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(71) Applicant(s):
Prevayl Innovations Limited
57 Spring Gardens, Manchester, M2 3AZ,
United Kingdom

(72) Inventor(s):
Mantas Jurkuvenas

(74) Agent and/or Address for Service:
Deborah Margaret Slater
Prevayl Innovations Limited, 57 Spring Gardens,
Manchester, M2 3AZ, United Kingdom

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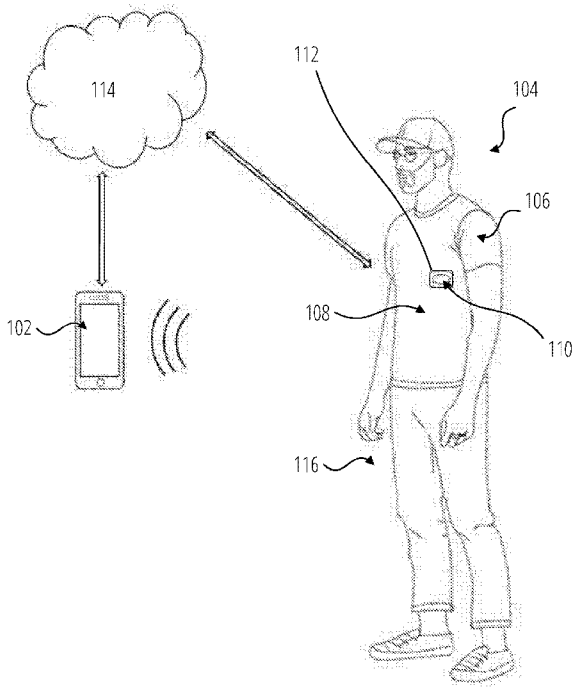
(56) Documents Cited:
GB 2591872 A
WO 2021/167385 A1
WO 2015/021312 A1
US 20210068713 A1
US 20150119760 A1
US 20140197946 A1
GB 2528828 A
WO 2015/087330 A1
US 20220036717 A1
US 20170274247 A1
US 20140278229 A1

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(54) Title of the Invention: **A wearable article, an electronics module for a wearable article and a method performed by a controller for an electronics module for a wearable article**
Abstract Title: **Electronics module with liquid detecting arrangement for a wearable article**

(57) An electronics module 110 for a wearable article e.g. garment 106 comprises a liquid detecting arrangement which is coupled to a controller. The liquid detecting arrangement determines if there is liquid in the environment of the electronics module, e.g. if a user 104 is swimming. The controller also receives contextual inputs such as information about the location, movement, health or wellbeing of the user e.g. GPS, gyroscope, accelerometer, magnetometer, temperature, biosignal, ECG. The operation of the controller is controller in response to the contextual inputs and the determination of the presence of liquid. Useful insights may be displayed to the wearer. Liquid may be detected by measuring impedance or resistance between a pair of electrical contacts, or optically using the sensor module of a photoplethysmography sensor.

FIG. 1



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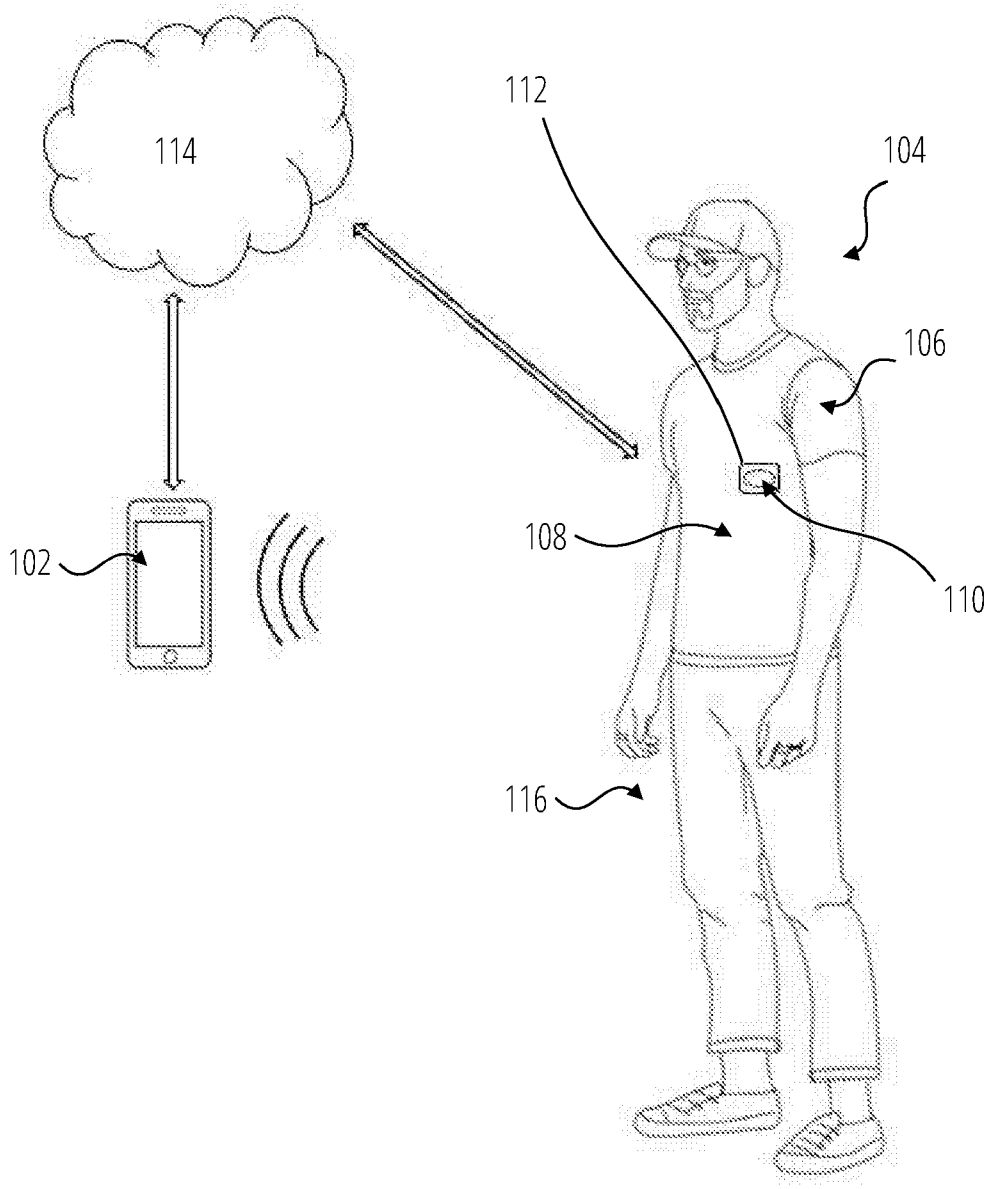


