(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
20 October 2016 (20.10.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/166740 A1

(51) International Patent Classification:
A61B 5/0478 (2006.01) *A61B 5/00* (2006.01)

(21) International Application Number:
PCT/IB2016/052209

(22) International Filing Date:
18 April 2016 (18.04.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
108375 16 April 2015 (16.04.2015) PT

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) **Title**: CAP WITH RETRACTABLE ELECTRODE PINS FOR USE IN EEG

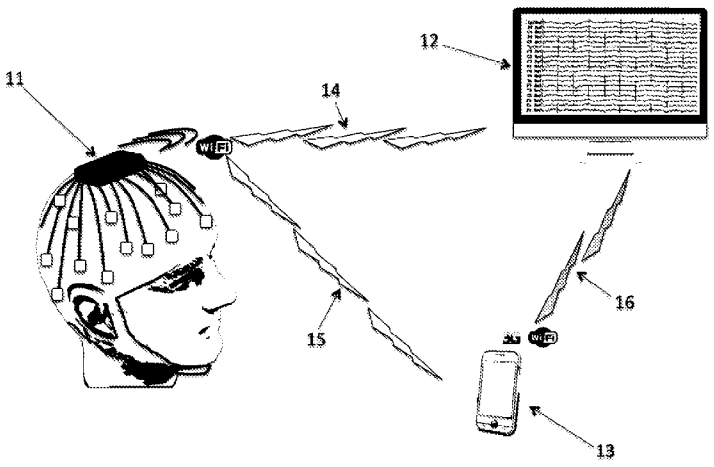

Fig. 1

(57) **Abstract**: Cap for use in electroencephalography, EEG, of a subject, comprising: a plurality of a dry EEG electrode, an internal elastic cap for supporting said plurality of electrodes, wherein the dry EEG electrode comprises a support member which is attached to the internal cap and, wherein the electrode comprises a plurality of retractable electrode pins for contacting simultaneously with the EEG subject, wherein the retractable electrode pins are attached throughout a surface of said support member. The support member may be pivotably attached to the internal cap or the flexibility of the internal elastic cap is such that the electrode is able to pivot about the surface of the EEG subject. The internal elastic cap may be of an elastic fabric. The support member may be releasably attached to the internal cap. The support member may comprise a male- female snap fastener for fastening the plurality of retractable electrode pins.

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D E S C R I P T I O N

CAP WITH RETRACTABLE ELECTRODE PINS FOR USE IN EEG

Technical field

[0001] The present disclosure relates to a cap with retractable electrode pins for use in electroencephalography (EEG).

Background

[0002] Document WO2011052847A1 discloses a multi-selective micromanipulator device able to select from a plurality of electrodes which one is to be applied in an EEG procedure. The device of WO2011052847A1 is complex and costly, involving micromachinery and the need for proper positioning of the device over the patient's head.

[0003] The present invention aims at overcoming these shortcomings among others.

General Description

[0004] The present invention includes a set of features which enables a hardware and software system with the main functions of acquisition, processing & analysis, and transmission of electroencephalogram (EEG) signals in outpatient regimen. The invention can be described in two main parts: dry electrodes; hardware and software for signal acquisition, processing and, in particular, wireless transmission. According to an embodiment, the system includes an internal elastic-fabric cap that supports the electrodes, in particular according to the standard 10-20 for EEG electrodes positioning [1], and preferably an outer hat-shaped cap to accommodate and support the electronic components, cables and batteries of the system. In each electrode location,

the inner cap features a plastic ring for electrode plugin, according to an embodiment. As an elastic tissue, the inner cap fits to the scalp providing more comfort to the patient and a better adaptation of the electrode to the scalp, according to an embodiment.

[0005] The electrodes present as key features: avoidance of preparation for signal acquisition (i.e. no need for electrolytic gel); and a mechanical interface which allows a better adaptation of the electrode to any form of the scalp surface. Each electrode is composed of two parts, according to an embodiment: the metallic interface with the scalp and a cable with a rubber support that wires the acquired signals to the acquisition and processing unit. The interface with the scalp consists of 32 retractable pins, according to an embodiment, which are soldered on a side of a perforated circuit board which features a female snap fastener on the other side. Each of the pins presents a system of piston and cylinder with a spring, according to an embodiment, which allows a retraction, e.g. of 1.4 mm, under pressure. The pins are constructed by a Beryllium-Copper alloy and plated with a 0.5 µm gold layer, according to an embodiment.

[0006] The embodiments of the electrode feature, as main advantages, low impedance on its interface to the skin due to its material constitution and the ability to shape three-dimensionally to the skin, always maintaining contact between the electrode and the scalp, even on spheroid surfaces.

[0007] Small movements of the cap or electrode, for instance generated by the difference of pressure applied between the top and side of the inner cap, do not affect the acquisition of the signals once the electrode pins has the ability to actively shape and compensate these movements.

[0008] The cable of the electrode consists of a male snap fastener, a rubber cylinder and a silicon part that holds the cable, according to an embodiment. The cable fits into the female snap fastener located on the top of the metallic interface, and the rubber cylinder allows the fixation of the entire electrode to the inner cap.

