(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 466 337 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
13.12.2023 Bulletin 2023/50

(21) Application number: **17805925.9**

(22) Date of filing: **24.05.2017**

(51) International Patent Classification (IPC):
A61B 5/1455 *(2006.01)* ***A61B 5/00*** *(2006.01)*
G01N 21/359 *(2014.01)* *A61B 5/026* *(2006.01)*
A61B 5/145 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
A61B 5/0075; A61B 5/14552; G01N 21/359;
A61B 5/0064; A61B 5/0261; A61B 5/14546;
A61B 5/14553

(86) International application number:
PCT/ES2017/070348

(87) International publication number:
WO 2017/207841 (07.12.2017 Gazette 2017/49)

(54) **INTERCHANGEABLE SENSOR DEVICE FOR A FUNCTIONAL NEAR-INFRARED SPECTROSCOPY SYSTEM**

AUSTAUSCHBARE SENSORVORRICHTUNG FÜR EIN FUNKTIONELLES NAHINFRAROTSPEKTROSKOPIESYSTEM

DISPOSITIF CAPTEUR INTERCHANGEABLE POUR UN SYSTÈME DE SPECTROSCOPIE FONCTIONNELLE DANS LE PROCHE INFRAROUGE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **30.05.2016 ES 201630689 U**

(43) Date of publication of application:
10.04.2019 Bulletin 2019/15

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Description

OBJECT OF THE INVENTION

[0001] The object of the present invention is a non-invasive interchangeable sensing device for a functional near infrared (fNIR) spectroscopy system intended to detect changes in the concentration of haemoglobin species on anybody surface.

[0002] Preferably, this body surface is a brain surface.

BACKGROUND OF THE INVENTION

[0003] Neurophysiological and neuroimaging technologies have contributed in recent years to the study of brain functioning.

[0004] The most common modalities of functional neuroimaging techniques are functional magnetic resonance imaging (fMRI), positron emission tomography (PET), both based on the indirect image of hemodynamic changes resulting from neuronal activity.

[0005] On the other hand, magneto-encephalography (MEG) and electro-encephalography (EEG) techniques, which are direct imaging technologies based on the electric-magnetic manifestations of neuronal activity, are also known.

[0006] Currently, these techniques have limitations in terms of explaining the neuronal bases of biological processes since MEG and EEG technologies have a high temporal resolution but a low spatial resolution, while the opposite happens with fMRI and PET technologies.

[0007] Because of this, functional near infrared (fNIR) spectroscopy has recently begun to be used. FNIR spectroscopy is an emerging technology that uses near-infrared light to measure changes in the concentration of oxygenated haemoglobin (HbO) and deoxygenated haemoglobin (Hb) in different parts of the body including the cerebral cortex. FNIR spectroscopy has a temporal resolution of the order of seconds and a spatial resolution in the order of centimetres. Among other advantages it also stands out for being a non-invasive technique, safe for the user and cheap.

[0008] Despite this, various problems have been encountered in using this fNIR technology in different parts of the body. These problems are mainly due to the fact that the morphological configuration of the measurement sensor does not adequately adapt to the surface of the human, allowing the passage of ambient light and introducing unwanted light signals that produce errors in the measurements.

[0009] In addition, the current systems using this fNIR technology are poorly portable systems due to their large volume and are very limited to a specific application for a typical user, as their measurement sensors are not adaptable to different parts of the body, or to different morphologies of the same part of the body that different users may have. This is mainly because each part of the body has a different shape that can vary with the age and morphology of the user.

[0010] Document US2016022223A1 describes a system for monitoring tissue at a plurality of depths, which comprises a sensor strip with a first photodetector element and a plurality of light-emitting elements, being all of the non-interchangeable; a data acquisition module capable of being coupled to the sensor strip; and an analysis software for analysing and displaying the received signals.

DESCRIPTION OF THE INVENTION

[0011] The present invention describes an interchangeable sensing device for a functional near infrared (fNIR) spectroscopy system to detect changes in the concentration of haemoglobin species on a body surface.

[0012] Preferably, this surface is a cranial surface for the fNIR system to detect changes in the concentration of haemoglobin species on the surface of the frontal cerebral cortex.

[0013] The interchangeable sensor device comprises:

- a plurality of units of measurement with different elastic configurations each designed to adapt to a body surface, where each unit of measurement comprises a first connector; and
- a control unit intended to control any of the units of measurement, wherein the control unit comprises a second connector which is connected to the first connector.

