique sélectionné parmi une régression des moindres carrés partiels, une régression linéaire, un réseau neuronal, un arbre de décision, un algorithme génétique, une programmation génétique, une méthode des k plus proches voisins, un réseau à fonctions de base radiales, une fonction aléatoire, une forêt, une machine à vecteurs de support et un apprentissage profond.

5. Appareil de génération de modèle de glycémie (800) selon l'une des revendications 1 à 4, dans lequel le dispositif de mesure de spectre de deuxième type (720) comprend :

une source lumineuse (721) configurée pour émettre de la lumière sur la peau de l'utilisateur ; et
un spectroscope (722) configuré pour détecter de la lumière absorbée, dispersée ou réfléchie par la peau de l'utilisateur et pour mesurer les données de spectre de deuxième type d'apprentissage sur base de la lumière détectée.

6. Appareil de génération de modèle de glycémie (800) selon l'une des revendications 1 à 5,
dans lequel le processeur (730) est en outre configuré pour générer le modèle de glycémie individualisé via un apprentissage automatique, et
dans lequel le processeur (730) est en outre configuré pour générer le modèle de glycémie individualisé en calculant une valeur de glycémie correspondant aux données de spectre de deuxième type d'apprentissage mesurées à partir des données de profil glycémique calculées et via l'apprentissage automatique avec les données de spectre de deuxième type d'apprentissage comme entrée et la valeur de glycémie calculée comme cible.

7. Procédé de fourniture d'un modèle de glycémie comprenant les étapes suivantes :

obtention (1210) de données de spectre de premier type d'apprentissage et de données de profil glycémique d'apprentissage ;
génération (1220) d'un modèle de relation de profil glycémique de spectre de premier type sur base des données de spectre de premier type d'apprentissage obtenues et des données de profil glycémique d'apprentissage ;
mesure (1310) de données de spectre de premier type pour la peau d'un utilisateur ;
calcul (1320) de données de profil glycémique de l'utilisateur sur base du modèle de relation de profil glycémique de spectre de premier type et des données de spectre de premier type mesurées ;
mesure (1420) de données de spectre de deuxième type d'apprentissage pour la peau de l'utilisateur ;
génération (1430) d'un modèle de glycémie individualisé sur base des données de profil glycémique calculées et des données de spectre de deuxième type d'apprentissage mesurées ; et
sortie du modèle de glycémie individualisé généré.

8. Procédé selon la revendication 7, comprenant en outre la génération (1220) du modèle de relation de profil glycémique de spectre de premier type via apprentissage automatique sur base de l'apprentissage des données de spectre de premier type et des données de profil glycémique d'apprentissage.

9. Procédé selon la revendication 8, dans lequel les données de profil glycémique d'apprentissage sont obtenues par
la mise en oeuvre d'un test oral de tolérance au glucose OGTT sur un sujet dont ledit apprentissage des données de spectre de premier type ont été mesurées, ou
la génération (1220) du modèle de relation de profil glycémique de spectre de premier type via apprentissage automatique avec les données de spectre de premier type d'apprentissage comme entrée et les données de profil glycémique d'apprentissage

comme cible, ou
la génération (1220) du modèle de relation de profil glycémique de spectre de premier type via apprentissage automatique avec les données de spectre de premier type d'apprentissage comme entrée et une valeur de l'aire sous la courbe AUC calculée à partir des données de profil glycémique d'apprentissage comme cible, ou
dans lequel l'apprentissage automatique comprend un algorithme d'apprentissage automatique sélectionné parmi une régression des moindres carrés partiels, une régression linéaire, un réseau neuronal, un arbre de décision, un algorithme génétique, une programmation génétique, une méthode des k plus proches voisins, un réseau à fonctions de base radiales, une fonction aléatoire, une forêt, une machine à vecteurs de support et un apprentissage profond.

10. Procédé selon la revendication 7, dans lequel l'étape de mesure (1310) de spectre de premier type comprend :

le placement d'une source lumineuse configurée pour émettre de la lumière sur la peau de l'utilisateur ; et
la détection de lumière absorbée, dispersée ou réfléchie provenant de la peau de l'utilisateur et la mesure (1310) des données de spectre de premier type sur base de la lumière détectée.

11. Procédé selon la revendication 10, comprenant en outre :

la génération (1220) du modèle de relation de profil glycémique de spectre de premier type via apprentissage automatique avec les données de spectre de premier type d'apprentissage comme entrée et les données de profil glycémique d'apprentissage comme cible,
dans lequel un processeur (730) est en outre configuré pour calculer (1320) le profil glycémique de l'utilisateur à partir d'une sortie de profil glycémique en entrant les données de spectre de premier type mesurées dans le modèle de relation de profil glycémique de spectre de premier type, ou
la génération (1220) du modèle de relation de profil glycémique de spectre de premier type via apprentissage automatique avec des données de spectre de premier type d'apprentissage comme entrée et une valeur de l'aire sous la courbe AUC calculée à partir de données de profil glycémique d'apprentissage comme cible, et dans lequel le processeur (730) est en outre configuré pour calculer (1320) le profil glycémique de l'utilisateur sur base de la valeur AUC sortie en entrant les données de spectre de premier type mesurées dans le modèle de relation de profil glycémique de spectre de premier type, dans lequel le processeur (730) est en outre configuré pour ajuster un profil glycémique de référence pour permettre à la valeur AUC du profil glycémique de référence d'être la valeur AUC de sortie et pour calculer (1320) des données de profil glycémique de l'utilisateur à partir des données du profil glycémique de référence ajusté.

