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(54) Title: SMART BODY ANALYZER WITH 3D BODY SCANNER AND VITAL PARAMETER SENSORS

(57) Abstract: The invention relates to a smart body analyzer apparatus comprising: a control unit (9) a rotating plate (1) for turning a body controlled by the control unit (9) and at least one group of touch-less sensors (4) for scanning the body, which comprises a far infrared temperature sensor (7) and a depth sensor (5) working with a time-of-flight imaging method, a stereoscopic imaging method, a microwave imaging method and/or a laser ranging method based on trigonometric principles.

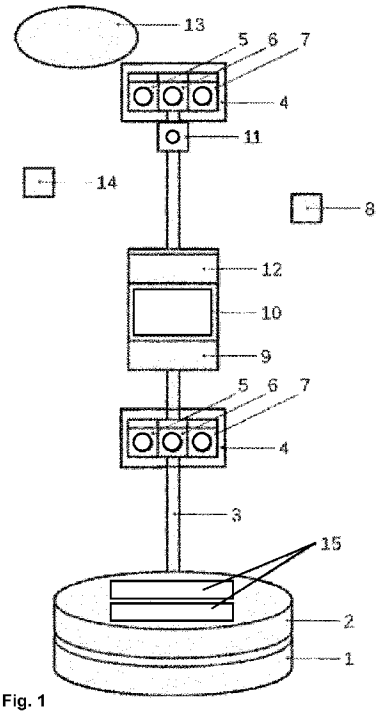

Fig. 1

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SMART BODY ANALYZER WITH 3D BODY SCANNER AND VITAL PARAMETER SENSORS

The invention relates to a smart body analyzer apparatus comprising a control unit, a rotating plate for turning a body controlled by the control unit and at least one group of touch-less sensors for scanning the body, which comprises a far infrared temperature sensor and a depth sensor working with a time-of-flight imaging method, a stereoscopic imaging method, a microwave imaging method and/or a laser ranging method based on trigonometric principles.

The invention relates generally to a smart body analyzer that can measure mechanical-, health- and mood parameters of the user – e.g. body volume, body composition, body dimensions, body mass, heart rate, skin temperature, blood pressure, blood oxygen content, musculature tension, skin humidity – by the means of a three dimensional body scan comprised by the measurement of further parameters with other sensors. The obtained information is analyzed and the parameters of merit may be extracted. The results may be stored in a data-base, that may be accessible e.g. via smart-phone, tablet, browser, notebook and/or desktop computer.

The state of art smart body analyzers fall into 3 categories:

1. Single value measurement instrumentation with no intelligence like simple body scales [http://www.bedbathandbeyond.com/store/category/bed-bath/bath-accessories/scales/1257/], body size measurement sticks [https://waagen-kurz.de/personenwaagen_zubehoer_laengenmessgeraet.htm, http://www.aliexpress.com/promotion/baby-toy_body-measurements-height-promotion.html], fewer thermometers [http://www.sanitas-online.de/web/de/produkte/koerpertemperatur/koerpertemperatur.php] and so on.

2. Measurement instrumentation with a rough indirect parameter estimation like scales processing the body mass index from measured weight and entered body height, age and gender [http://www.medicalexpo.com/prod/beurer/digital-patient-weighing-scales-bmi-calculation-67780-431419.html]. Another example is body fat content from analysis from weight and an impedance measurement [http://bathroom-scales-review.toptenreviews.com/].

3. Measurement instrumentation of two parameters like body mass and height [http://www.sonkascale.com/Products/LatestSK-V7-003Ultra.html, http://sell.lulusoso.com/selling-leads/1133885/Mechanical-Bathroom-Scale-measurement-of-body-height-.html], weight and body impedance measurement a rough indication of body fat content [http://bathroom-scales-review.toptenreviews.com/, http://www.sonkascale.com/Products/electronicweighingsc.html], blood pressure and heart rate [http://www.omron-healthcare.com/eu/en/our-products/blood-pressure-monitoring] or blood oxygen saturation and heart rate [http://www.upcmedical.com/shop/product_info.php?products_id=103?osCsid=8b9ed075fdffb6af7c8fbc7d53289845, http://www.chinamedevice.com/Suppliers/4878/BloodOxygenMeter-449848.html].