[0009] The electronic circuitry of acquisition, processing and transmission of EEG data presents a multi-tasking operating system (OS) with priorities setting, according to an embodiment. As main functions, according to an embodiment, this unit is responsible for: programming analog-to-digital converters (ADCs) for converting analog EEG signals into digital representations; reading of EEG data samples, saving acquired data into a storage unit, processing of EEG data by an event detection algorithm; and transmission of data and events. This unit is fully configurable, according to an embodiment, to allow the selection of any number of electrodes between 1 and 32, sampling rates (250, 500 and 1000 samples per second), electrode amplification ranging from 1 to 24 and different electrode configurations. These functionalities are achieved through the combination of two software structures to deal with the acquired data: a kernel driver and a userspace application, according to an embodiment.

[0010] The described system features several advantages and added value for monitoring of patients with neurological disorders in outpatient regimen. Monitoring of patients is traditionally held in hospital environment under continuous surveillance of health professionals, which cannot be considered a natural and familiar environment and thus may affect EEG recordings. Besides enabling patient monitoring in more natural environments, the surveillance time spent by health professionals can be reduced due to the system's ability to trigger pathological events. The paradigm of EEG signals monitoring in outpatient regimen is necessarily dependent on the available environment measurements in order to partially control a naturally uncontrollable setting.

[0011] In outpatient regimen, patients often perform daily activities that typically impair the acquisition of EEG signals with high quality. Being the movement common to most daily activities, it is necessary to develop solutions to minimize the occurrence of motion artifacts in the acquired EEG signals. In this invention, motion artifacts are attenuated by the adaptive mechanical structure of the electrode pins as well as through an artifact correction algorithm. The presence of an accelerometer and gyroscope also allows the detection of artifact-imposing movements, providing the opportunity to ignore EEG signals in which artifact attenuation might not be

satisfactory. The use of algorithms for inhibition of artifacts and the detection of specific pathological events, may be a useful tool for monitoring of EEG in medical diagnosis and therapy of outpatients. The system presented has a set of advantageous features, which allow monitoring of patients in outpatient regimen in non-controlled environments. The advantages presented at the level of the electrodes and the integral processing of the EEG signals in a single hardware and software system enable high-quality monitoring of neurologic patients in non-hospital environments.

[0012] It is disclosed a cap for use in electroencephalography, EEG, comprising:
a plurality of dry EEG electrodes,
an internal elastic cap for supporting said electrodes,
wherein the electrode comprises a support member which is attached to the internal cap and,
wherein the electrode comprises a plurality of retractable electrode pins for contacting simultaneously with the EEG subject,
wherein the retractable electrode pins are attached throughout a surface of said support member.

[0013] In an embodiment, the support member is pivotably attached to the internal cap.

[0014] In the context of the invention, pivotably means able to have some rotary motion and/or inclination motion, not that it requires a ball-joint or mechanical pivot like a Cardan joint. In particular, the attachment to the internal cap is such that the pivot motion is given by the elasticity of the cap and does not require pivot joint.

[0015] In an embodiment, the internal elastic cap is an elastic fabric cap.

[0016] In an embodiment, the support member comprises a female snap fastener on the surface opposite the surface where the retractable electrode pins are attached.

[0017] In an embodiment, the internal cap comprises one or more rings fitted to the internal cap where the electrodes are to be attached, wherein the internal cap has an opening fully or partially aligned with the ring opening.

[0018] An embodiment comprises a connecting cable for each electrode, said cable comprising a male snap fastener for snapping to the female snap fastener of the electrode support member and a cylinder for inserting through openings of the internal cap or through the rings of the internal cap, such that the support member is pivotably attached to the internal cap through the insertion pressure of the cylinder of the connecting cable.

[0019] In an embodiment, the rings of the internal cap are of plastic and the cylinders of the connecting cables are of rubber; in particular the plastic rings are two-part male-female rings.

[0020] In an embodiment, the retractable electrode pin comprises a cylinder and a piston having a resilient member for driving out the piston.

[0021] In an embodiment, the resilient member is a spring, in particular a helical spring.

[0022] In an embodiment, the support member is a circuit board and the retractable electrode pins are soldered to the circuit board, in particular the circuit board being perforated.

[0023] In an embodiment, the retractable electrode pin has displacement of 0.5mm - 2mm, in particular 1mm - 1.8mm, further in particular 1.2-1.6mm.

[0024] In an embodiment, the retractable electrode pin is made of a Beryllium-Copper alloy and plated with a gold layer.

[0025] In an embodiment, the electrode comprises 32 retractable electrode pins arranged in a matrix layout, in particular a 6 pin by 6 pin matrix layout.

[0026] In an embodiment, the matrix layout has an area of 150-250mm^2, in particular 180-210mm^2.

[0027] In an embodiment, the retractable electrode pin is a telescopic retractable electrode pin.

[0028] An embodiment comprises an external cap for receiving and supporting electronic components, cables and battery, in particular the external cap comprises a

temperature and humidity-isolated compartment for receiving electronic components, cables and battery.