[0014] All units of measurement comprise:

- an elastic base comprising transmitting and receiving compartments with light guides,
- a plurality of transmitters, located in transmitting compartments, intended to emit a first luminous signal on the body surface,
- a plurality of receivers, located in the receiving compartments, intended to receive a second luminous signal from the body surface through the light guides,
- a measuring base plate, linked to the plurality of transmitters and receivers, comprising the first connector,
- a receptacle intended to protect the transmitters, receivers and the measuring base plate comprising a hole allowing the first connector to pass through, and
- a first clamping strap which at least covers the plurality of transmitters and receivers and which is intended to be linked to at least a first clamping mechanism to adjust the interchangeable sensing device to the body surface, and/or
- a second clamping strap comprising a hole allowing the passage of the first connector, wherein the second strap wraps around the receptacle and is intended to be linked to at least a second clamping mechanism for adjusting the interchangeable sensing device to the body surface.

[0015] More specifically, each unit of measurement comprises different configurations to adapt to the surface of different body areas, although preferably cranial areas.

[0016] Preferably, the unit of measure comprises at least two receivers per transmitter.

[0017] It should be noted that both the first and second fastening mechanism preferably use an elastic band that can be adapted to the user's body and can adjust the surface of the elastic base to the body surface in order to prevent ambient light from entering and creating interference in the transmitters or receivers.

[0018] The connection between the clamping straps and the fastening mechanisms is preferably made by means of a clip system, a Velcro system, a sewing system or a combination of the above.

[0019] As for the control unit, it comprises a rigid receptacle which houses:

- a control base plate comprising the second connector to be linked to the unit of measurement in order to manage the first and second signals,
- a data transfer unit to transfer the second signal to an external computer unit which, using this second signal, calculates and detects changes in the concentration of haemoglobin species on the brain surface,
- an interface for transmitting luminous and/or acoustic signals on the operating status of an interchangeable sensor device,
- a power supply unit for powering both base plates, transmitters, receivers, the data transfer unit and the interface, and

wherein this control base plate is intended to control the transmitters and receivers of the unit of measurement, as well as the data transfer unit and the interface.

[0020] More specifically, the data transfer unit comprises a wireless and/or wired transfer mechanism intended to establish communication with the external computer unit.

[0021] Preferably, the data transfer unit is a WiFi or Bluetooth receiver/transmitter.

[0022] Preferably, the data transfer unit is a USB port.

[0023] This results in an interchangeable sensor device that allows units of measurement from different configurations to be used by simply disconnecting the unit of measurement and connecting another unit with a different configuration. For example, these units of measurement may have different distances between transmitters and receivers, or increase or decrease the number of these, have different ways to adapt different parts of the skull and even an individual's body. In addition, it is also possible to have several control units whose control base plate is configured for different, special electronic control situations, allowing these to be combined with any of the measurement units.

DESCRIPTION OF THE DRAWINGS

[0024] To supplement the description being given and with the aim of promoting a better understanding of the characteristics of the invention, in accordance with a preferred example of a practical embodiment of the same, a set of drawings are provided as an integral part of the description in which, for merely illustrative purposes, the following has been represented:

Figure 1. Shows a schematic view of a preferred embodiment of the interchangeable sensor device.
Figure 2. Shows an expanded schematic view of the preferred embodiment of the interchangeable sensor device.

PREFERRED EMBODIMENT OF THE INVENTION

[0025] In a preferred embodiment, as shown in Figure 1, the present invention describes an interchangeable sensor device (1) comprising:

- a unit of measurement (200) with an elastic configuration intended to be fitted to the forehead of an individual, and comprising a first connector (212); and

a control unit (300) intended to control the unit of measurement (200), and comprising a second connector (312) to connect to the first connector (212).