FIG. 1

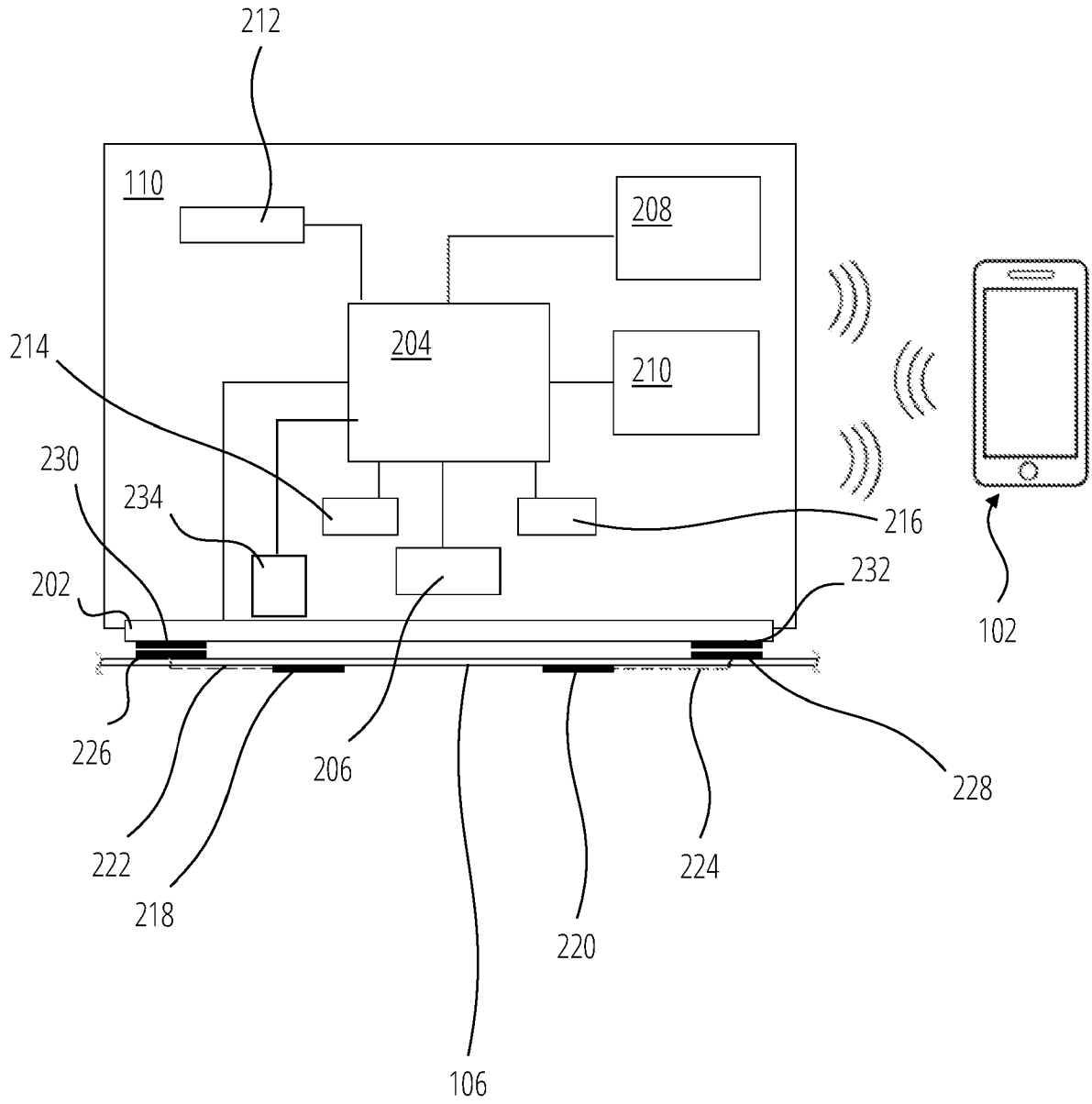

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110
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218
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106