[0029] In an embodiment, the external cap is a hat or hat-shaped.

[0030] References

[1] JASPER, H. H. (1958). The ten twenty electrode system of the international federation. Electroencephalography and clinical neurophysiology, 10, 371-375.

Brief Description of the Drawings

[0031] The following figures provide preferred embodiments for illustrating the disclosure and should not be seen as limiting the scope of invention.

[0032] **Figure 1:** Schematic representation of an embodiment in what regards to the final structure and communications.

[0033] **Figure 2:** Schematic representation of an embodiment of the dry EEG electrode.

[0034] **Figure 3:** Schematic representation of an embodiment of the interface between the inner and outer caps and the head of the subject.

[0035] **Figure 4:** Schematic representation of an embodiment of the electrode and pins.

[0036] **Figure 5:** Schematic representation of an embodiment of the interaction between the head, the electrode and the inner cap.

[0037] **Figure 6:** Schematic representation of an embodiment of the software structure used in the system for signal acquisition.

[0038] **Figure 7:** Schematic representation of an embodiment of the software structure developed for processing and wireless transmission of the acquired data.

Detailed Description

[0039] The following provides preferred embodiments for illustrating the disclosure.

[0040] Fig. 1 is a perspective schematic and simplified representation of a realization of the system developed in accordance with the invention in what regards to the final structure and communications. In (11) the developed system is illustrated as well as the electrodes positioning on the head. The structure in (11) establishes a communication using the IEEE 802.11 b/g Protocol (Wifi) for transmission of data directly (14) to a computer (12) or indirectly (15) through a smartphone (13) which then forwards (16) to the computer (12).

[0041] Fig. 2 is a schematic representation of the dry EEG electrode. The electrode consists of 32 retractable pins (21) aligned in a 6 by 6 matrix, soldered on the inferior surface of a perforated printed circuit board (22). On its superior surface, a female snap fastener is also soldered to the printed circuit board (23), in which the male snap of the cable (24) is plugged. The cable part also features a rubber cylinder (25) to fix the electrode in the inner cap and a silicon support (26) that allows the fixation of the wires (27) that connect to the signal acquisition circuitry.

[0042] Fig. 3 represents a schematic of the interface between the inner (32) and outer (31) caps and the head of the subject. The external cap (31) features 3 fixing points for snap fastening (36) to the inner cap (32). The external cap also features a temperature and humidity-isolated compartment on top (35) where the acquisition electronics and wireless data transmission (34) are placed. The electrodes (33) are fixed to the inner cap according to standard 10-20 electrode locations. The cable of each electrode is routed among the inner cap (32) and the outer cap (31) and connects to the electronic circuitry for acquisition and transmission of data (34).

[0043] Fig. 4 represents a schematic of the electrode and pins. The electrode has an area of 196 mm^2 (42) x (41), each side with a length of 14 mm. The electrode has a volume of 2744 mm^3 or 1960 mm^3 depending on the length of the pins (43) which can vary between 5 mm or 9 mm with no compression. Each pin consists of a piston (47), a

cylinder (46), a spring (45) and a head (44), so that the piston, compressed by the spring against the scalp skin, can sense the EEG signals. The head (44) of the pin is soldered to the printed circuit board. The maximum movement of the piston in respect to the cylinder is 1.4 mm. The piston features a diameter of 1.07 mm.

[0044] Fig. 5 represents a schematic of the interaction between the head (51), the electrode (57) and the inner cap (52). The inner cap (52) includes a series of plastic rings (55) at positions specified by the standard 10-20. Each of these plastic structures consists of a male and female that fit and adhere to the inner cap elastic tissue creating a circular opening with a diameter of 10 mm and thickness of 5 mm. The rubber part (54) of electrode is 11 mm thick, thus enabling optimal plugin and grip of the electrode in designated positions of the cap. The interface between the cable part of the electrode, including wires (58), silicon (53) and rubber (54), and the metallic interface is held by the male (56) and female (57) snap fasteners. As depicted in Fig. 5, the 32-pin electrode with retractable pistons (59) allow the printed circuit board (58) to maintain its parallel alignment with the surface of the head, while each pin change its compression level accordingly (51) and thus, maximizing the contact surface between the electrode pins and the head. In addition, different pressures in different regions of the cap are compensated by the level of compression on the pins, without affecting the contact between the electrode and the scalp.

[0045] Fig. 6 shows a schematic of the software structure used in the system for signal acquisition. The microcontroller uses a multitasking operating system to establish a connection with the analog-to-digital converters (61) through a kernel driver (64). This presents a bidirectional communication (62) for programming the converters and reading the acquired data (63). Synchronization of the real-time acquisition is established through an interruption signal (65) provided by converters in a scheduled interval. For each interrupt, the kernel driver reads and saves data in a block of memory readings (66).

[0046] Fig. 7 represents a schematic of the software structure developed for processing and wireless transmission of the acquired data. The kernel driver (71) copies the data block of the memory readings to the shared memory block (74) in an

established time window. When these data are copied, a flag (76) is turned on, as a shared variable (75) with an application of the userspace (72). Once the variable is flagged (77), the userspace application copies the data through a mapped access (73) to the shared memory, saves the data in a storage unit (79), processes the data in an event detection algorithm (710) and sends them wirelessly to a mainframe (712), in case an ictal or inter-ictal event is detected.