Some of such measurement systems with connectivity may memorize and track the users parameters and display it in either through a browser or an app on a smart phone.

The state of the art systems have the following shortcomings:

- Prior art does not measure the volume of the body.
- Prior art does not measure the physical constitution of the body like arm and leg length.
- Prior art makes calculation of indirect derived parameters (e.g. body mass index) from one measured and other entered values by

calculating with equations derived from the average of the population. This leads to extreme inaccurate results.

- Prior art does not measure more than two body parameters.
- Prior art is not intelligent enough to make any assessments or diagnostics about the user with the limited measurements it has made.
- Prior art does not measure valuable other health parameters together with mass like blood pressure, heart rate, blood oxygen content, lough volume the temperature measurement of the user in course of the body measurement.
- Prior art does not derive mood of the user.
- Prior art does not derive stress level or tiredness of the user.
- Prior art does not recommend measures to improve health, fitness, reduce stress.

State of the art physical vital and emotional body parameters are measured in a fragmented way by different equipment like length measurement tapes, scales, temperature meters and blood pressure measurement equipment. Some of this instrumentation may be linked to a computer to store data. Others are not. Especially obtaining the physical data of the body like length, volume and constitution is currently domain of heavy medical equipment and not available in a low cost way usable for private applications. Also the combination of this data to obtain more complicated body parameters is not properly solved yet.

The object of the present invention is to provide a Smart body analyzer apparatus, which eliminates theses disadvantages.

The aforementioned object is achieved by means of a smart body analyzer apparatus exhibiting the features disclosed in the independent patent claim 1.

Proposed is an smart body analyzer apparatus comprising a control unit a rotating plate for turning a body controlled by the control unit and at least one group of touch-less sensors for scanning the body. The at least one group of touch-less sensors comprises a far infrared temperature sensor and a depth sensor. The depth sensor is designed in such a way that it works with a time-of-flight imaging method, a stereoscopic imaging method, a microwave imaging method and/or a laser ranging method based on trigonometric principles.

It is advantageous if the depth sensor is a stereoscopic depth sensor and/or comprises two cameras, which are spaced apart from one another.

In an advantageous further aspect, the two cameras are spaced apart from one another, in particular with respect to the rotating plate, in vertical direction.

It is advantageous if the group of touch-less sensors comprises at least one, in particular high resolution, color camera.

It is advantageous if the control unit is designed in such a way that it scans the face of the user with the color camera in conjunction with the depth sensor and recognizes the mood of the user.

It is advantageous if the color camera is at the same time a camera of the depth sensor.

In an advantageous further aspect, the apparatus comprises a second group of touch-less sensors for scanning the body, in particular according to the previous specification.

It is advantageous if the first and second group of touch-less sensors are spaced apart from one another with respect to the rotating plate in vertical direction.

It is advantageous if the first group of touch-less sensors comprises a bottom detection zone and the second group of touch-less sensors comprises a top detection zone, in particular with a common overlapping area.

In an advantageous further aspect, the apparatus comprises a scale for measuring the weight of the body, which is in particular integrated into the rotating plate.

It is advantageous if the apparatus comprises at least one auxiliary body function sensor, in particular a blood pressure sensor, heart rate, a blood oxygen saturation sensor, a body conductivity sensor and/or a breathing air flow sensor.

In an advantageous further aspect, the apparatus comprises a wireless communication inter-face, in particular WiFi, Bluetooth or ZigBee, for connecting the control unit wireless with the auxiliary sensor, the rotating plate, the scale, a cloud, a local cloud data base, a smart-phone, a tablet, a laptop and/or a PC.

It is advantageous if the apparatus comprises a mast, which is in particular separated from the rotating plate and/or which carries the control unit, the at least one group of touch-less sensors and/or the wireless communication interface.

It is advantageous if the control unit is designed in such a way that it manages the operation of the rotary plate, the scale, the at least one group of touch-less sensors and/or the at least one auxiliary body function sensor.