12. Procédé selon l'une quelconque des revendications 7 à 11, comprenant en outre les étapes suivantes :

mesure (1510) de données de spectre de deuxième type pour la peau de l'utilisateur ; et
calcul (1520) de la glycémie de l'utilisateur sur base des données de spectre de deuxième type mesurées et du modèle de glycémie individualisé.

FIG. 1

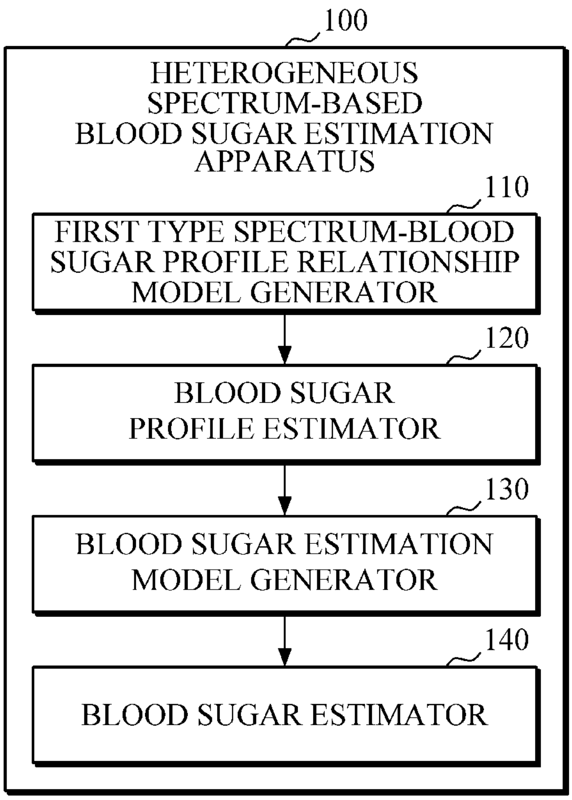

100
HETEROGENEOUS SPECTRUM-BASED BLOOD SUGAR ESTIMATION APPARATUS
110
FIRST TYPE SPECTRUM-BLOOD SUGAR PROFILE RELATIONSHIP MODEL GENERATOR
120
BLOOD SUGAR PROFILE ESTIMATOR
130
BLOOD SUGAR ESTIMATION MODEL GENERATOR
140
BLOOD SUGAR ESTIMATOR

FIG. 2

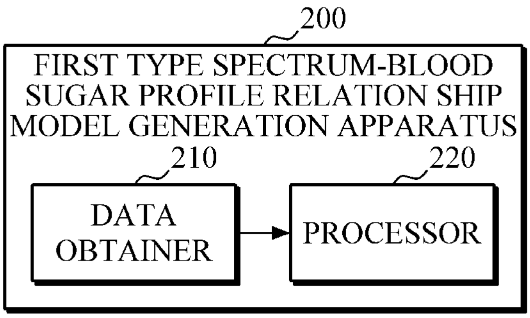
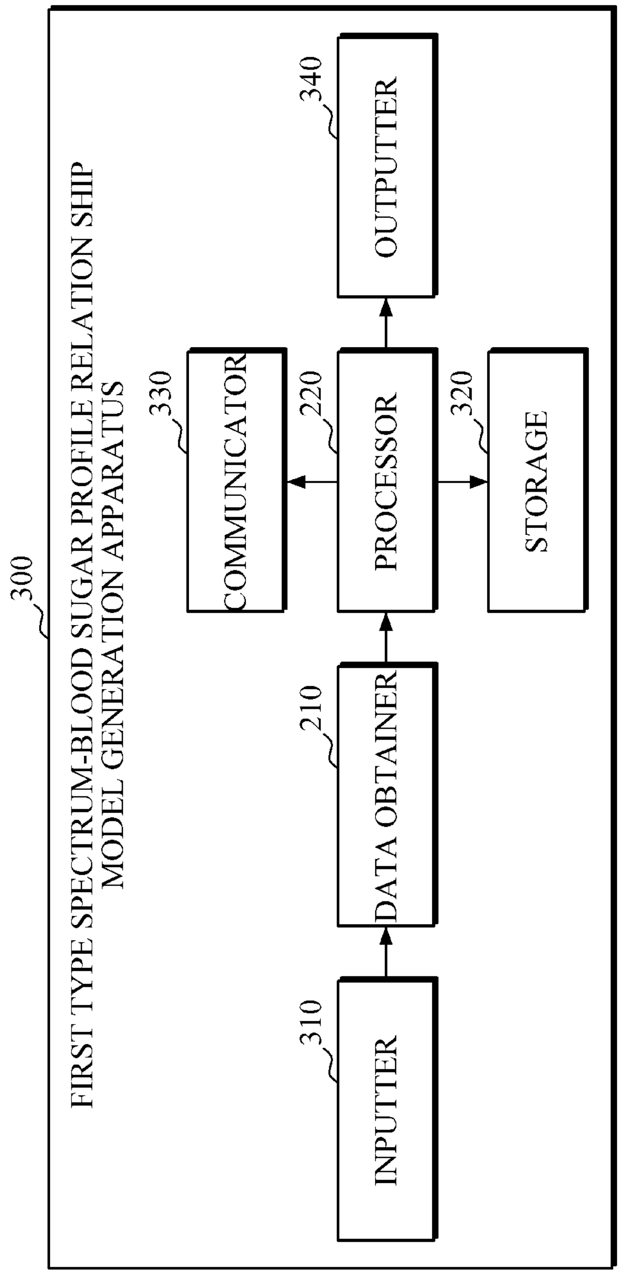