FIG. 2

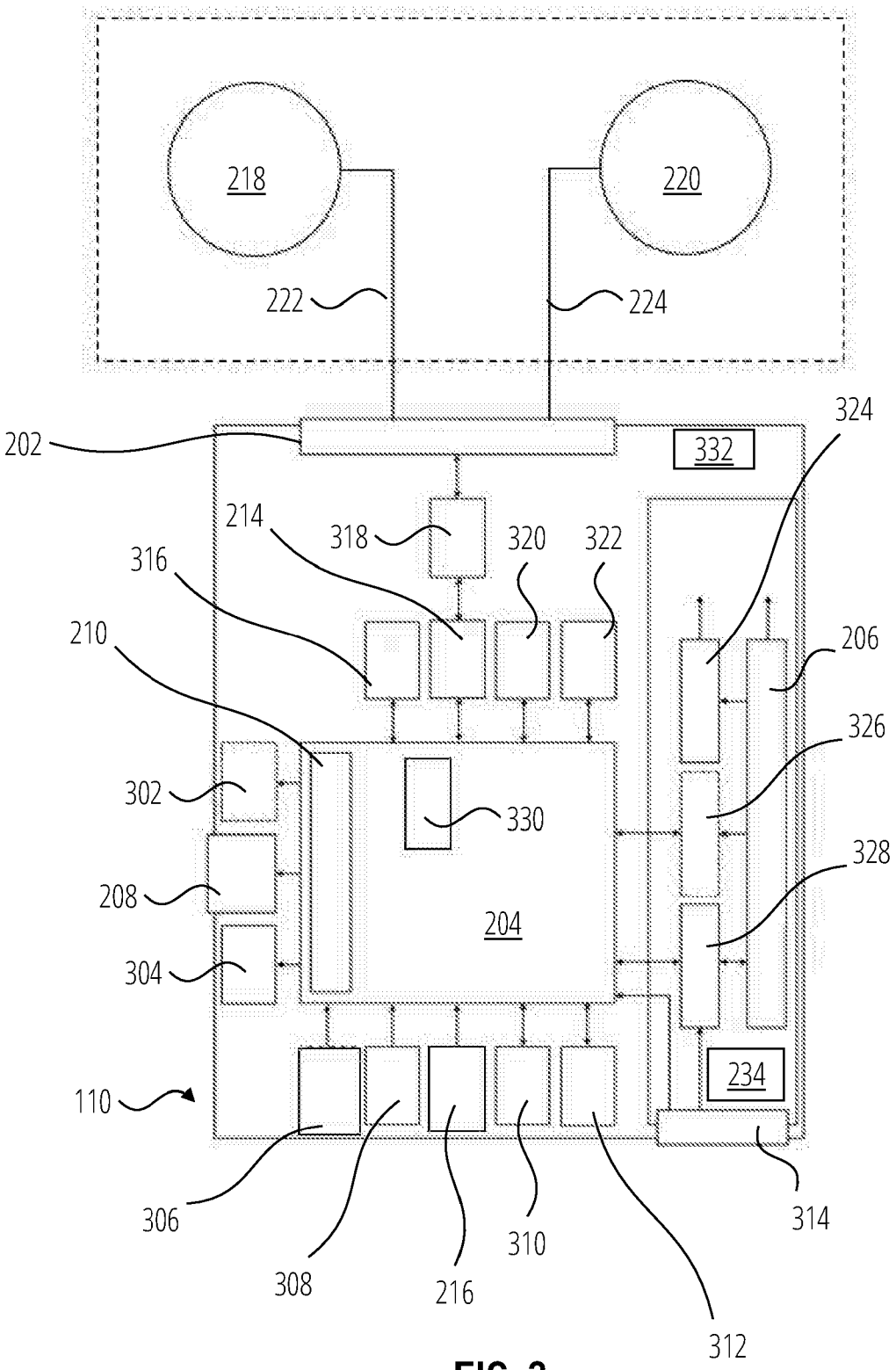

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FIG. 3

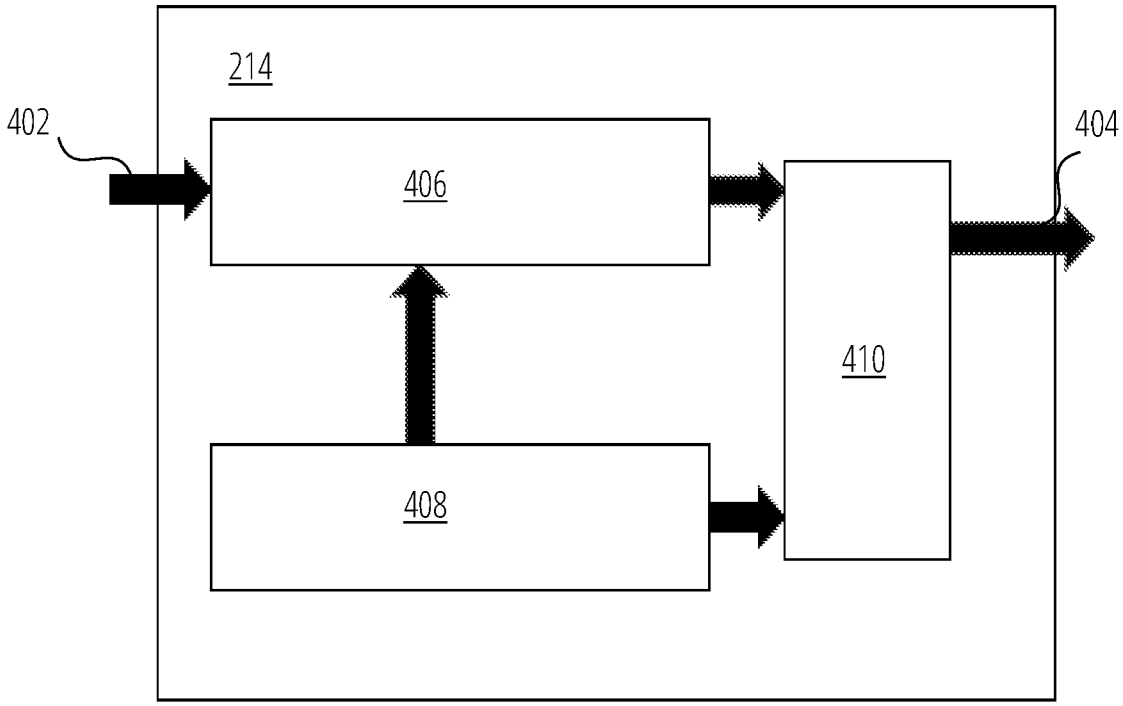


FIG. 4

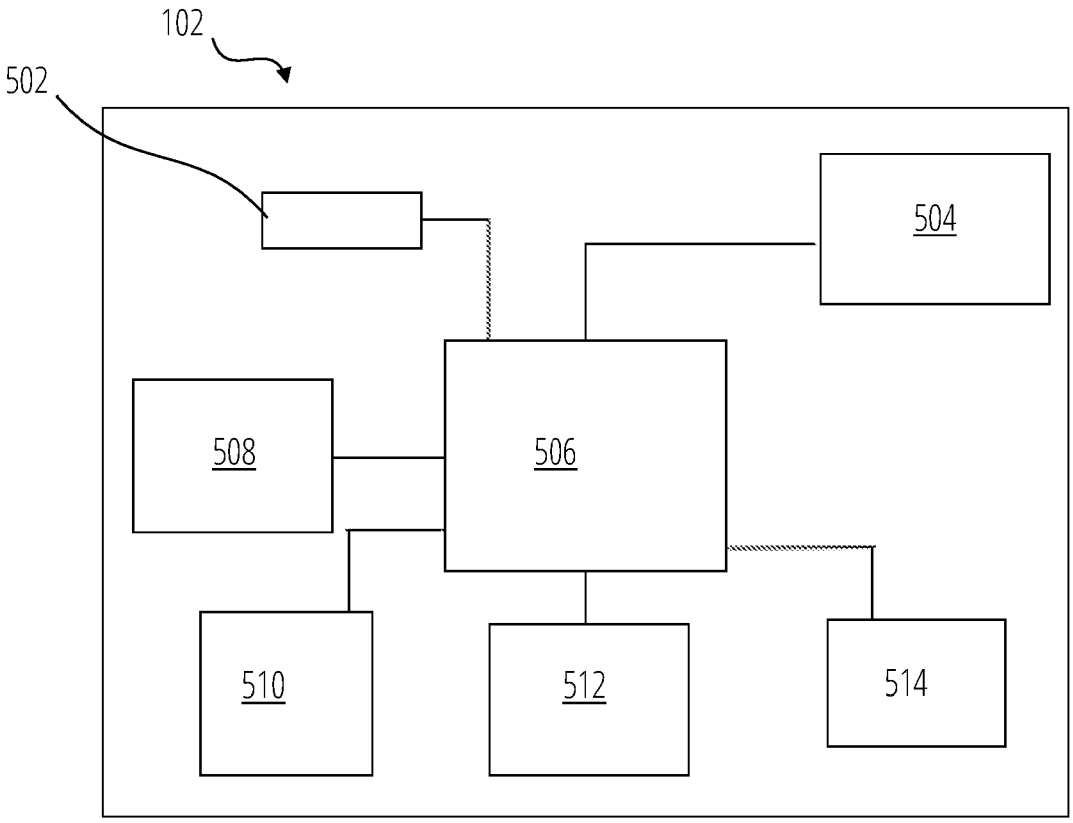


FIG. 5

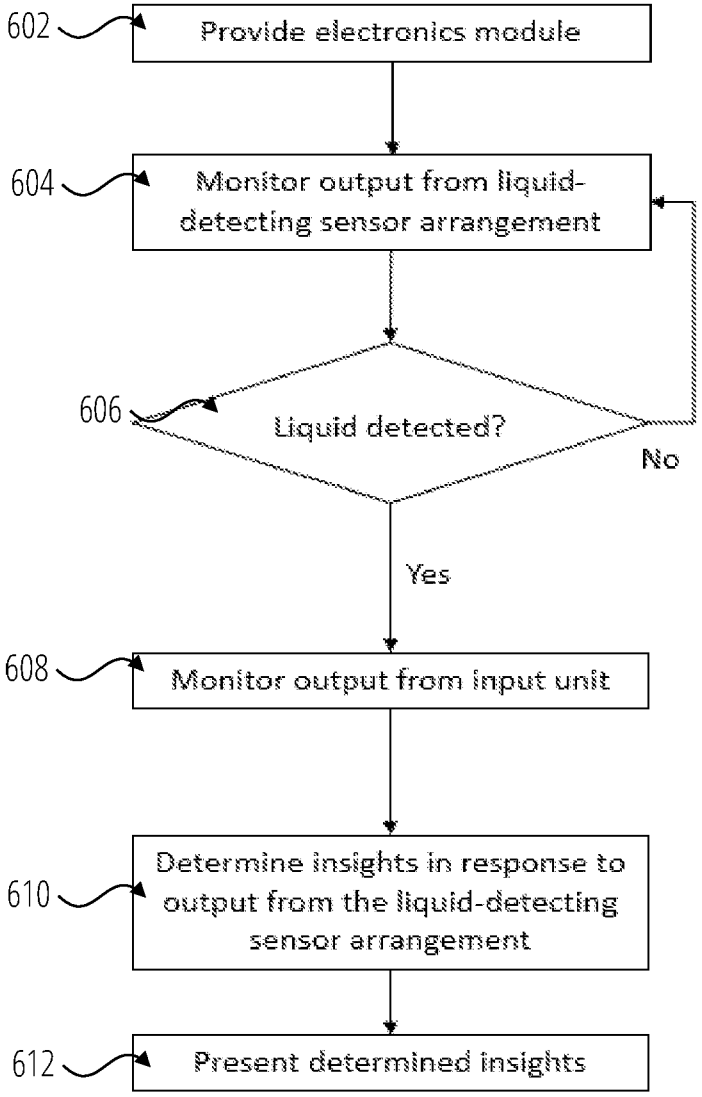

602
Provide electronics module
604
Monitor output from liquid-detecting sensor arrangement
606
Liquid detected?
No
Yes
608
Monitor output from input unit
610
Determine insights in response to output from the liquid-detecting sensor arrangement
612
Present determined insights

FIG. 6

A WEARABLE ARTICLE, AN ELECTRONICS MODULE FOR A WEARABLE ARTICLE, AND A METHOD PERFORMED BY A CONTROLLER FOR AN ELECTRONICS MODULE FOR A WEARABLE ARTICLE

[0001] The present invention is directed towards a system comprising an electronics module, a wearable article in the form of a garment, and a user electronic device communicatively coupled to the electronics module. More particularly, the wearable article comprises a biosignal measuring apparatus for sensing biosignals from a wearer of the wearable article, and which incorporates a sensor assembly and the electronics module. The electronics module is arranged to transmit biosignal data to the user electronics module or other remote device. The present invention is also directed towards a controller for an electronics module and a wearable article incorporating an electronics module.

BACKGROUND

[0002] Wearable articles, such as garments, incorporating sensors are wearable electronics used to measure and collect information from a wearer. It is advantageous to measure biosignals of the wearer during exercise, or other scenarios.

[0003] It is known to provide a garment, or other wearable article, to which an electronic device (i.e. an electronics module, and/or related components) is attached in a prominent position, such as on the chest or between the shoulder blades. Advantageously, the electronic device is a detachable device. The electronic device is configured to process the incoming signals, and the output from the processing is stored and/or displayed to a user in a suitable way

[0004] A sensor senses a biosignal such as electrocardiogram (ECG) signals and the biosignals are coupled to the electronic device, via an interface.

[0005] The sensors may be coupled to the interface by means of conductors which are connected to terminals provided on the interface to enable coupling of the signals from the sensor to the interface.