[0026] More specifically, as Figure 2 shows, the unit of measure (200) comprises:

- an elastic base (201) with four transmitting compartments (213) and ten receiving compartments (214) with ten light guides (202),
- four transmitters (206), intended to emit a first luminous signal on the forehead surface, and which are located in the four transmitting compartments (213) by means of four first adapters (205),
- ten receivers (204), intended to receive a second luminous signal from the surface of the forehead and through the light guides (202), and which are located in ten receiving compartments (214) by means of four second adapters (203),
- a pressure cap (207) comprising a flat body of 5 adaptable modules covering the transmitters (206) and receivers (204) to ensure that they do not move from their adapters (205, 203), and to protect them from impacts,
- a first clamping strap (208) covering that pressure cap (207) and comprising a hole, wherein that first clamping strap (208) is intended to be linked to clamping mechanisms for adjusting the interchangeable sensing device (1) to the individual's skull,
- a measuring base plate (209) with electronic circuitry linked to the transmitters (206) and receivers (204) by wiring through the hole of the first clamping strap

(208); this measuring base plate (209) comprising the first connector (212), and linked to the elastic base (201) by means of two clip fastening mechanisms (210),

- a receptacle (211) resting on the elastic base (201) and comprising a hole intended to receive the first connector (212), in such a way that the receptacle (211) protects the transmitters (206) and receivers (204) from ambient light, and

    - a second clamping strap (215) comprising a hole allowing the passage of the first connector (212), wherein the second strap (215) surrounds the receptacle (211) and is intended to be linked to at least a second clamping mechanism for adjusting the elastic base (201) to the cranial surface.

[0027] In addition, each emitter (206) comprises a first LED diode that emits a wavelength signal in the near infrared, preferably 740nm, and a second LED diode that emits a wavelength signal in the near infrared, preferably 860nm. Just as each receiver (204) comprises a photodetector to receive a wavelength signal in the near infrared, this wavelength is preferably between 690 and 900 nm.

[0028] Preferably, the four transmitters (206) are arranged in one line and surrounded by a first line of five of the ten receivers (204), and by a second line of five of the ten receivers (204) in such a way that each transmitter (206) is surrounded by four receivers (204).

[0029] As for the control unit (300), this comprises a rigid receptacle (303) which houses:

- a contact plate (301) comprising a hole,
- control base (302) comprising the second connector (312) that passes through the hole in the contact plate (301) to link up with the unit of measurement (200) used to manage the first and second signals,
- a data transfer unit (304) integrated in the base plate (302), to transfer the second signal to an external computer unit to use this second signal to calculate and detect changes in the concentration of haemoglobin species on the brain surface,
- an interface (305) to emit luminous and/or acoustic signals on the operating status of the interchangeable sensor device (1),
- a power supply unit, not represented, to supply both base plates (209, 302), the transmitters (206), the receivers (204), the data transfer unit (304) and the interface (305), and

    - wherein this control base plate (302) is intended to control the transmitters (206) and receivers (204) of the unit of measurement (200), as well as the data transfer unit (304) and the interface (305).

[0030] It should be noted that HbO absorbs infrared radiation more intensely at these wavelengths than Hb and vice versa, thus the second signals comprise this information and through the external computer unit it is possible to measure the relative variations in concentration of both species of haemoglobin through the equations derived from the Lambert-Beer law.

Claims

1. Interchangeable sensor device (1) far a near-infrared functional (fNIR) spectroscopy system intended to detect changes in the concentration of haemoglobin species on a body surface; wherein such interchangeable sensor device (1) comprises:

- a unit of measurement (200) which in turn comprises:

    - a plurality of transmitters (206) intended to emit a first luminous signal on the body surface,
    - a plurality of receivers (204) intended to receive a second luminous signal from the body surface,

- a control unit (300) intended to control the unit of measurement (200),

wherein the interchangeable sensor device (1) comprises a plurality of said unit of measurement (200), wherein each unit of measurement (200) is elastic, interchangeable and intended to be adapted to different parts of the body surface, and wherein each unit of measurement (200) further comprises:

- an elastic base (201) comprising a plurality of transmitting compartments (213) wherein the transmitters (206) are located and a plurality of receiving compartments (214) wherein the receivers (204) are located,
- light guides (202) located in correspondence with the receiving compartments (214) through which the receivers (204) receive the second luminous signal,
- a measuring base plate (209) linked to the transmitters (206) and receivers (204), comprising a first connector (212),
- a receptacle (211) resting on the elastic base (201) and comprising a hole intended to receive the first connector (212) in such a way that the receptacle (211) protects the transmitters (206) and receivers (204) from ambient light,
- a first clamping strap (208) which at least covers the transmitters (206) and receivers (204) and which is intended to be linked with at least a first clamping mechanism to adjust the inter-

changeable sensing device (1) to the body surface, and/or
- a second clamping strap (215) comprising a hole allowing the passage of the first connector (212), wherein the second clamping strap (215) surrounds the receptacle (211) and is intended to be linked to at least a second clamping mechanism far adjusting the interchangeable sensing device (1) to the body surface,

and wherein the control unit (300) comprises a second connector (312) intended to be connected with the first connector (212) of the units of measurement (200).