200
FIRST TYPE SPECTRUM-BLOOD SUGAR PROFILE RELATION SHIP MODEL GENERATION APPARATUS
210
DATA OBTAINER
220
PROCESSOR

FIG. 3



300
FIRST TYPE SPECTRUM-BLOOD SUGAR PROFILE RELATION SHIP MODEL GENERATION APPARATUS
310
INPUTTER
210
DATA OBTAINER
330
COMMUNICATOR
220
PROCESSOR
320
STORAGE
340
OUTPUTTER

FIG. 4

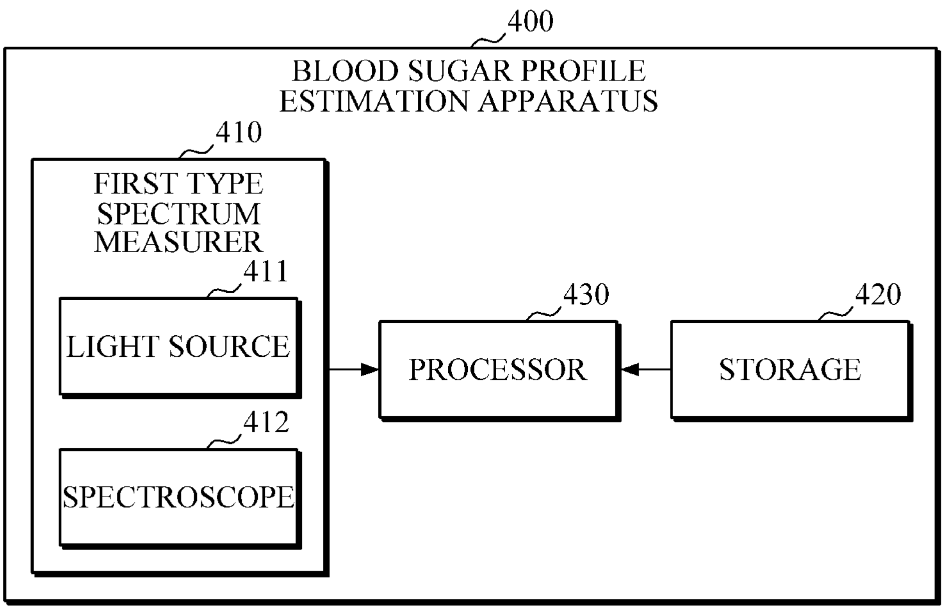

400
BLOOD SUGAR PROFILE
ESTIMATION APPARATUS
410
FIRST TYPE
SPECTRUM
MEASURER
411
LIGHT SOURCE
412
SPECTROSCOPE
430
PROCESSOR
420
STORAGE