[0006] Electronics modules for wearable articles such as garments are known to communicate with mobile devices over wireless communication protocols such as Bluetooth ® and Bluetooth ® Low Energy. These electronics modules are typically removably attached to the wearable

article, interface with internal electronics of the wearable article, and comprise a Bluetooth ® antenna for communicating with the mobile device.

[0007] The electronic device includes drive and sensing electronics comprising components and associated circuitry, to provide the required functionality.

[0008] The drive and sensing electronics include a power source to power the electronic device and the associated components of the drive and sensing circuitry.

[0009] It may be helpful to be able to determine the environment in which the wearable article and electronics module are being used in order that context can be given for the measurements, insights and information being collected.

[0010] One environment could be when a wearer of the wearable article is in water, for example whilst swimming or undertaking water-based sports such as water polo.

SUMMARY OF THE INVENTION

[0011] According to an aspect of the present invention, there is provided an electronics module for a wearable article comprising a controller, at least one input unit and a liquid-detecting arrangement, the at least one input unit and the liquid-detecting arrangement being coupled to the controller, the liquid-detecting arrangement being arranged to provide a signal indicative of the presence of a liquid in the environment of the electronics module to the controller, and the input unit being arranged to provide an input to the controller providing contextual information for the controller, wherein the controller is further configured to monitor signals from the liquid-detecting sensor to determine if liquid is present in the environment of the electronics module, and to control operation of the controller in response to a determination of the presence of liquid in the environment of the electronics module and in response to any input received from the input unit.

[0012] This information, along with inputs from one or more input units enables more targeted and useful insights to be displayed to the wearer.

[0013] The liquid-detecting arrangement may measure the impedance between a pair of electrical contacts on the electronics module. Measuring the impedance may comprise measuring the resistance between the pair of electrical contacts.

[0014] The electronics module may further comprise an interface arranged to communicatively couple with a sensing unit of the wearable article, and wherein the pair of contacts are part of the interface.