It is advantageous if the smart body analyzer apparatus comprises at least one of the following features:

It is advantageous if the smart body analyzer apparatus is designed in such a way that it can measure in a convenient way body mass, body volume in the form of a 3D scan, skin temperature, heart rate, body composition and/or facial mood recognition of the user.

It is advantageous if the apparatus employs a depth sensor in conjunction with a color camera to scan the user's body in order to create an accurate 3D rendering of the body, which can be sent directly to the user via wireless or stored on the cloud. The accurate 3D scan from the apparatus allows the calculation of accurate body composition and tracking body dimensions.

It is advantageous if the depth sensor and color camera are also used to scan the face of the user to recognize the mood, measure heart rate and measure body temperature.

It is advantageous if the temperature and heart rate measurement of the user's body are made with the use of the color camera in conjunction with the depth sensor.

It is advantageous if facial mood recognition is done via the use of color camera in conjunction with the depth sensor.

It is advantageous if the apparatus will use the combination of facial mood recognition, body temp and/or heart rate to diagnose certain medical conditions.

Additional advantages of the invention are described in the following exemplary embodiments. The drawings show in:

Figure 1 realization example of the smart body analyzer in particular with 3D body scanner and other vital parameter sensors.

The invented apparatus shown in Figure 1 is composed in an advantageous way by a rotating plate 1, a scale 2 and a mast 3 carrying at least one, typically but not limited to two groups of touch-less sensors 4 a control unit 9 a manual and optical user interface 10, an acoustic user interface 11 and a communication interface 12.

The rotating plate 1 turns the user controlled by the control unit 9 around to ensure that the whole body is visible by the groups of touch-less sensors 4.The rotating plate 1 has the ability to stop at any angle via the control unit 9.

The groups of touch-less sensors 4 contain a depth sensor 5 a high-resolution color camera 6 and a far infrared temperature sensor 7. Multiple groups of touch-less sensors 4 are used at different heights to capture the full body surface of the user.

The other sensors include auxiliary body function sensors 8, which may be, but not limited to, a blood pressure sensor, a blood oxygen saturation sensor, body conductivity sensor connected to the recommended foot positions 15, and breathing air flow sensor which are connected e.g. by a wireless link to the control unit 9.

The communications interface 12 connects, e.g. in a wireless way, the control unit 9 with the scale 2, the rotating plate 1 and/or the auxiliary sensors by for example, but not limited to Bluetooth, Bluetooth low energy, ZigBee or any proprietary RF connection. Furthermore the communications interface 12

connects the invention, e.g. in a wireless way, with e.g. a cloud or local cloud data base or with a Smart-phone/Tablet/laptop/PC 14 for on-line or off-line visualization and presentation of the results.

The control unit 9 manages under control of the manual and optical user interface 10 and/or the acoustic user interface 11 the operation of the rotary plate 1, the scale 2, the group of touch-less sensors 4 and/or the auxiliary body function sensors 8.

The control unit 9 also collects measurement result of the scale 2, the raw 3D depth scan data of the multiple depth sensors 4, the color image data of the multiple high resolution color cameras 6 and/or the body temperature data of the multiple far infrared temperature sensors 7 and/or the other vital measurement values obtained from the auxiliary body function sensors 8 like but not limited to, blood pressure, blood oxygen saturation, body conductivity and/or breathing air flow of the auxiliary body function sensors.

Due to each group of touch-less sensors 4 may see only a part of the user's body and may deliver only a part of the body scan image. The control unit 9 calculates from the 3D depth sensors 5 part scan's raw data by combining and eliminating of shadowing effects a particularly full 3D depth scan model of the user's body.

From part images of the body of the color cameras 6 the control unit 9 calculates a 3D color image of the user's body. Also here shadowing effects are eliminated by combining of the part images obtained from different positions. From part images of the body of far infrared temperature sensors 7 the control unit 9 calculates in the same way a 3D thermal image of the user's body.

From the body mass from the scale 2 and the 3D full body scan image the control unit 9 calculates basic body parameters as are but not limited to: body height, body mass, body volume, body composition and/or clothing retail parameters.

From measurement of the short-term changes of the body during the scanning process like but not limited to: chest motion, eye closing and/or musculature tension and/or tremor further significant body parameters like but not limited to: breathing rate, breathing volume, heart rate, tiredness and/or temporary physical overstress can be derived.