[0047] The term "comprising" whenever used in this document is intended to indicate the presence of stated features, integers, steps, components, but not to preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

[0048] The disclosure should not be seen in any way restricted to the embodiments described and a person with ordinary skill in the art will foresee many possibilities to modifications thereof.

[0049] The above described embodiments are combinable.

[0050] The following claims further set out particular embodiments of the disclosure.

C L A I M S

1. Cap for use in electroencephalography, EEG, of a subject, comprising:
   a plurality of a dry EEG electrode,
   an internal elastic cap for supporting said plurality of electrodes,
   wherein the dry EEG electrode comprises a support member which is attached to the internal cap and,
   wherein the electrode comprises a plurality of retractable electrode pins for contacting simultaneously with the EEG subject,
   wherein the retractable electrode pins are attached throughout a surface of said support member.

2. Cap according to the previous claim wherein the support member is pivotably attached to the internal cap.

3. Cap according to claim 1 wherein the flexibility of the internal elastic cap is such that the electrode is able to pivot about the surface of the EEG subject.

4. Cap according to any of the previous claims wherein the internal elastic cap is an elastic fabric cap.

5. Cap according to any of the previous claims wherein the support member is releasably attached to the internal cap.

6. Cap according to the previous claims wherein the support member comprises a male-female snap fastener for fastening the plurality of retractable electrode pins.

7. Cap according to any of the previous claims the support member comprises cylindrical part and the internal cap comprises one or more rings with a circular opening, fitted to the internal cap, wherein the internal cap has an opening fully or partially aligned with each ring opening, each said opening being suitable for

receiving a cylindrical part of the electrode support member that is to be attached thereto.

8. Cap according to the previous claim wherein the ring has a diameter of 10 mm and thickness of 5 mm.

9. Cap according to any of the claims 7 - 8 wherein the rings of the internal cap are of plastic and the cylindrical parts of the support members are of rubber; in particular the plastic rings are two-part male-female rings.

10. Cap according to any of the previous claims comprising a connector cable for each electrode, said cable comprising a male-female snap fastener for snapping to a male-female snap fastener of the electrode support member and a cylindrical part for inserting through openings of the internal cap or through ring-lined openings of the internal cap, such that the support member is releasably attachable to the internal cap through the insertion pressure of the cylindrical part of the connector cable in said openings.

11. Cap according to the previous claim wherein the connecting cable comprises a silicone cable-holding part.

12. Cap according to any of the previous claims wherein the retractable electrode pin comprises a cylinder and a piston having a resilient member for driving out the piston.

13. Cap according to the previous claim wherein the resilient member is a spring, in particular a helical spring.

14. Cap according to any of the previous claims wherein the support member comprises a circuit board and the retractable electrode pins are soldered to the circuit board, in particular the circuit board being perforated by the electrode pins.

15. Cap according to any of the previous claims wherein the retractable electrode pin has displacement of 0.5mm - 2mm, in particular 1mm - 1.8mm, further in particular 1.2-1.6mm.

16. Cap according to any of the previous claims wherein the retractable electrode pin is made of a Beryllium-Copper alloy and plated with a gold layer.

17. Cap according to any of the previous claims wherein the retractable electrode pins are arranged in a matrix layout, in particular a square matrix layout.

18. Cap according to any of the previous claims wherein the electrode comprises 32 retractable electrode pins arranged in a matrix layout, in particular a 6 pin by 6 pin matrix layout except for a central 2 pin by 2 pin area.

19. Cap according to the previous claim wherein the matrix layout has an area of 150-250mm^2, in particular 180-210mm^2.

20. Cap according to any of the previous claims wherein the retractable electrode pin is a telescopic retractable electrode pin.

21. Cap according to any of the previous claims comprising an external cap for receiving and supporting electronic components, cables and battery, in particular the external cap comprises a temperature and humidity-isolated compartment for receiving electronic components, cables and battery.

22. Cap according to the previous claim wherein the external cap is a hat or hat-shaped.

23. Cap according to any of the previous claims wherein the cap is connected wirelessly to a data processor for processing EEG signals.