FIG. 5

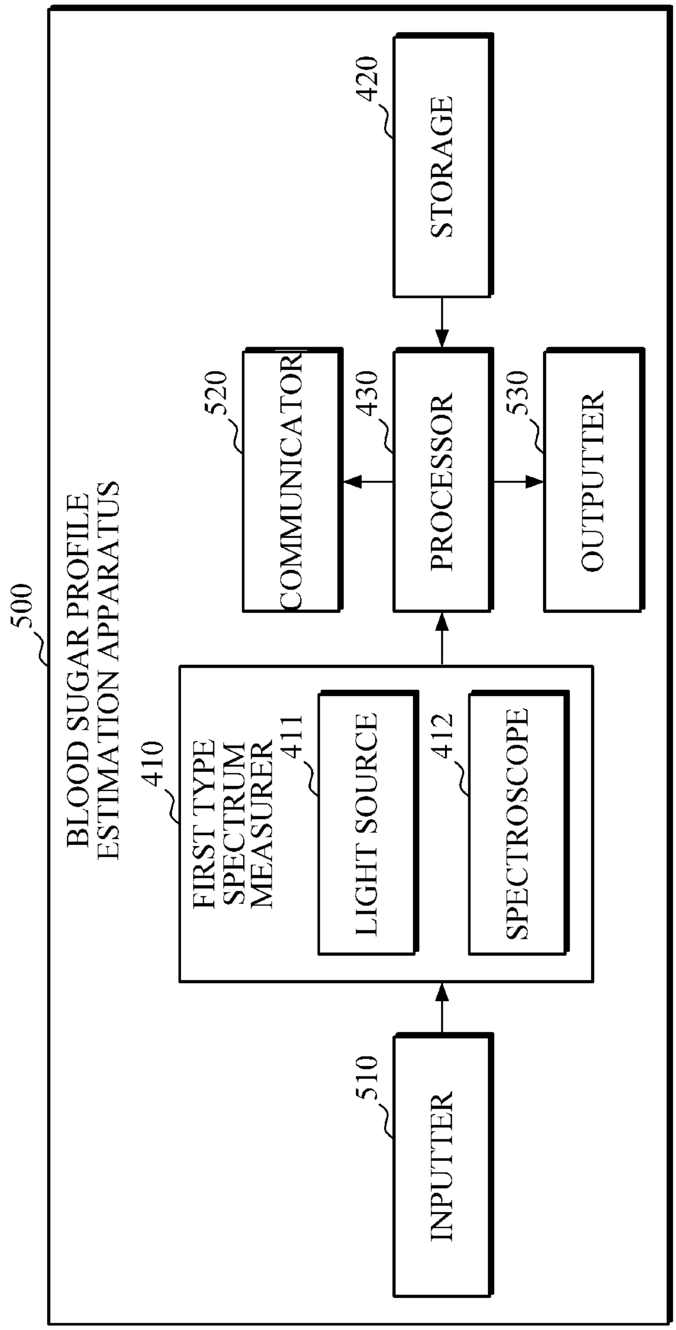
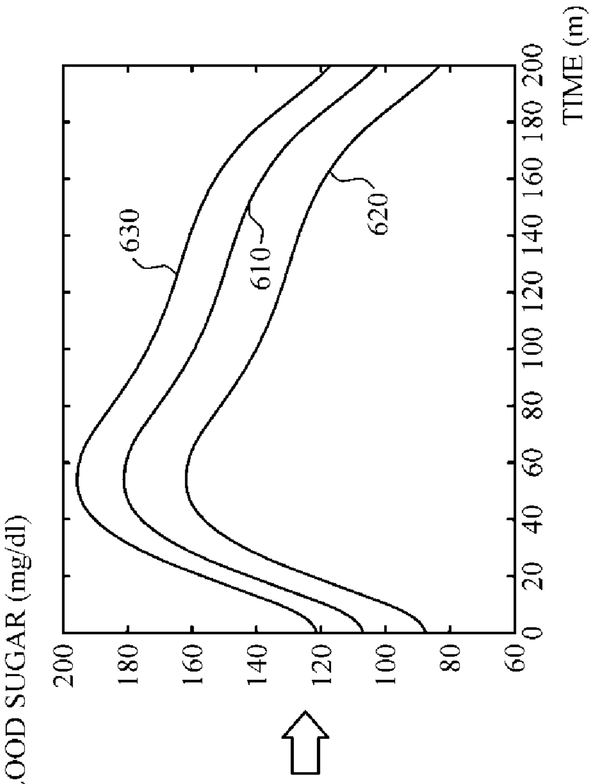

500
BLOOD SUGAR PROFILE ESTIMATION APPARATUS
410
FIRST TYPE SPECTRUM MEASURER
411
LIGHT SOURCE
412
SPECTROSCOPE
510
INPUTTER
420
STORAGE
520
COMMUNICATOR
430
PROCESSOR
530
OUTPUTTER

FIG. 6



BLOOD SUGAR PROFILE	AUC
Case 1	90
Case 2	110

FIG. 7

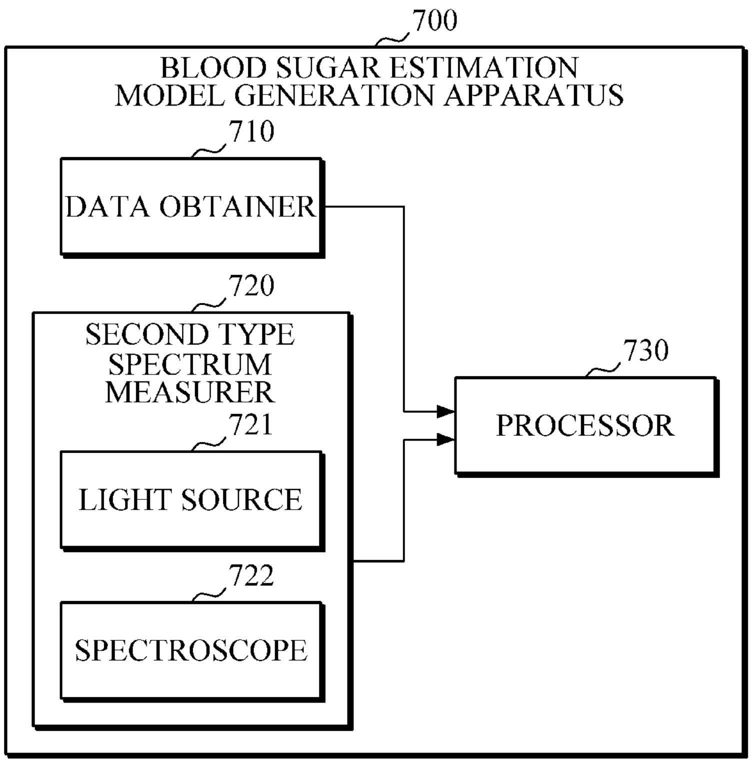

700
BLOOD SUGAR ESTIMATION
MODEL GENERATION APPARATUS
710
DATA OBTAINER
720
SECOND TYPE
SPECTRUM
MEASURER
721
LIGHT SOURCE
722
SPECTROSCOPE
730
PROCESSOR