[0015] The liquid detection arrangement may be a liquid detection device or a humidity sensor.

[0016] The electronics module may also include an optical sensor module configured to transmit an optical signal externally of the electronics module and to detect a change in the optical signal in response to the presence of a liquid external to the electronics module.

[0017] The optical sensor module may comprise a photoplethysmography sensor. The electronics module may include a housing, and the optical sensor module may be arranged inside the housing.

[0018] The input unit may be a location device, for example a GPS unit. The input unit may be a motion detection device, for example an inertial measurement unit which may comprise an accelerometer and optionally one or both of a gyroscope and a magnetometer. The input unit may be a temperature sensor.

[0019] According to another aspect of the invention, there is provided a method performed by an electronics module for a wearable article, the method includes the steps of monitoring an environment of the electronics module for the presence of a liquid in the environment, monitoring for contextual information indicative of the context of use or operation of the electronics module, determining insights for a wearer of the wearable article depending upon whether liquid is present in the environment and any contextual information, and presenting determined insights via a presentation device.

[0020] The environment may be monitored by measuring the impedance between a pair of electrical contacts provided on the electronics module.

[0021] The impedance may be measured by measuring the resistance.

[0022] The environment may be monitored by transmitting an optical signal externally of the electronics module and detecting a change in the optical signal in response to the presence of liquid in the environment.

[0023] The step of monitoring the environment comprises detecting a refracted optical signal using an optical sensor of the electronics module. The optical sensor my be a PPG sensor.

[0024] The contextual environment may be derived from a location device of the electronics module. The location device me be a GPS unit.

[0025] The contextual environment may be derived from a motion detection device of the electronics module. The motion detection device, nay be an inertial measurement unit which may comprise an accelerometer and optionally one or both of a gyroscope and a magnetometer.

[0026] The step of monitoring for contextual information may be measuring ambient temperature or a temperature of a wearer of the wearable article. The temperature may be derived from a temperature sensor on the electronics module.

[0027] Other technical features may be readily apparent to one skilled in the art from the following figures, descriptions, and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] Examples of the present disclosure will now be described with reference to the accompanying drawings, in which:

[0029] FIG. 1 shows a schematic diagram for an example system according to aspects of the present disclosure;

[0030] FIG. 2 shows a schematic diagram for an example electronics module according to aspects of the present disclosure;

[0031] FIG. 3 shows a detailed schematic diagram of the electronics components of an example electronics module according to aspects of the present disclosure;

[0032] FIG. 4 shows a schematic diagram for an example analogue to digital converter used in the example electronics module of Figures 4 and 5 according to aspects of the present disclosure;

[0033] FIG. 5 shows a detailed schematic diagram of a user electronics device according to aspects of the present disclosure;

[0034] FIG. 6 illustrates an aspect of the subject matter in accordance with one embodiment.

DETAILED DESCRIPTION

[0035] The following description with reference to the accompanying drawings is provided to assist in a comprehensive understanding of various embodiments of the disclosure as defined

by the claims and their equivalents. It includes various specific details to assist in that understanding but these are to be regarded as merely exemplary. Accordingly, those of ordinary skill in the art will recognize that various changes and modifications of the various embodiments described herein can be made without departing from the scope and spirit of the disclosure. In addition, descriptions of well-known functions and constructions may be omitted for clarity and conciseness.

[0036] The terms and words used in the following description and claims are not limited to the bibliographical meanings but are merely used by the inventor to enable a clear and consistent understanding of the disclosure. Accordingly, it should be apparent to those skilled in the art that the following description of various embodiments of the disclosure is provided for illustration purpose only and not for the purpose of limiting the disclosure as defined by the appended claims and their equivalents.

[0037] It is to be understood that the singular forms "a," "an," and "the" include plural referents unless the context clearly dictates otherwise.

[0038] "Wearable article" as referred to throughout the present disclosure may refer to any form of device interface which may be worn by a user such as a smart watch, necklace, garment, bracelet, or glasses. The wearable article may be a textile article. The wearable article may be a garment. The garment may refer to an item of clothing or apparel. The garment may be a top. The top may be a shirt, t-shirt, blouse, sweater, jacket/coat, or vest. The garment may be a dress, garment brassiere, shorts, pants, arm or leg sleeve, vest, jacket/coat, glove, armband, underwear, headband, hat/cap, collar, wristband, stocking, sock, or shoe, athletic clothing, personal protective equipment, including hard hats, swimwear, wetsuit or dry suit.

[0039] The term "wearer" includes a user who is wearing, or otherwise holding, the wearable article.

[0040] The type of wearable garment may dictate the type of biosignals to be detected. For example, a hat or cap may be used to detect electroencephalogram or magnetoencephalogram signals.

[0041] The wearable article may be constructed from a woven or a non-woven material. The wearable article/garment may be constructed from natural fibres, synthetic fibres, or a natural fibre blended with one or more other materials which can be natural or synthetic. The yarn may

be cotton. The cotton may be blended with polyester and/or viscose and/or polyamide according to the application. Silk may also be used as the natural fibre. Cellulose, wool, hemp and jute are also natural fibres that may be used in the wearable article/garment. Polyester, polycotton, nylon and viscose are synthetic fibres that may be used in the wearable article/garment.

[0042] The wearable article may be a tight-fitting garment. Beneficially, a tight-fitting garment helps ensure that the sensor devices of the garment are held in contact with or in the proximity of a skin surface of the wearer. The garment may be a compression garment. The garment may be an athletic garment such as an elastomeric athletic garment.

[0043] The wearable article has sensing units (not shown in FIG. 1) provided on an inside surface which are held in close proximity to a skin surface of a wearer 116 wearing the wearable article. This enables the sensing units to measure biosignals for the wearer wearing the garment.

[0044] The sensing units may be arranged to measure one or more biosignals of a wearer wearing the garment.

[0045] "Biosignal" as referred to throughout the present disclosure may refer to signals from living beings that can be continually measured or monitored. Biosignals may be electrical or non-electrical signals. Signal variations can be time variant or spatially variant.

[0046] Sensing components may be used for measuring one or a combination of bioelectrical, bioimpedance, biochemical, biomechanical, bioacoustics, biooptical or biothermal signals of the wearer 600. The bioelectrical measurements include electrocardiograms (ECG), electrogastrograms (EGG), electroencephalograms (EEG), and electromyography (EMG). The bioimpedance measurements include plethysmography (e.g., for respiration), body composition (e.g., hydration, fat, etc.), and electroimpedance tomography (EIT). The biomagnetic measurements include magnetoneurograms (MNG), magnetoencephalography (MEG), magnetogastrogram (MGG), magnetocardiogram (MCG). The biochemical measurements include glucose/lactose measurements which may be performed using chemical analysis of the wearer 600's sweat. The biomechanical measurements include blood pressure. The bioacoustics measurements include phonocardiograms (PCG). The biooptical measurements include a photoplethysmography (PPG) or orthopantomogram (OPG). The biothermal measurements include skin temperature and core body temperature measurements.