From the parameters above and measurement values from the auxiliary body function sensors 8 as are for example but not limited to: heart rate, blood pressure, blood oxygen content, body conductivity and/or breathing air flow.

The control unit 9 calculates from the parameters above together with given age and gender of the user indirect fitness-, stress-, health-, as are but not limited to: body mass index, body fat content, muscle improvement/decline with respect to different stimuli such as diet and/or exercise posture analysis along with improvement techniques, body metabolism, heat maps of muscle density and/or body balance.

The analysis of mid-term and long-term changes of the body parameters are stored either in the control unit 9, in the private or public cloud data base 13 and/or in the smart-phone/tablet/laptop/PC 14. The fitness-, stress- and/or health-behave of the user can be monitored and controlled. By comparing the skin images from the high-resolution color camera 6 with the history a skin-cancer per-warning can be given.

By analysis the skin temperature images from the far infrared temperature sensor 7 with a fever or sub-cutaneous inflammation warning can be given.

The display of the manual and optical user interface 10 will show information such as 3D body scan, mass, body composition and/or other results or warnings.

The acoustic user interface 11 will accept spoken commands by the user like but not limited to “start scan” and/or “stop scan” and/or guide the user acoustically through the scan process. Background music and/or commercials can shorten the time of the scanning process for the user.

The depth sensors 5 may be realized by any 3D imaging method like but not limited to stereoscopic cameras, time of flight cameras, microwave imaging, ultrasonic imaging and/or laser ranging on trigonometric principles.

Using dynamic movement information obtained from such as the 3D depth image and color camera and the group of touch-less sensors, the mood of the user can be approximated using the facial expression, heart-rate, temperature and/or complexion of the user.

By analyzing the shape and changes in the 3D scans of body which are obtained by the touch-less sensors 4 and/or the computation of body composition, heat maps of muscle density and/or fat distribution can be obtained.

An apparatus that combines the measurement of the physical dimensions (size volume) of the users body obtained by a three dimensional scan of the user's body turning around on a rotating plate 1 with one or more depth sensors 5.

A 3D color image of the body is obtained by one or more high resolution color cameras 6. A 3D thermal image of the body is obtained by one or more infrared sensors 7.

The weight measured by a scale 2 and other vital body functions measured by one or more different auxiliary body function sensors 8.

The apparatus calculates from the signals of the sensor/s e.g. in control unit 9 body-size, body-weight, body-constitution, cloth sizes, fitness parameters, mood-level, stress-level and/or health-level and may display this information on the display of a manual and optical user interface 10.

The apparatus may send this information for storing via a communication interface 12 e.g. to a private or public cloud data base 13, or for presentation or post processing e.g. to a smart-phone/tablet/laptop/PC 14.

The apparatus may create a 3D scan image from a human body by using more than one of depth sensor 5 which contributes part images of the body that are combined to a particularly complete 3D image of the body in way to avoid non modeled parts of the body due to shadowing effects of the body's contours.

The apparatus may create a 3D color scan image from a human body by using preferably more than one of high resolution color camera 6 which contribute part images of the body that are combined to a particularly complete 3D image of the body in way to avoid non modeled parts of the body due to shadowing effects of the body's contours.

The apparatus may create a 3D color scan image from a human body by using preferably more than one far infrared temperature sensor 7 which contribute part images of the body that are combined to a particularly

complete 3D image of the body in way to avoid non modeled parts of the body due to shadowing effects of the body's contours.

The apparatus may be composed by a rotating plate 1, a scale 2 and/or a mast 3 carrying at least one, typically but not limited to two groups of touch-less sensors 4 a control unit 9, a manual and/or optical user interface 10, an acoustic user interface 11 and/or a communication interface 12.

The depth sensors 4 may be realized by any 3D imaging method like but not limited to stereo imaging, time-of-flight based depth cameras, microwave imaging, ultrasonic imaging and/or laser ranging based on trigonometric principles.

The apparatus may calculate from the 3D full body scan image the basic physical body parameters as are but not limited to body height, body volume, and/or body composition.