2. Interchangeable sensor device (1) according to Claim 1, wherein each transmitter (206) comprises a first LEO diode and a second LEO diode configured to emit a wavelength signal in the near infrared respectively.

3. Interchangeable sensor device (1), according to Claim 2, wherein the first LEO diode is configured to emit a wavelength signal of 740nm and the second LEO diode is configured to emit a wavelength signal of 860nm.

4. Interchangeable sensor device (1) according to Claim 1, wherein each receiver (204) comprises at least one photodetector to receive at least one near-infrared wavelength signal from the cranial surface.

5. Interchangeable sensor device (1), according to Claim 4, wherein the wavelength is between 690 and 900 nm.

6. Interchangeable sensor device (1), according to claim 1, wherein the unit of measurement (200) comprises at least two receivers (204) for each transmitter (206).

7. Interchangeable sensor device (1), according to claim 1, wherein the control unit (300) comprises:

a control base plate (302) comprising the second connector (312) to be linked to the unit of measurement (200) to manage the first and second signals,
a data transfer unit (304) built into the base plate (302) capable of transferring the second signal to an external computer unit to calculate and detect changes in the concentration of haemoglobin species on the brain surface,
an interface (305) to emit luminous and/or acoustic signals on the operating status of an interchangeable sensor device (1), and
a power supply unit to supply both base plates (209, 302), the transmitters (206), receivers (204), the data transfer unit (304) and the interface (305), and
a rigid receptacle (303) of a material of grater rigidity than the rest of the interchangeable sensor device (1) which houses the control base plate (302), the data transfer unit (304), the interface (305) and the power supply unit,

wherein this control base plate (302) is intended to control the transmitters (206) and receivers (204) of the unit of measurement (200), as well as the data transfer unit (304) and the interface (305).

8. Interchangeable sensor device (1), according to Claim 7, wherein the data transfer unit (304) comprises a wireless and/or wired transfer mechanism intended to establish a communication with the external computer unit.

9. Interchangeable sensor device (1), according to Claim 7, wherein the data transfer unit (304) is a WiFi or Bluetooth receiver/transmitter.

10. Interchangeable sensor device (1), according to Claim 7, wherein the data transfer unit is a USB port.

Patentansprüche

1. Austauschbare Sensorvorrichtung (1) für ein funktionelles Nahinfrarot (fNIR) Spektroskopiesystem, welches dazu vorgesehen ist, Veränderungen bei der Konzentration von Hämoglobin-Spezies auf einer Körperoberfläche zu detektieren; wobei solche austauschbare Sensorvorrichtung (1) Folgendes umfasst:

- eine Messeinheit (200),welche wiederum Folgendes umfasst:

  - eine Vielzahl von Sendern (206), welche dazu vorgesehen sind, ein erstes Lichtsignal auf die Körperoberfläche auszusenden,
  - eine Vielzahl von Empfängern (204), welche dazu vorgesehen sind, ein zweites Lichtsignal von der Körperoberfläche zu empfangen,

- eine Steuereinheit (300), welche dazu vorgesehen ist, die Messeinheit (200),

zu steuern, wobei die austauschbare Sensorvorrichtung (1) eine Vielzahl von den genannten Messeinheiten (200) umfasst, wobei jede Messeinheit (200) elastisch, austauschbar und dazu vorgesehen ist, an unterschiedliche Teile der Körperoberfläche angepasst zu werden, und wobei jede Messeinheit (200) zusätzlich Folgendes umfasst:

- eine elastische Basis (201) umfassend eine Vielzahl von Sendeabteilungen (213), in welchen sich die Sender (206) befinden, und eine Vielzahl von Empfangsabteilungen (214), in welchen sich die Empfänger (204) befinden,
- Lichtleiter (202), welche sich in Übereinstimmung mit den Empfangsabteilungen (214) befinden, über welche die Empfänger (204) das zweite Lichtsignal empfangen,
- eine Messgrundplatte (209), welche mit den Sendern (206) und Empfängern (204) verknüpft ist, umfassend einen ersten Verbinder (212),
- ein Behältnis (211), welches auf der elastischen Basis (201) liegt und ein Loch umfasst, welches dazu vorgesehen ist, den ersten Verbinder (212) derart zu empfangen, dass das Behältnis (211) die Sender (206) und Empfänger (204) vom Umgebungslicht schützt,
- eine erste Spannlasche (208), welche mindestens die Sender (206) und Empfänger (204) deckt, und welche dazu vorgesehen ist, mit mindestens einem ersten Spannmechanismus verknüpft zu werden, um die austauschbare Sensorvorrichtung (1) auf der Körperoberfläche zu justieren, und/oder
- eine zweite Spannlasche (215) umfassend ein Loch, welches den Durchgang des ersten Verbinders (212) erlaubt, wobei die zweite Spannlasche (215) das Behältnis (211) umgibt und dazu vorgesehen ist, mit mindestens eine zweiten Spannmechanismus verknüpft zu werden, um die austauschbare Sensorvorrichtung (1) auf der Körperoberfläche zu justieren,

und wobei die Steuereinheit (300) einen zweiten Verbinder (312) umfasst, welcher dazu vorgesehen ist, mit dem ersten Verbinder (212) der Messeinheiten (200) verbunden zu werden.

2. Austauschbare Sensorvorrichtung (1) nach Anspruch 1, wobei jeder Sender (206) eine erste LED-Diode und eine zweite LED-Diode umfasst, welche dazu ausgebildet sind, jeweils ein Wellenlängensignal im Nahinfrarot auszusenden.

3. Austauschbare Sensorvorrichtung (1) nach Anspruch 2, wobei die erste LED-Diode dazu ausgebildet ist, ein Wellenlängensignal von 740 nm auszusenden, und die zweite LED-Diode dazu ausgebildet ist, ein Wellenlängensignal von 860 nm auszusenden.

4. Austauschbare Sensorvorrichtung (1) nach Anspruch 1, wobei jeder Empfänger (204) mindestens einen Fotodetektor umfasst, um mindestens ein Nahinfrarot-Wellenlängensignal von der Schädeloberfläche zu empfangen.

5. Austauschbare Sensorvorrichtung (1) nach Anspruch 4, wobei die Wellenlänge zwischen 690 und 900 nm liegt.

6. Austauschbare Sensorvorrichtung (1) nach Anspruch 1, wobei die Messeinheit (200) mindestens zwei Empfänger (204) für jeden Sender (206) umfasst.

7. Austauschbare Sensorvorrichtung (1) nach Anspruch 1, wobei die Steuereinheit (300) Folgendes umfasst:

eine Steuergrundplatte (302) umfassend den zweiten Verbinder (312), welcher mit der Messeinheit (200) verknüpft werden soll, um die ersten und zweiten Signale zu verwalten,
eine Datenübertragungseinheit (304), welche in die Grundplatte (302) integriert ist und welche in der Lage ist, das zweite Signal auf eine äußeren Computereinheit zu übertragen, um Veränderungen bei der Konzentration von Hämoglobin-Spezies auf der Gehirnoberfläche zu berechnen und zu detektieren,
eine Schnittstelle (305) zum Aussenden von Licht- und/oder Schallsignalen über den Betriebszust einer austauschbaren Sensorvorrichtung (1), und
eine Stromversorgungseinheit, um beide Grundplatten (209, 302), die Sender (206), die Empfänger (204), die Datenübertragungseinheit (304) und die Schnittstelle (305) zu versorgen, und
ein starres Behältnis (303) aus einem Material mit höherer Starrheit als der Rest der austauschbaren Sensorvorrichtung (1), welches die Steuergrundplatte (302), die Datenübertragungseinheit (304), die Schnittstelle (305) und die Stromversorgungseinheit aufnimmt,

wobei diese Steuergrundplatte (302) dazu vorgesehen ist, die Sender (206) und die Empfänger (204) der Messeinheit (200), sowie die Datenübertragungseinheit (304) und die Schnittstelle (305) zu steuern.

8. Austauschbare Sensorvorrichtung (1) nach Anspruch 7, wobei die Datenübertragungseinheit (304) einen drahtlosen und/oder verdrahteten Übertragungsmechanismus umfasst, welcher dazu vorgesehen ist, eine Kommunikation mit der äußeren Computereinheit herzustellen.

9. Austauschbare Sensorvorrichtung (1) nach Anspruch 7, wobei die Datenübertragungseinheit (304) ein WLAN- oder Bluetooth-Empfänger/Sender ist.