[0047] Referring to Figures 1 to 7, there is shown an example system 104 according to aspects of the present disclosure. The system 104 comprises an electronics module 110, a wearable article in the form of a garment 106, and a user electronic device 102. The garment 106 is worn by a user who in this embodiment is the wearer 116 of the garment 106.

[0048] The electronics module 110 is arranged to couple with the sensing units incorporated into the garment 106 to obtain signals from the sensors.

[0049] The electronics module 110and the wearable article and including the sensing units comprise a wearable assembly 500.

[0050] The sensing units comprise one or more sensors with associated conductors and other components and circuitry. For example, in the embodiment described herein, the sensing units comprise sensor 218 and sensor 220 and the first conductive pathway 222, the first termination point 226, the second conductive pathway 224 and second termination point 228 as illustrated in FIG. 2 and FIG. 3.

[0051] The electronics module 110 is further arranged to wirelessly communicate data to the user electronic device 102. Various protocols enable wireless communication between the electronics module 110and the user electronic device 102. Example communication protocols include Bluetooth ®, Bluetooth ® Low Energy, and near-field communication (NFC).

[0052] The garment 106 has an electronics module holder in the form of a pocket 112. The pocket 112 is sized to receive the electronics module 110. When disposed in the pocket 112, the electronics module 110 is arranged to receive sensor data from the sensing units. The electronics module 110 is therefore removable from the garment 200.

[0053] The present disclosure is not limited to electronics module holders in the form pockets.

[0054] The electronics module 110 may be configured to be releasably mechanically coupled to the garment 106. The mechanical coupling of the electronics module 110 to the garment 106 may be provided by a mechanical interface such as a clip, a plug and socket arrangement, etc. The mechanical coupling or mechanical interface may be configured to maintain the electronics module 110 in a particular orientation with respect to the garment 200 when the electronics module 100 is coupled to the garment 106. This may be beneficial in ensuring that the electronics module 110 is securely held in place with respect to the garment 106 and/or that any electronic coupling of the electronics module 110 and the garment 106 (or a component of the

garment 200) can be optimized. The mechanical coupling may be maintained using friction or using a positively engaging mechanism, for example.

[0055] Beneficially, the removable electronics module 110 may contain all the components required for data transmission and processing such that the garment 200 only comprises the sensing units e.g. the sensors 218, 220 and first conductive pathways 222, 224. In this way, manufacture of the garment 106 may be simplified. In addition, it may be easier to clean a garment 200 which has fewer electronic components attached thereto or incorporated therein. Furthermore, the removable electronics module 100 may be easier to maintain and/or troubleshoot than embedded electronics. The electronics module 100 may comprise flexible electronics such as a flexible printed circuit (FPC).

[0056] The electronics module 110 may be configured to be electrically coupled to the garment 106.

[0057] Referring to Figure 2, there is shown a schematic diagram of an example of the electronics module 110.

[0058] The electronics module 110 comprises an interface 202, a controller 204, a power source 206, and one or more communication devices which, in the exemplar embodiment comprises a first antenna 208, a second antenna 210and a wireless communicator 212. The electronics module 110 also includes an input unit, such as a proximity sensor or a motion sensor, for example in the form of an inertial measurement unit 322. The input unit is arranged to provide input data to the controller providing contextual information for the controller 204 indicative of the context of use or operation of the electronics module 110. Contextual information could include information about the kind of activity being undertaken by the wearer 116 of the wearable assembly 108, the activity level of the wearer 116 of the wearable assembly 108, or the location or environment of the wearer 116. Contextual information could also include data relating to the health or wellbeing (or otherwise) of the wearer 116. The contextual information can be determined by the input unit directly or can be input by the wearer 116 of the wearable assembly 108 by means of a user input unit 508 or user interface of a user electronic device 102 in communication with the electronics module 110.

[0059] The electronics module 110 also includes additional peripheral devices that are used to perform specific functions as will be described in further detail herein.

[0060] The interface 202 is arranged to communicatively couple with the sensing unit of the garment 106. As discussed above, the sensing unit comprises – in this example – the two sensors 218, 220 coupled to respective first and second electrically first conductive pathways 222, 224, each with respective first termination point 226 and second termination point 228. The interface 202receives signals from the sensors 218, 220. The controller 204 is communicatively coupled to the interface 202and is arranged to receive the signals from the interface 202for further processing.

[0061] The interface 202 of the embodiment described herein comprises a first contact 230 and a second contact 232 which are arranged to be communicatively coupled to the first termination point 226 and second termination point 228, and the respective first and second electrically first conductive pathways 222, 224. The coupling between the termination points 2226, 227 and the respective first and second contacts 230, 232 may be conductive or a wireless (e.g., inductive) communication coupling.

[0062] In this example the sensor 218 and sensor 220 are used to measure electropotential signals such as electrocardiogram (ECG) signals, although they could be configured to measure other biosignal types as also discussed above.

[0063] In this embodiment, the sensor 218 and sensor 220 are configured for so-called dry connection to the wearer's skin to measure ECG signals.

[0064] The power source 206 may comprise one or a plurality of power sources. The power source 206 may be a battery. The battery may be a rechargeable battery. The battery may be a rechargeable battery adapted to be charged wirelessly such as by inductive charging. The power source 206 may comprise an energy harvesting device. The energy harvesting device may be configured to generate electric power signals in response to kinetic events such as kinetic events performed by the wearer 116 of the garment 106 . The kinetic event could include walking, running, exercising or respiration of the wearer 116. The energy harvesting material may comprise a piezoelectric material which generates electricity in response to mechanical deformation of the converter. The energy harvesting device may harvest energy from body heat of the wearer 600 of the garment. The energy harvesting device may be a thermoelectric energy harvesting device. The power source 206 may be a super capacitor, or an energy cell.

[0065] The first antenna 208 is arranged to communicatively couple with the user electronic device 102 using a first communication protocol. The user electronic device 102 is powered to

induce a magnetic field in an antenna of the user electronic device 102. When the user electronic device 102 is placed in the magnetic field of the first antenna 208, the user electronic device 102 induces current in the first antenna 208. This induced current is used to retrieve the information from a memory of the electronics module 110 and transmit the same back to the user electronic device 102. The controller 204 is arranged to energize the first antenna 208 to transmit information.