FIG. 8

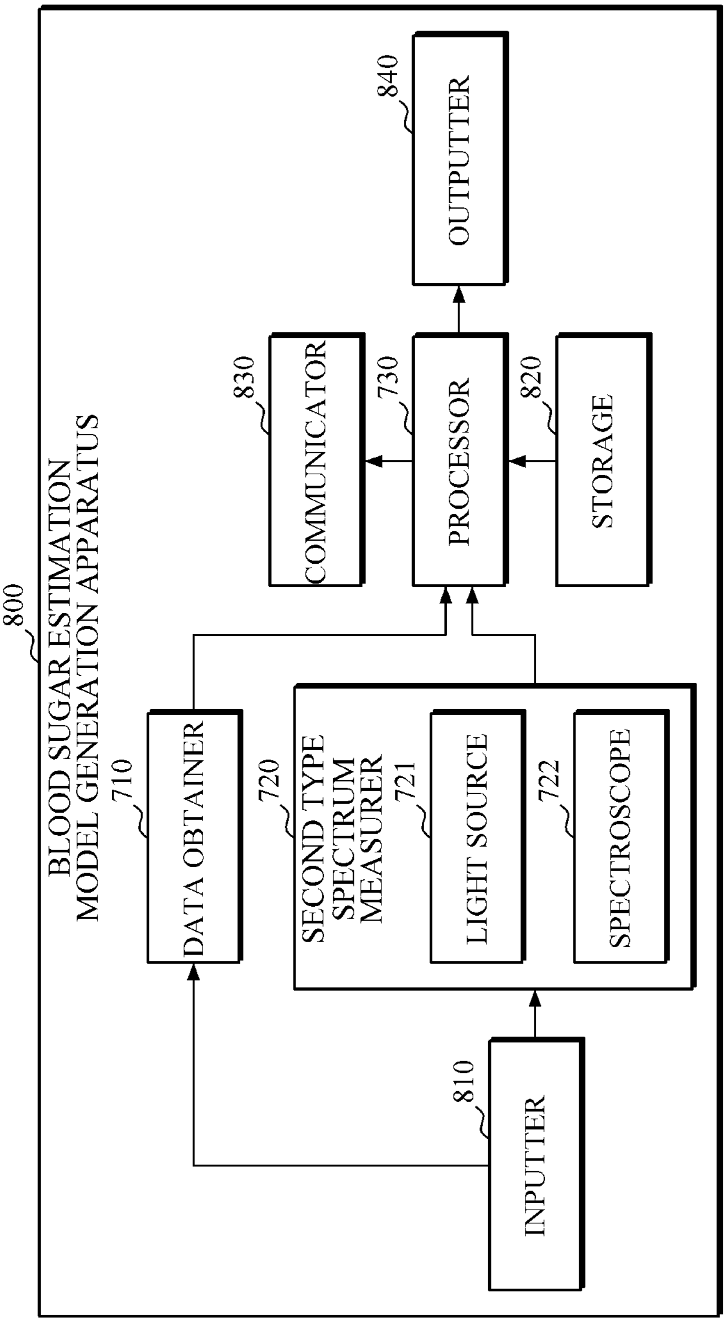

800
BLOOD SUGAR ESTIMATION
MODEL GENERATION APPARATUS
710
DATA OBTAINER
720
SECOND TYPE
SPECTRUM
MEASURER
721
LIGHT SOURCE
722
SPECTROSCOPE
810
INPUTTER
830
COMMUNICATOR
730
PROCESSOR
820
STORAGE
840
OUTPUTTER