10. Austauschbare Sensorvorrichtung (1) nach An-

spruch 7, wobei die Datenübertragungseinheit ein USB-Anschluss ist.

Revendications

1. Dispositif capteur interchangeable (1) pour un système de spectroscopie fonctionnelle dans le proche infrarouge (fNIR) destiné à détecter des changements dans la concentration d'espèces d'hémoglobine sur une surface corporelle ; dans lequel tel dispositif capteur interchangeable (1) comprend :

- une unité de mesure (200) qui à son tour comprend :
  - une pluralité de transmetteurs (206) destinés à émettre un premier signal lumineux sur la surface corporelle,
  - une pluralité de récepteurs (204) destinés à recevoir un deuxième signal lumineux depuis la surface corporelle,
- une unité de contrôle (300) destinée à contrôler l'unité de mesure (200),

dans lequel le dispositif capteur interchangeable (1) comprend une pluralité de ladite unité de mesure (200), dans lequel chaque unité de mesure (200) est élastique, interchangeable et destinée à être adaptée à différentes parties de la surface corporelle, et dans lequel chaque unité de mesure (200) comprend en outre :

- une base élastique (201) comprenant une pluralité de compartiments de transmission (213) dans lesquels sont situés les transmetteurs (206) et une pluralité de compartiments de réception (214) dans lesquels sont situés les récepteurs (204),
- des guides lumineux (202) situés en correspondance avec les compartiments de réception (214) à travers lesquels les récepteurs (204) reçoivent le deuxième signal lumineux,
- une plaque de base de mesure (209) reliée aux transmetteurs (206) et récepteurs (204), comprenant un premier connecteur (212),
- un réceptacle (211) reposant sur la base élastique (201) et comprenant un trou destiné à recevoir le premier connecteur (212) de telle sorte que le réceptacle (211) protège les transmetteurs (206) et les récepteurs (204) de la lumière ambiante,
- un premier collier de serrage (208) qui couvre au moins les transmetteurs (206) et récepteurs (204) et qui est destiné à être relié avec au moins un premier mécanisme de serrage pour ajuster le dispositif capteur interchangeable (1) à la surface corporelle, et/ou
- un deuxième collier de serrage (215) comprenant un trou permettant le passage du premier connecteur (212), dans lequel le deuxième collier de serrage (215) entoure le réceptacle (211) et est destiné à être relié à au moins un deuxième mécanisme de serrage pour ajuster le dispositif capteur interchangeable (1) à la surface corporelle,

et dans lequel l'unité de contrôle (300) comprend un deuxième connecteur (312) destiné à être connecté avec le premier connecteur (212) des unités de mesure (200).

2. Dispositif capteur interchangeable (1), selon la revendication 1, dans lequel chaque transmetteur (206) comprend une première diode LED et une deuxième diode LED configurées pour émettre respectivement un signal de longueur d'onde dans le proche infrarouge.

3. Dispositif capteur interchangeable (1), selon la revendication 2, dans lequel la première diode LED est configurée pour émettre un signal de longueur d'onde de 740 nm et la deuxième diode LED est configurée pour émettre un signal de longueur d'onde de 860 nm.

4. Dispositif capteur interchangeable (1), selon la revendication 1, dans lequel chaque récepteur (204) comprend au moins un photodétecteur pour recevoir au moins un signal de longueur d'onde dans le proche infrarouge provenant de la surface crânienne.

5. Dispositif capteur interchangeable (1), selon la revendication 4, dans lequel la longueur d'onde est entre 690 et 900 nm.

6. Dispositif capteur interchangeable (1), selon la revendication 1, dans lequel l'unité de mesure (200) comprend au moins deux récepteurs (204) pour chaque transmetteur (206).

7. Dispositif capteur interchangeable (1), selon la revendication 1, dans lequel l'unité de contrôle (300) comprend :

une plaque de base de contrôle (302) comprenant le deuxième connecteur (312) à être relié à l'unité de mesure (200) pour gérer les premier et deuxième signaux,
une unité de transfert de données (304) incorporée dans la plaque de base (302) capable de transférer le deuxième signal à une unité informatique externe pour calculer et détecter des changements dans la concentration d'espèces d'hémoglobine sur la surface du cerveau,

une interface (305) pour émettre des signaux lumineux et/ou acoustiques sur l'état de fonctionnement d'un dispositif capteur interchangeable (1), et

une unité d'alimentation de puissance pour alimenter les deux plaques de base (209, 302), les transmetteurs (206), les récepteurs (204), l'unité de transfert de données (304) et l'interface (305), et

un réceptacle rigide (303) d'un matériau de plus grande rigidité que le reste du dispositif capteur interchangeable (1) qui loge la plaque de base de contrôle (302), l'unité de transfert de données (304), l'interface (305) et l'unité d'alimentation de puissance,

dans lequel cette plaque de base de contrôle (302) est destinée à contrôler les transmetteurs (206) et les récepteurs (204) de l'unité de mesure (200), ainsi que l'unité de transfert de données (304) et l'interface (305).