D R A W I N G S

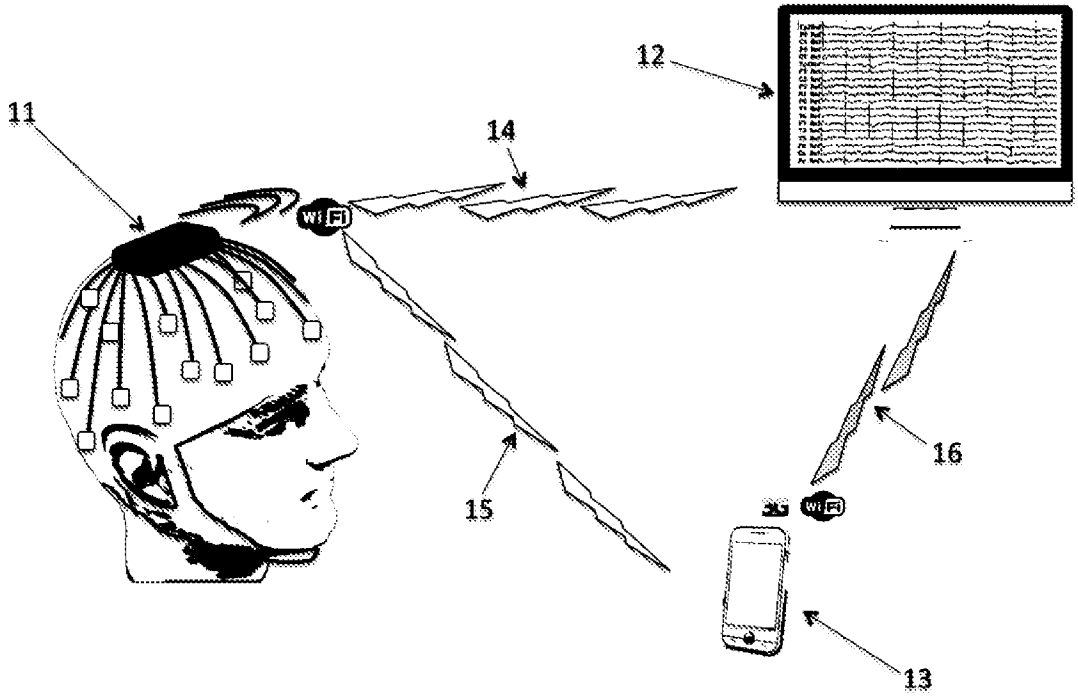


Fig. 1

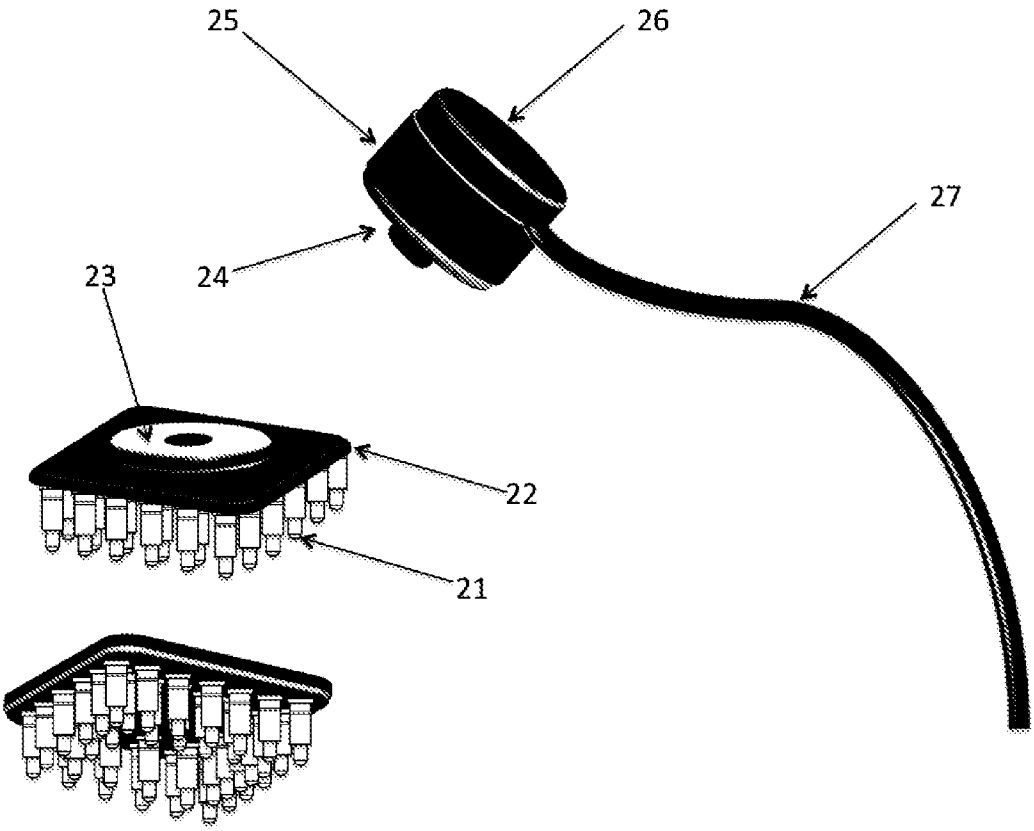


Fig. 2