FIG. 9

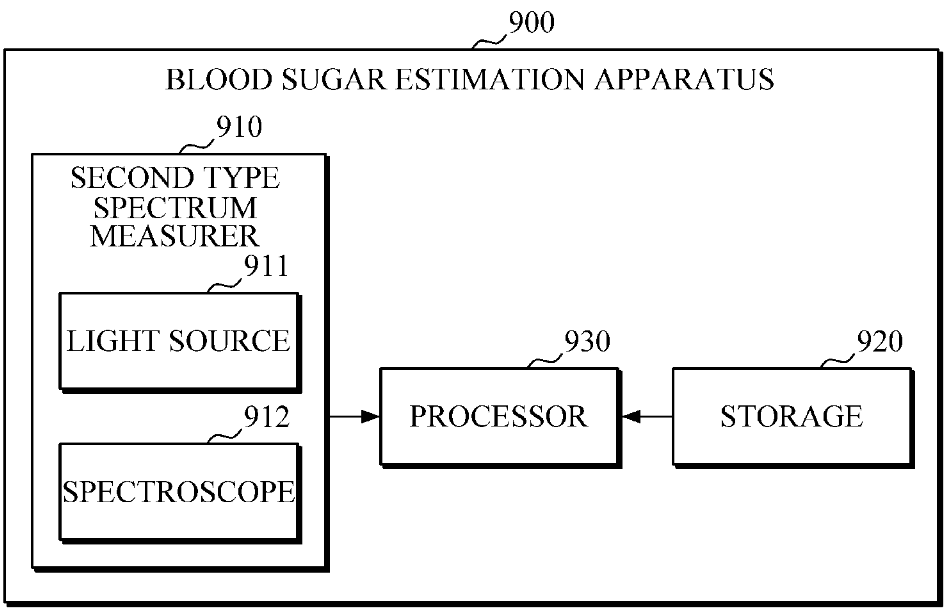

900
BLOOD SUGAR ESTIMATION APPARATUS
910
SECOND TYPE SPECTRUM MEASURER
911
LIGHT SOURCE
912
SPECTROSCOPE
930
PROCESSOR
920
STORAGE

FIG. 10

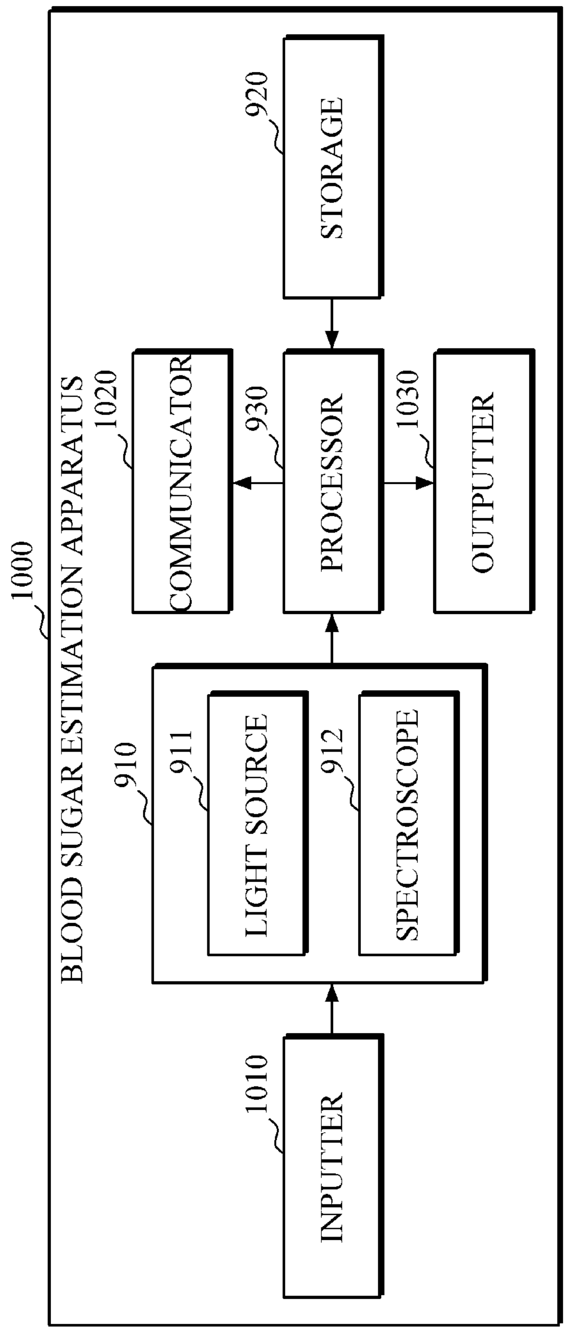

1000
BLOOD SUGAR ESTIMATION APPARATUS
1010
INPUTTER
910
911
LIGHT SOURCE
912
SPECTROSCOPE
1020
COMMUNICATOR
930
PROCESSOR
1030
OUTPUTTER
920
STORAGE