The apparatus may precisely calculate clothing retail size numbers from the basic physical body parameters.

The apparatus derives together with the measurement values from the scale 2 and/or the auxiliary body function sensors 8 and/or the age and/or gender of the user to automatically calculate fitness-, stress-, and/or health-, parameters of the user.

The apparatus may give the user a friendly warning if the vital body parameters like for example, but not limited to, weight related to body composition, tiredness, body temperature, heart rate, breathing rate, breathing volume, blood pressure, exceed the commonly accepted health limits.

The apparatus may compare the actual measurement values, vital- fitness-, stress- and/or health-parameters of the user with their history stored for example but not limited to the control unit 9, the private and/or public cloud data base 13 and/or a smart-phone/tablet/laptop/PC 14 to track and/or display their changes and give the user a friendly warning at unhealthy deviations.

The apparatus may compare the high-resolution color images from the past with the actual ones to give e.g. a skin cancer pre-warning.

The apparatus may use a wireless connection for example, but not limited to Bluetooth, Bluetooth low energy, ZigBee and/or any other public or proprietary RF connection between the control unit 9 and the auxiliary body function sensors 8 to avoid cabling problems when rotating the user´s body by the turn table 1.

The auxiliary body function sensors 8 may be third party vital body parameter sensors so called “wearables”.

The acoustic user interface 11 allows in an advantageous way control of standstill body which may be a precondition for a successful scan and even if the manual and optical user interface 10 is out of reach- and visibility distance of the user.

The at least one depth sensor 5 can be also realized by the, in particular high-resolution, color cameras 6. In this case the color camera 6 is one of the two cameras of the depth sensor 5.

The at least one depth sensor 5 can be also realized by one or more, in particular high-resolution, color camera/s 6 generating a stereo effect by the rotation of the users by the rotation plate 1.

The apparatus may be simplified in a way that it is using instead of the depth sensors 5 only one or more high-resolution color cameras 6 to record pictures of the body in one or more angles of the rotating plate 1 and/or to calculate from the circumference of the body of the user obtained from the photos the 3D body parameters.

The invention is not limited to the embodiments shown or described. Rather, any and all combinations of the individual features described, as shown in the figures or described in the description, and to the extent that a corresponding combination appears possible and sensible, are subject matters of the invention.

To measure size, weight, constitution, fitness, mood-, stress- and/or health level, of a person needs today's a number of separate technical instrumentation and/or analysis methods. The invention declares a compact apparatus and method to analyze a human body by the means of a scale, a 3D full body scanner on geometrical depth-, color imaging and/or body temperature imaging level combined with other vital body parameter sensors. From this measurements body -size, -weight, -constitution, cloth sizes, fitness parameters, mood-, stress- and/or health- level are automatically calculated and may be provided on various user interfaces. By comparing this data with images from the past the development of the body, its fitness and/or health can be tracked.

LIST OF REFERENCE CHARACTERS

1: Rotating plate
2: Scale
3: Mast
4: Group of touch-less sensors
5: Depth sensor
6: Color camera
7: Far infrared temperature sensor
8: Auxiliary body function sensors
9: Control unit
10 Manual and optical user interface
11: Acoustic user interface
12: Communication interface
13: Private or public cloud data base
14: Smart-phone/Tablet/laptop/PC
15: Recommended foot positions

Patent Claims

1. Smart body analyzer apparatus comprising:
a control unit (9)
a rotating plate (1) for turning a body controlled by the control unit (9) and
at least one group of touch-less sensors (4) for scanning the body, which comprises a far infrared temperature sensor (7) and
a depth sensor (5) working with
a time-of-flight imaging method,
a stereoscopic imaging method,
a microwave imaging method and/or
a laser ranging method based on trigonometric principles.

2. Apparatus according to the previous claim, wherein the depth sensor (5) is a stereoscopic depth sensor and/or comprises two cameras, which are spaced apart from one another.

3. Apparatus according to one or several of the previous claims, wherein the two cameras are spaced apart from one another, in particular with respect to the rotating plate (1), in vertical direction.

4. Apparatus according to one or several of the previous claims, wherein the group of touch-less sensors (4) comprises at least one, in particular high resolution, color camera (6).