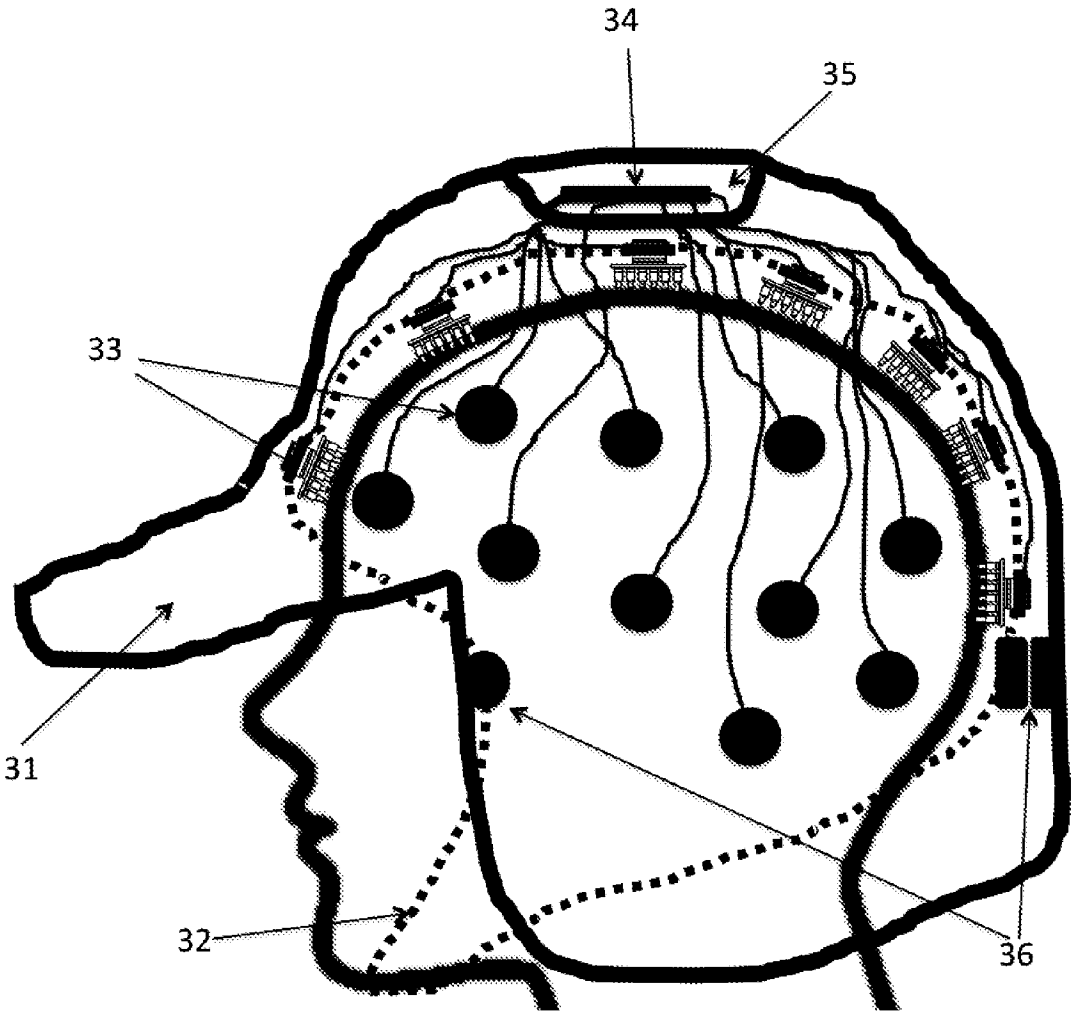


Fig. 3

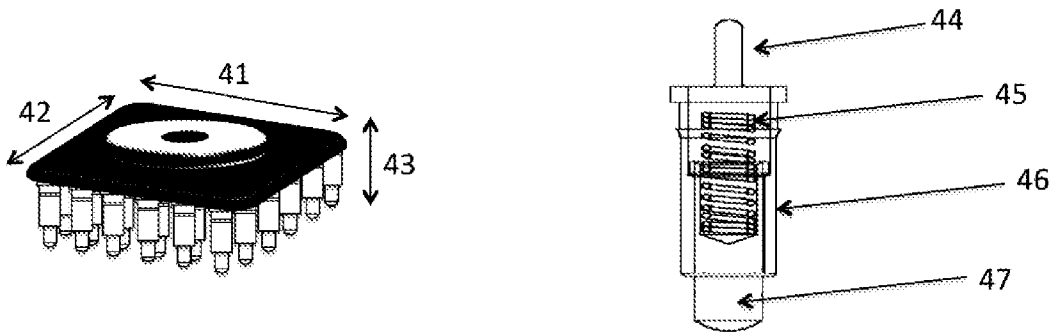


Fig. 4