FIG. 11

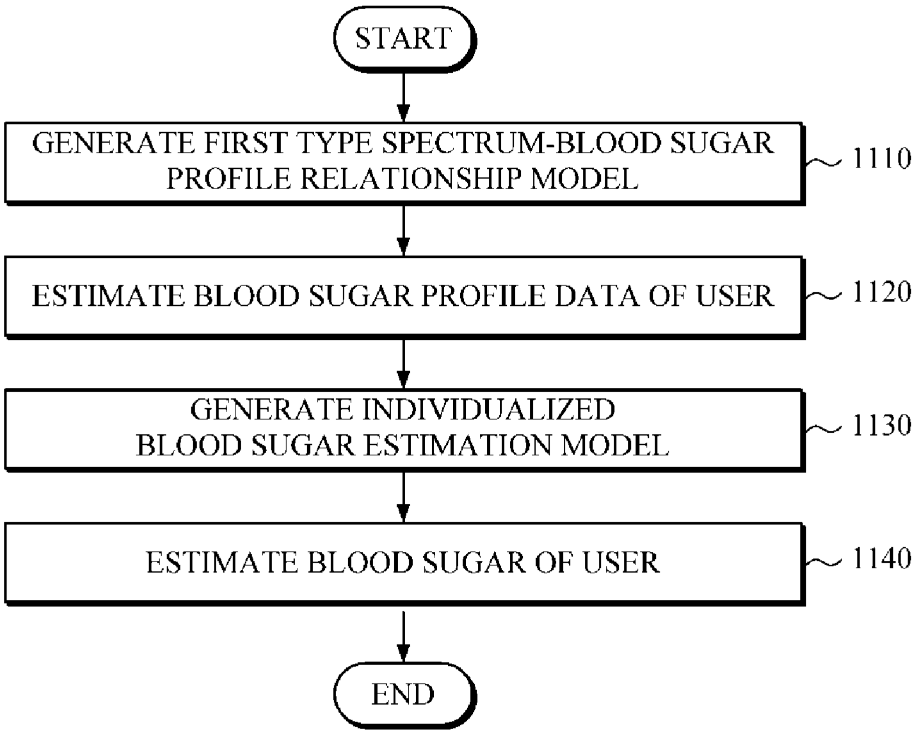

START
GENERATE FIRST TYPE SPECTRUM-BLOOD SUGAR PROFILE RELATIONSHIP MODEL
1110
ESTIMATE BLOOD SUGAR PROFILE DATA OF USER
1120
GENERATE INDIVIDUALIZED BLOOD SUGAR ESTIMATION MODEL
1130
ESTIMATE BLOOD SUGAR OF USER
1140
END

FIG. 12

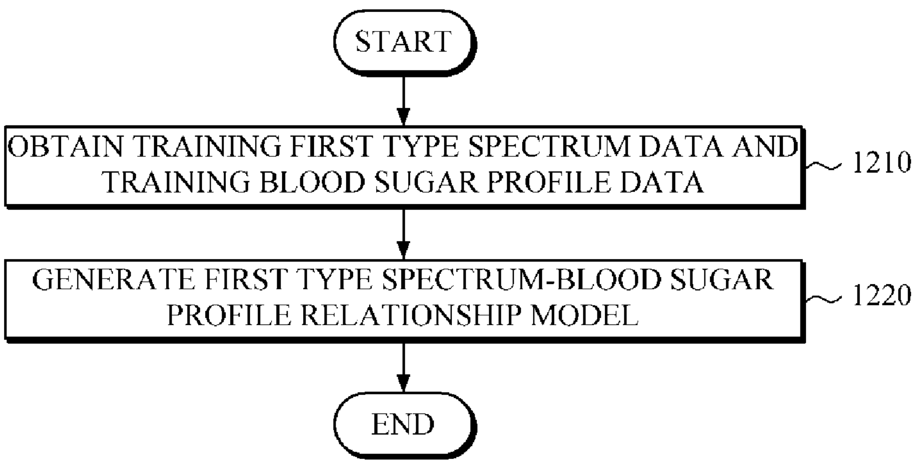

START
OBTAIN TRAINING FIRST TYPE SPECTRUM DATA AND TRAINING BLOOD SUGAR PROFILE DATA
1210
GENERATE FIRST TYPE SPECTRUM-BLOOD SUGAR PROFILE RELATIONSHIP MODEL
1220
END