5. Apparatus according to one or several of the previous claims, wherein the control unit (9) is designed in such a way that it scans the face of the user with the color camera in conjunction with the depth sensor and recognizes the mood of the user.

6. Apparatus according to one or several of the previous claims, wherein the color camera (6) is at the same time a camera of the depth sensor (5).

7. Apparatus according to one or several of the previous claims, wherein the apparatus comprises a second group of touch-less sensors (4) for scanning the body, in particular according to one or several of the previous claims.

8. Apparatus according to one or several of the previous claims, wherein the first and second group of touch-less sensors (4) are spaced apart from one another with respect to the rotating plate (1) in vertical direction.

9. Apparatus according to one or several of the previous claims, wherein the first group of touch-less sensors (4) comprises a bottom detection zone and the second group of touch-less sensors (4) comprises a top detection zone, in particular with a common overlapping area.

10. Apparatus according to one or several of the previous claims, wherein the apparatus comprises a scale (2) for measuring the weight of the body, which is in particular integrated into the rotating plate (1).

11. Apparatus according to one or several of the previous claims, wherein the apparatus comprises at least one auxiliary body function sensor (8), in particular a blood pressure sensor, heart rate, a blood oxygen saturation sensor, a body conductivity sensor and/or a breathing air flow sensor.

12. Apparatus according to one or several of the previous claims, wherein the apparatus comprises a wireless communication interface (12), in particular WiFi, Bluetooth or ZigBee, for connecting the control unit (9)

wireless with the auxiliary sensor (8), the rotating plate (1), the scale (2), a cloud (13), a local cloud data base (13), a smart-phone (14), a tablet (14), a laptop (14) and/or a PC (14).

13. Apparatus according to one or several of the previous claims, wherein the apparatus comprises a mast (3), which is in particular separated from the rotating plate (1) and/or which carries the control unit (9), the at least one group of touch-less sensors (4) and/or the wireless communication interface (12).

14. Apparatus according to one or several of the previous claims, wherein the control unit (9) is designed in such a way that it manages the operation of the rotary plate (1), the scale (2), the at least one group of touch-less sensors (4) and/or the at least one auxiliary body function sensor (8).