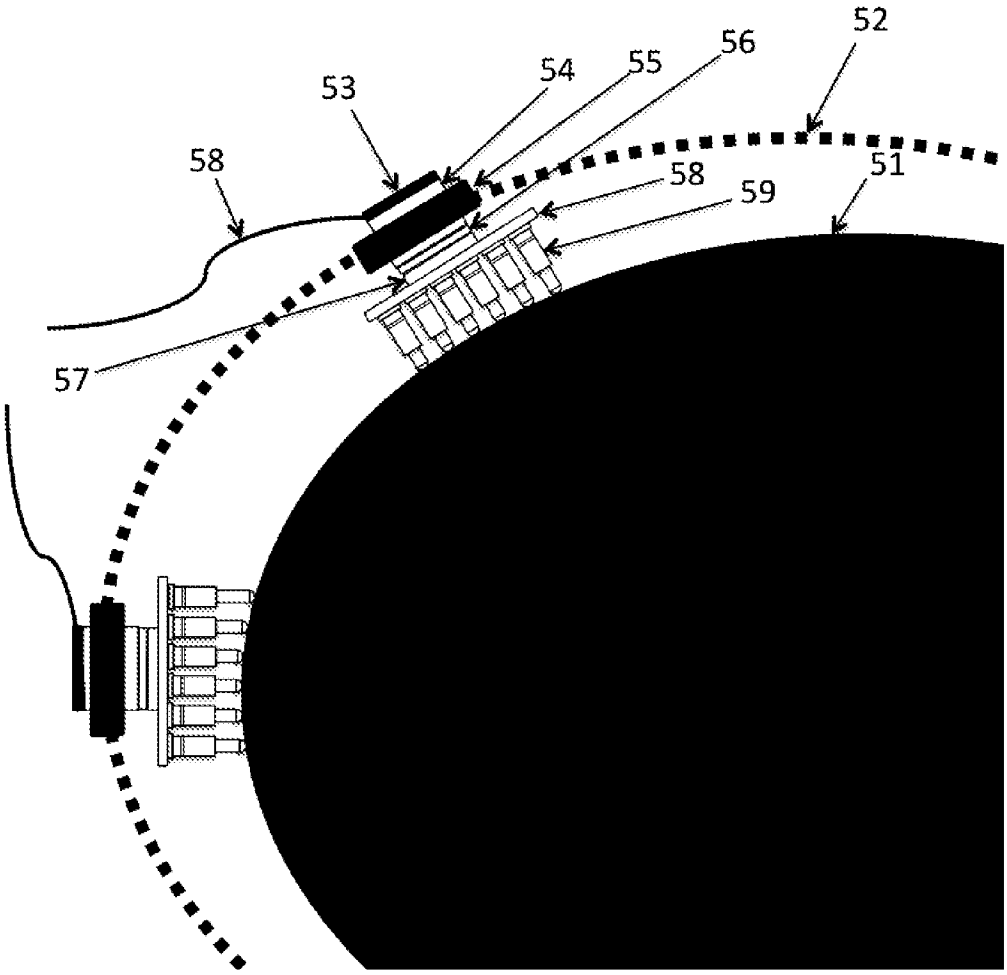


Fig. 5

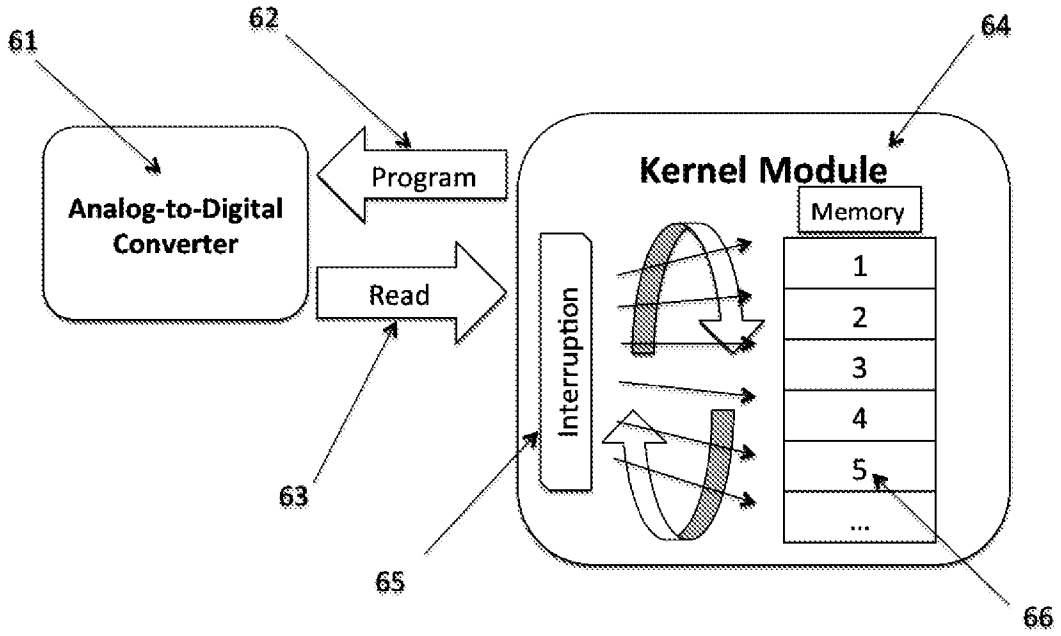
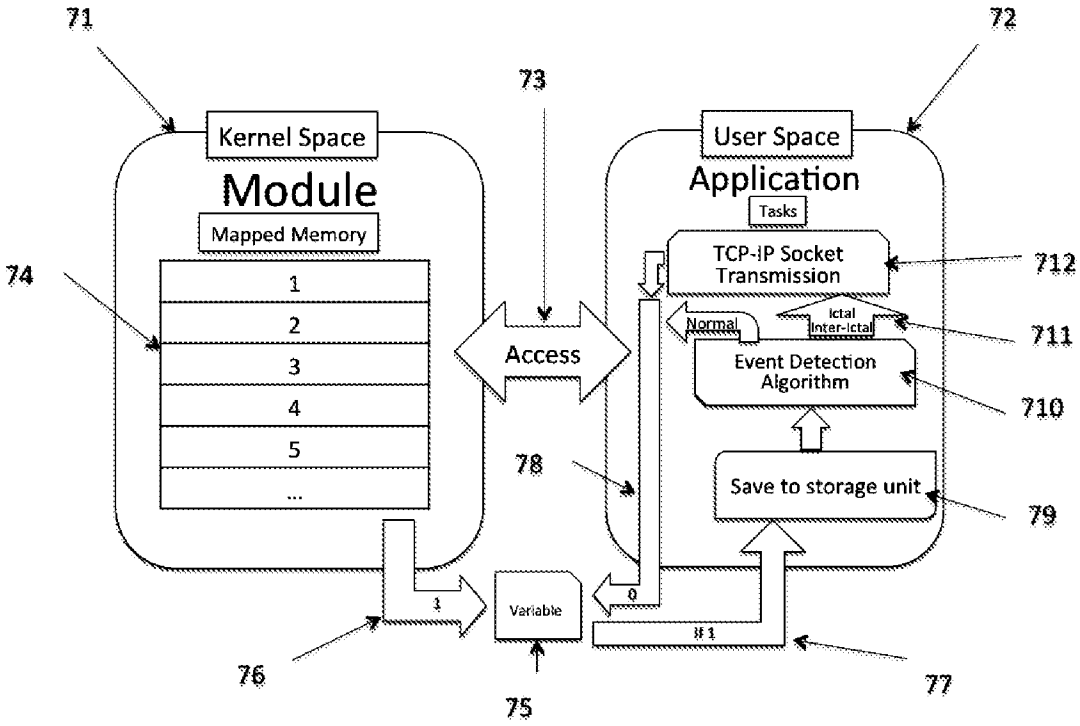