[0066] In an example operation, the user electronic device 102 is brought into proximity with the electronics module 110. In response to this, the electronics module 100 is configured to energize the first antenna 208 to transmit information to the user electronic device 102 over the first wireless communication protocol. Beneficially, this means that the act of the user electronic device 102 approaching the electronics module 110 energizes the first antenna 107 to transmit the information to the user electronic device 102.

[0067] The information may comprise a unique identifier for the electronics module 110. The unique identifier for the electronics module 100 may be an address for the electronics module 100 such as a MAC address or Bluetooth ® address.

[0068] The information may comprise authentication information used to facilitate the pairing between the electronics module 110 and the user electronic device 102 over the second wireless communication protocol. This means that the transmitted information is used as part of an out of band (OOB) pairing process.

[0069] The information may comprise application information which may be used by the user electronic device 102 to start an application on the user electronic device 102 or configure an application running on the user electronic device 102. The application may be started on the user electronic device 102 automatically (e.g. without wearer 116 input). Alternatively, the application information may cause the user electronic device 102 to prompt the wearer 116 to start the application on the user electronic device. The information may comprise a uniform resource identifier such as a uniform resource location to be accessed by the user electronic device, or text to be displayed on the user electronic device for example. It will be appreciated that the same electronics module 110 can transmit any of the above example information either alone or in combination. The electronics module 100 may transmit different types of information depending on the current operational state of the electronics module 100 and based on information it receives from other devices such as the user electronic device 102.

[0070] The second antenna 210 is arranged to communicatively couple with the user electronic device 300 over a second wireless communication protocol. The second wireless communication protocol may be a Bluetooth ® protocol, Bluetooth ® 5 or a Bluetooth ® Low Energy protocol but is not limited to any particular communication protocol. In the present embodiment, the second antenna 210 is integrated into controller 204. The second antenna 210enables communication between the user electronic device 102 and the controller 204 for configuration and set up of the controller 204and the peripheral devices as may be required. Configuration of the controller 204and peripheral devices utilises the Bluetooth ® protocol.

[0071] Other wireless communication protocols can also be used, such as used for communication over: a wireless wide area network (WWAN), a wireless metro area network (WMAN), a wireless local area network (WLAN), a wireless personal area network (WPAN), Bluetooth ® Low Energy, Bluetooth ® Mesh, Thread, Zigbee, IEEE 802.15.4, Ant, a Global Navigation Satellite System (GNSS), a cellular communication network, or any other electromagnetic RF communication protocol. The cellular communication network may be a fourth generation (4G) LTE, LTE Advanced (LTE-A), LTE Cat-M1, LTE Cat-M2, NB-IoT, fifth generation (5G), sixth generation (6G), and/or any other present or future developed cellular wireless network.

[0072] The electronics module 110 further comprises an optical sensor module 234. The optical sensor module 234 may measure the amount of ultraviolet, visible, and/or infrared light in the environment. The optical sensor module 234 may comprise a photoplethysmography (PPG) sensor. PPG sensors measure blood volume changes within the microvascular bed of the wearer's tissue. PPG sensors use a light source to illuminate the tissue. Photodetectors within the PPG sensor measure the variations in the intensity of absorbed or reflected light when blood perfusion varies. The optical sensor module 234 can also be configured to measure the presence of liquid in the environment of the electronics module 110.

[0073] The optical sensor module 234 may comprise one or more light emitters and one or more photodetectors. The light emitters emit light to the skin tissue of the wearer or to the external environment, for example in an environment in which liquid is present. The light emitters may emit light in one or more of the infrared, visible, and ultraviolet spectrums. The photodetectors measure the reflected light from the tissue, or, for example, light refracted by

the liquid in the external environment. The photodetectors may measure light in one or more of the infrared, visible and ultraviolet spectrums. The optical sensor module 234 can be used to detect a heartrate of a wearer 116. Light is more strongly absorbed by blood than surrounding tissues, so the change in blood flow is measurable based upon the change in the intensity of the reflected light over time. This can be used to obtain a heartrate of the wearer.

[0074] Other properties of the wearer can be determined from the optical sensor module 234. The optical sensor module 234 is not limited to the use in determining the heartrate of the wearer. The optical sensor module 234 may be arranged to measure the oxygen saturation of the wearer. Oxygen saturation is the fraction of oxygen-saturated haemoglobin relative to total haemoglobin (unsaturated + saturated) in the blood. The optical sensor module 234 may be arranged to measure the capillary perfusion of the wearer. The optical sensor module 234 may be useable to measure the capillary perfusion using a double-wavelength method. The capillary perfusion can be derived from a variation in the detected signal strength. The optical sensor module 234 may be arranged to measure the temperature of the wearer.

[0075] Properties of the external environment can be detected, for example, the presence of liquid such as water in the electronics module 110 is being used can be detected as described above.

[0076] For the detection of wearer properties, the optical sensor modules 234 is positioned proximate to a bottom surface of the electronics module 110 that faces towards the skin surface of the wearer when the electronics module 110 is worn. However, if the optical sensor module 234 is being used solely for environment detection then it can be sited elsewhere inside a housing of the electronics module 110. The housing may have an opening to allow for the optical sensor module 234 to have line of sight out of the electronics module 110. The housing may comprise a window that covers the optical sensor module 234. The window may be formed from an optically transparent or translucent material.

[0077] A more detailed block diagram of the electronics components of electronics module 100 and garment are shown in Figure 3.

[0078] The electronics module 110includes configured a clock unit in the form of a real time clock 216 coupled to the controller 204 and, for example, to be used for data logging, clock building, time stamping, timers, and alarms. As an example, the real time clock 216 is driven by a low frequency clock source or crystal operated at 32.768 Hz.

[0079] The electronics module 110 also includes an input unit in the form of a location device 306 such as a GNSS (Global Navigation Satellite System) device which is arranged to provide location and position data for applications as required. In particular, the location device 306 provides geographical location data at least to a nation state level. Any device suitable for providing location, navigation or for tracking the position could be utilised. The GNSS device may include Global Positioning System (GPS), BeiDou Navigation Satellite System (BDS) and the Galileo system devices.

[0080] The power source 206 in this example is a lithium polymer battery. The battery is rechargeable and charged via a USB-C input 314 of the electronics module 110. Of course, the present disclosure is not limited to recharging via USB and instead other forms of charging such as inductive of far field wireless charging are within the scope of the present disclosure. Additional battery management functionality is provided in terms of a charge controller 328, battery monitor 326 and regulator 324. These components may be provided through use of a dedicated power management integrated circuit (PMIC).