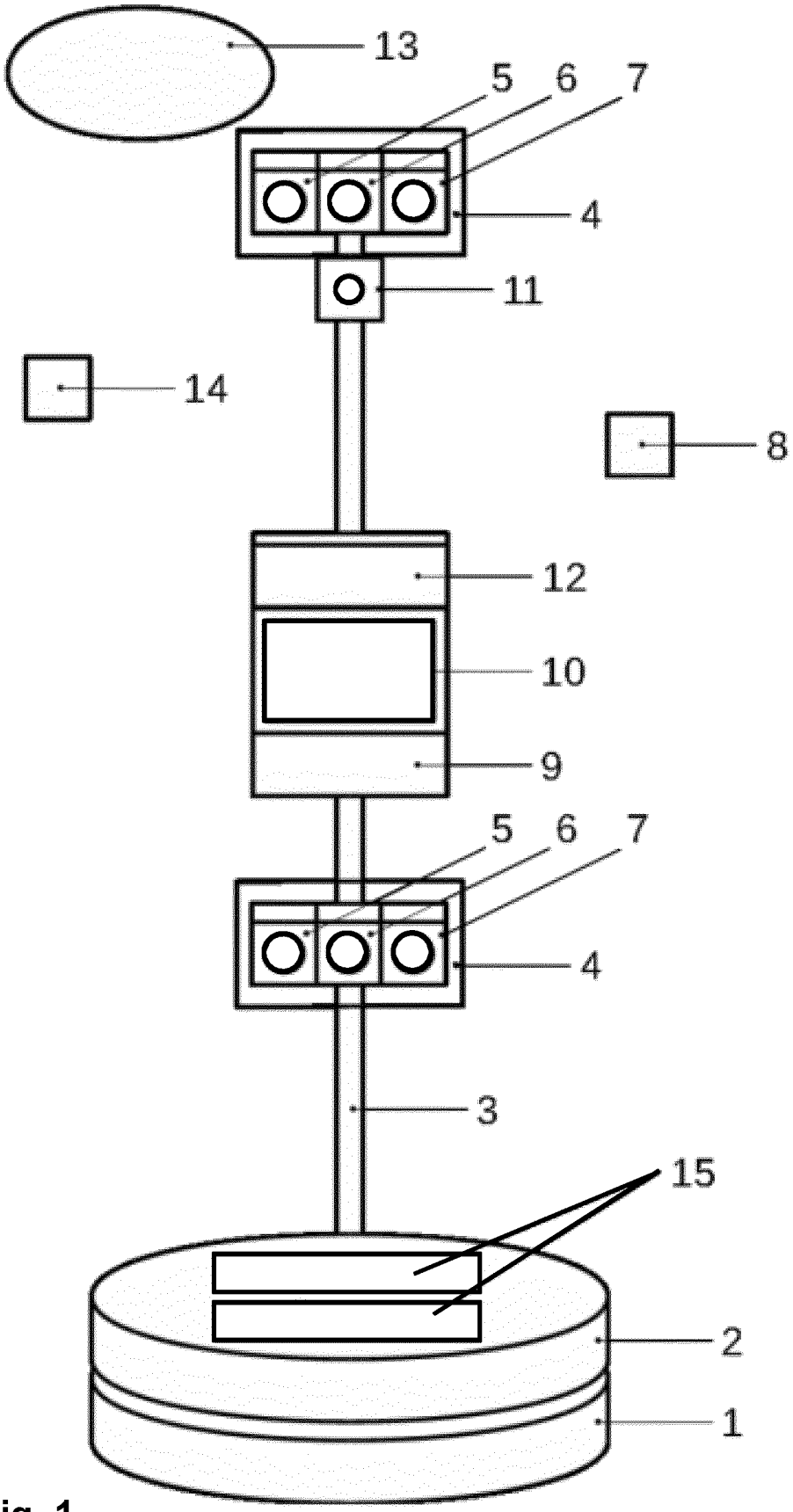

Fig. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/067664

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B5/00 A61B5/01
ADD. A61B5/05 A61B5/107 A61B5/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A41H A61B G01C G01S G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data, BIOSIS, COMPENDEX, EMBASE, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/123078 A1 (GUINTA ROBERT [US]) 20 May 2010 (2010-05-20)	1,14
Y	paragraph [0023] - paragraph [0025] paragraph [0031] - paragraph [0037] figures 1-3 claim 6	2-13

Y	US 2013/123015 A1 (JUNG JUNG KYU [KR] ET AL) 16 May 2013 (2013-05-16)	4,6,12
A	paragraph [0004] - paragraph [0006] paragraph [0045] - paragraph [0062] paragraph [0095] - paragraph [0101] figures 1-2B,9	1-3,5, 7-11,13, 14

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
28 September 2017	09/10/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Görlach, Tobias

1

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2012/326959 A1 (MURTHI RAGHU [US] ET AL) 27 December 2012 (2012-12-27)	2
A	paragraph [0023] - paragraph [0028] paragraphs [0038], [0047], [0049] paragraph [0064] - paragraph [0067] paragraph [0083] - paragraph [0087] paragraph [0106] - paragraph [0112] figures 1,3,4,7,11	1,3-14
Y	US 2010/191541 A1 (PROKOSKI FRANCINE J [US]) 29 July 2010 (2010-07-29) paragraph [0088] - paragraph [0099] paragraph [0374]	5
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A	paragraph [0030] - paragraph [0032] paragraph [0036] - paragraph [0040] paragraph [0046] figures 1-7,10-13,23 paragraph [0049]	7-10,14
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专利名称(译)	智能身体分析仪，配有3D人体扫描仪和重要参数传感器		
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外部链接	Espacenet		

摘要(译)

本发明涉及一种智能体分析仪装置，包括：控制单元（9），用于转动由控制单元（9）控制的主体的旋转板（1）和至少一组用于扫描的无触摸传感器（4）主体，包括远红外温度传感器（7）和深度传感器（5），其工作有飞行时间成像方法，立体成像方法，微波成像方法和/或基于三角测量的激光测距方法原则。