61
62
64
Analog-to-Digital Converter
Program
Read
Kernel Module
Memory
Interruption
1
2
3
4
5
...
63
65
66

Fig. 6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Kernel Space
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Mapped Memory
74
1
2
3
4
5
...
Access
User Space
Application
Tasks
TCP-IP Socket Transmission
712
Normal
Ictal
Inter-ictal
711
Event Detection Algorithm
710
78
Save to storage unit
79
Variable
0
1
If 1
76
75
77

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2016/052209

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B5/0478 A61B5/00
ADD.

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)
A61B

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2014/288406 A1 (CHAI YUN [TW]) 25 September 2014 (2014-09-25) figures 2-5 paragraphs [0002], [0016], [0018], [0019], [0024] -----	1-23
X	DE 10 2010 056099 A1 (UNIV ILMENAU TECH [DE]) 21 June 2012 (2012-06-21) figures 1-4 paragraphs [0004], [0025], [0027], [0028], [0030], [0035] -----	1-23
X	EP 2 767 632 A1 (NIPPON TELEGRAPH & TELEPHONE [JP]) 20 August 2014 (2014-08-20) figures 9B, 19A-D, 22A, B, 23A, 24B paragraphs [0232], [0245], [0272], [0281], [0307], [0327] ----- -/--	1-23

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

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
17 June 2016	24/06/2016

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2016/052209

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2014/051044 A1 (BADOWER YAKOB [DE] ET AL) 20 February 2014 (2014-02-20) paragraph [0161]	23
A	US 2011/054288 A1 (BESIO WALTER G [US]) 3 March 2011 (2011-03-03) paragraph [0040]	23

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2016/052209

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2014288406 A1	25-09-2014	TW 201436763 A	01-10-2014
		US 2014288406 A1	25-09-2014
		US 2016000351 A1	07-01-2016
		US 2016000352 A1	07-01-2016
		US 2016000353 A1	07-01-2016
DE 102010056099 A1	21-06-2012	NONE	
EP 2767632 A1	20-08-2014	CN 103930612 A	16-07-2014
		EP 2767632 A1	20-08-2014
		EP 3001947 A1	06-04-2016
		JP 5706539 B2	22-04-2015
		JP 5706574 B2	22-04-2015
		JP 5706575 B2	22-04-2015
		JP 2015037695 A	26-02-2015
		JP 2015037696 A	26-02-2015
		JP 2015077414 A	23-04-2015
		JP WO2013073673 A1	02-04-2015
		US 2014303470 A1	09-10-2014
		WO 2013073673 A1	23-05-2013
US 2014051044 A1	20-02-2014	CN 103720470 A	16-04-2014
		JP 5665205 B2	04-02-2015
		JP 2014036862 A	27-02-2014
		US 2014051044 A1	20-02-2014
		US 2014051960 A1	20-02-2014
		US 2014051961 A1	20-02-2014
		US 2015141789 A1	21-05-2015
		US 2015282730 A1	08-10-2015
		US 2016166169 A1	16-06-2016
US 2011054288 A1	03-03-2011	US 2011054288 A1	03-03-2011
		WO 2009134763 A1	05-11-2009