8. Dispositif capteur interchangeable (1), selon la revendication 7, dans lequel l'unité de transfert de données (304) comprend un mécanisme de transfert sans fil et/ou par câble destiné à établir une communication avec l'unité informatique externe.

9. Dispositif capteur interchangeable (1), selon la revendication 7, dans lequel l'unité de transfert de données (304) est un récepteur/transmetteur WiFi ou Bluetooth.

10. Dispositif capteur interchangeable (1), selon la revendication 7, dans lequel l'unité de transfert de données est un port USB.

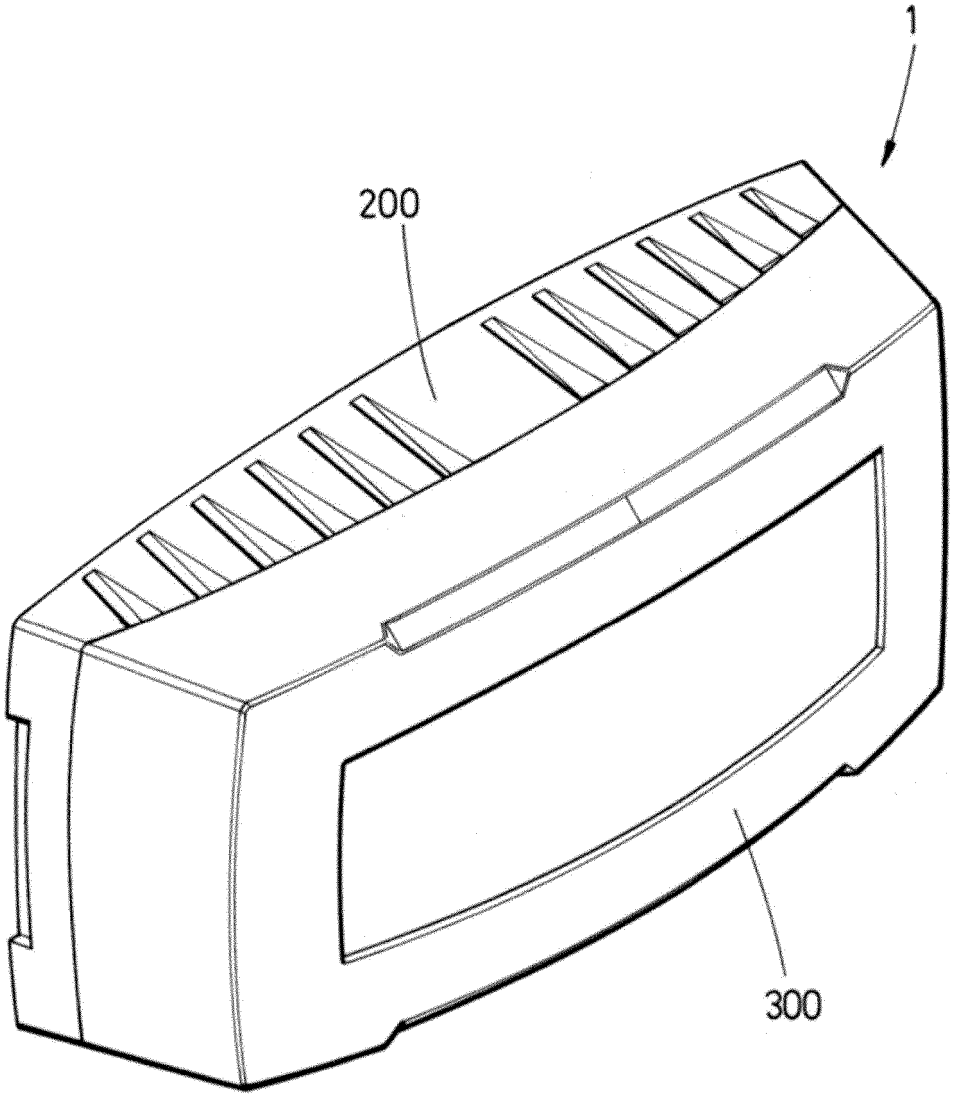
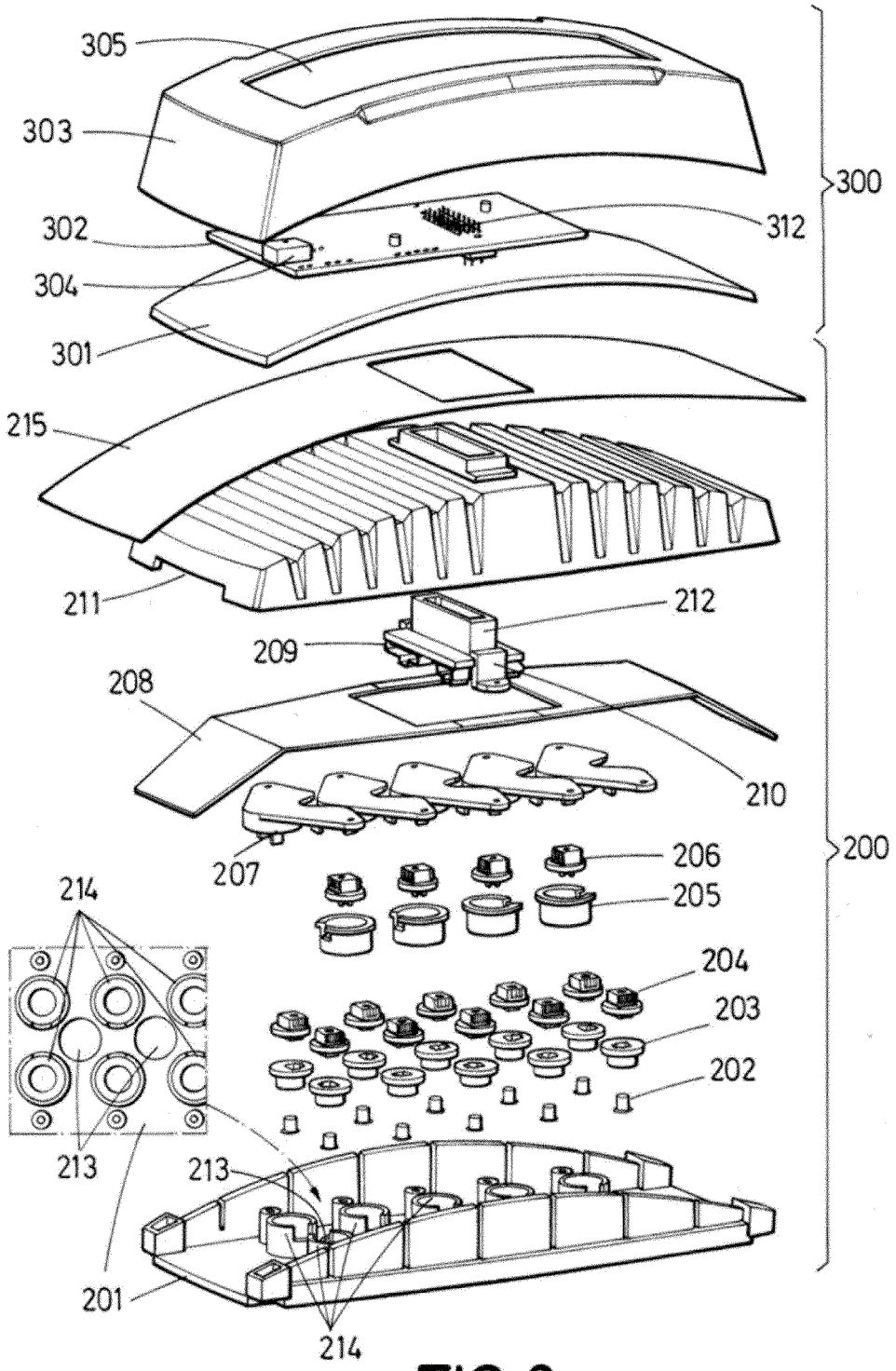


FIG.1


305
303
302
304
301
312
300
215
211
212
209
208
210
207
206
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204
203
202
214
213
213
201
214
200

FIG.2

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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