FIG. 13

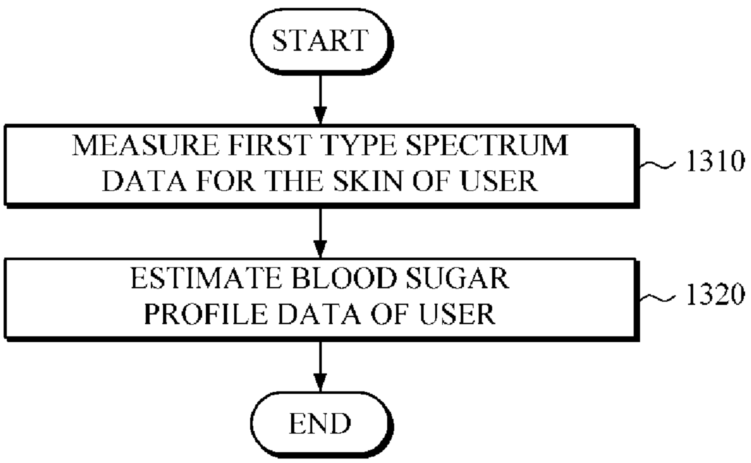

START
MEASURE FIRST TYPE SPECTRUM DATA FOR THE SKIN OF USER
1310
ESTIMATE BLOOD SUGAR PROFILE DATA OF USER
1320
END

FIG. 14

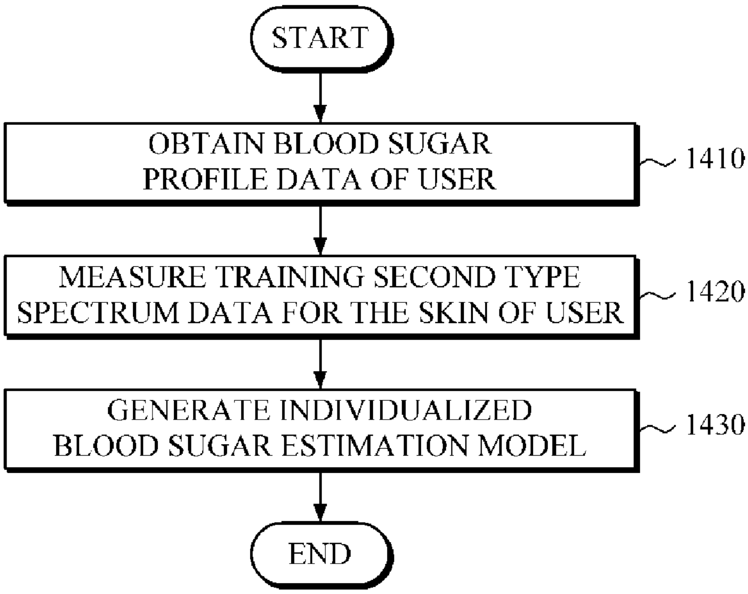
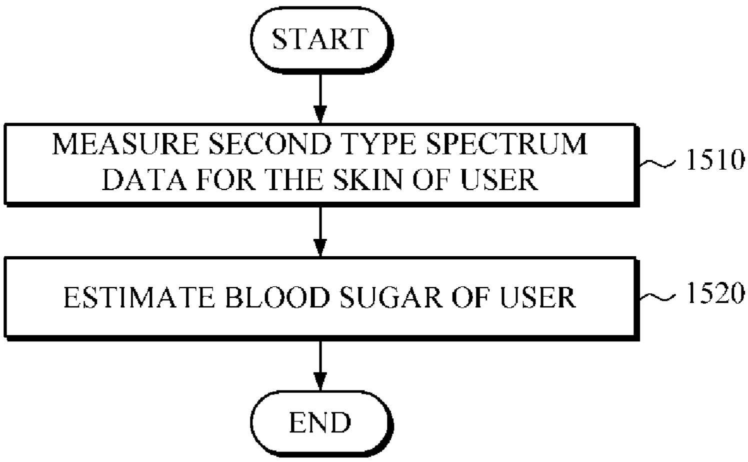

START
OBTAIN BLOOD SUGAR PROFILE DATA OF USER
1410
MEASURE TRAINING SECOND TYPE SPECTRUM DATA FOR THE SKIN OF USER
1420
GENERATE INDIVIDUALIZED BLOOD SUGAR ESTIMATION MODEL
1430
END

FIG. 15


START
MEASURE SECOND TYPE SPECTRUM DATA FOR THE SKIN OF USER
1510
ESTIMATE BLOOD SUGAR OF USER
1520
END

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2012035442 A1 **[0006]**

Non-patent literature cited in the description

- Near-Infrared Diffuse Reflection Spectroscopy for Non-Invasive Blood-Glucose Monitoring. **DANZER K et al.** LEOS NEWSLETTER. THE SOCIETY, 01 April 1998, vol. 12 **[0007]**

patsnap

专利名称(译)	用于基于异质光谱估计血糖的装置和方法		
公开(公告)号	EP3272280B1	公开(公告)日	2019-07-31
申请号	EP2017163889	申请日	2017-03-30
[标]申请(专利权)人(译)	三星电子株式会社 高丽大学校产学协力团		
申请(专利权)人(译)	SAMSUNG ELECTRONICS CO. , LTD. 高丽大学研究和商业基金会		
当前申请(专利权)人(译)	SAMSUNG ELECTRONICS CO. , LTD. 高丽大学研究和商业基金会		
[标]发明人	LEE WOO CHANG KIM YOUNG HOON PARK JIN YOUNG SHIN EUI SEOK CHOI WOO SIK KIM SEOUNG BUM		
发明人	LEE, WOO CHANG KIM, YOUNG HOON PARK, JIN YOUNG SHIN, EUI-SEOK CHOI, WOO SIK KIM, SEOUNG BUM		
IPC分类号	A61B5/00 A61B5/145 A61B5/1455 G16H50/50		
CPC分类号	A61B5/14532 A61B5/0075 A61B5/1455 A61B5/443 A61B5/4884 A61B5/7267 A61B5/7275 A61B5/7278 A61B2560/0475 A61B2562/0238 G16H50/50		
优先权	1020160091622 2016-07-19 KR		
其他公开文献	EP3272280A1		
外部链接	Espacenet		

摘要(译)

提供了一种用于基于异质光谱确定血糖的装置和方法。血糖模型生成装置包括：数据获取器（710），被配置为基于第一类型光谱 - 血糖分布关系模型获得用户的血糖分布数据;第二类型光谱测量器（720），被配置为测量训练第二类型用户皮肤的光谱数据，以及处理器（730），其配置成基于获得的血糖曲线数据和测量的训练第二类型光谱数据生成个体化血糖模型。

FIG. 1