[0081] The USB-C input 314is also coupled to the controller 204 to enable direct communication between the controller 204 and an external device if required.

[0082] The controller 204 is communicatively connected to a battery monitor 326 so that that the controller 204 may obtain information about the state of charge of the power source 206.

[0083] The controller 204 has an internal memory 330 and is also communicatively connected to an external memory 320 which in this example is a NAND Flash memory. The external memory 320 is used to for the storage of data when no wireless connection is available between the electronics module 110 and a user electronic device 102. The external memory 320 may have a storage capacity of at least 1GB and preferably at least 2 GB.

[0084] The electronics module 110 also comprises a temperature sensor 316 and a light emitting diode 304 for conveying status information. The electronics module 110 also comprises conventional electronics components including a power-on-reset generator 312, a development connector 310, the real time clock 216 and a PROG header 308. The electronics module 110 may also comprise a humidity sensor 332 coupled to the controller 204.

[0085] Additionally, the electronics module 110 may comprise a haptic feedback unit 302 for providing a haptic (vibrational) feedback to the wearer 116.

[0086] The wireless communicator 159 may provide wireless communication capabilities for the garment 200 and enables the garment to communicate via one or more wireless communication protocols to a remote server 114. Wireless communications may include : a wireless wide area network (WWAN), a wireless metro area network (WMAN), a wireless local area network (WLAN), a wireless personal area network (WPAN), Bluetooth ® Low Energy, Bluetooth ® Mesh, Bluetooth ® 5, Thread, Zigbee, IEEE 802.15.4, Ant, a near field communication (NFC), a Global Navigation Satellite System (GNSS), a cellular communication network, or any other electromagnetic RF communication protocol. The cellular communication network may be a fourth generation (4G) LTE, LTE Advanced (LTE-A), LTE Cat-M1, LTE Cat-M2, NB-IoT, fifth generation (5G), sixth generation (6G), and/or any other present or future developed cellular wireless network.

[0087] The wireless communicator 212 may be an alternative, or in addition to, the first antenna 208 and the second antenna 210.

[0088] The electronics module 110 may additionally comprise a Universal Integrated Circuit Card (UICC) that enables the garment to access services provided by a mobile network operator (MNO) or virtual mobile network operator (VMNO). The UICC may include at least a read-only memory (ROM) configured to store an MNO or VMNO profile that the garment can utilize to register and interact with an MNO or VMNO. The UICC may be in the form of a Subscriber Identity Module (SIM) card. The electronics module 100 may have a receiving section arranged to receive the SIM card. In other examples, the UICC is embedded directly into a controller of the electronics module 100. That is, the UICC may be an electronic/embedded UICC (eUICC). A eUICC is beneficial as it removes the need to store a number of MNO profiles, i.e. electronic Subscriber Identity Modules (eSIMs). Moreover, eSIMs can be remotely provisioned to garments. The electronics module 110 may comprise a secure element that represents an 35 embedded Universal Integrated Circuit Card (eUICC).

[0089] The controller 204 is connected to the interface 202 101 via an ADC (analog-to-digital converter) front end 214 and an electrostatic discharge protection circuit 318.

[0090] Figure 4 is a schematic illustration of the component circuitry for the ADC front end 214.

[0091] In the example described herein, the ADC front end 214 is an integrated circuit (IC) chip which converts the raw analogue biosignal received from the sensor 218 and sensor 220

into a digital signal for further processing by the controller 204. ADC IC chips are known, and any suitable one can be utilised to provide this functionality. ADC IC chips for ECG applications include, for example, the MAX30003 chip produced by Maxim Integrated Products Inc.

[0092] The ADC front end 214 includes an ADC input 402 and an ADC output 404.

[0093] Raw biosignals from the sensor 218 and sensor 220 are input to the ADC front end 214, where received signals are processed in an ECG channel 406 and subject to appropriate filtering through high pass and low pass filters for static discharge and interference reduction as well as for reducing bandwidth prior to conversion to digital signals. The reduction in bandwidth is important to remove or reduce motion artefacts that give rise to noise in the signal due to movement of the sensors 218 and sensor 220.

[0094] The output digital signals may be decimated to reduce the sampling rate prior to being passed to a serial programmable interface of the ADC front end 214.

[0095] ADC front end IC chips suitable for ECG applications may be configured to determine information from the input biosignals such as heart rate and the QRS complex and including the R-R interval of the QRS complex. Support circuitry 408 provides base voltages for the ECG channel 406.

[0096] The determining of the QRS complex can be implemented for example using the known Pan Tomkins algorithm as described in Pan, Jiapu; Tompkins, Willis J. (March 1985). "A Real-Time QRS Detection Algorithm". IEEE Transactions on Biomedical Engineering. BME-32 (3): 230–236.

[0097] Signals are output to the controller 204 via the serial peripheral interface 410.

[0098] The controller 204 can also be configured to apply digital signal processing (DSP) to the digital signal from the ADC front end 214.

[0099] The DSP may include noise filtering additional to that carried out in the ADC front end 214 and may also include additional processing to determine further information about the signal from the ADC front end 214.

[0100] The controller 204 is configured to send the biosignals to the user electronic device 102 using either of the first antenna 208, second antenna 210, or wireless communicator 212.

[0101] In some examples, in another form of an input unit – such as the inertial measurement unit 322 - is arranged to detect a displacement of the electronics module 110. These displacements of the electronics module 110 may be caused by the object being tapped against the electronics module 110 or by the wearer 116 of the electronics module 110 being in motion, for example walking or running, or simply getting up from a recumbent position.

[0102] In the exemplar embodiment described herein, motion detection is provided by the inertial measurement unit 322 which may comprise an accelerometer and optionally one or both of a gyroscope and a magnetometer. A gyroscope/magnetometer is not required in all examples, and instead only an accelerometer may be provided, or a gyroscope/magnetometer may be present but put into a low power state.

[0103] The input unit could be an AI system, machine or engine.

[0104] The inertial measurement unit 322 can therefore be used to detect orientation and gestures with event-detection interrupts enabling motion tracking and contextual awareness. It has recognition of free-fall events, tap and double-tap sensing, activity or inactivity, stationary/motion detection, and wakeup events in addition to 6D orientation. A single tap, for example, can be used enable toggling through various modes or waking the electronics module 110 from a low power mode.

[0105] Known examples of inertial measurement units 322 that can be used for this application include the ST LSM6DSOX manufactured by STMicroelectronics. This example is a system-in-package inertial measurement unit (IMU) featuring a 3D digital accelerometer and a 3D digital gyroscope.

[0106] Another example of a known IMU suitable for this application is the LSM6DSO also be STMicroelectronics.

[0107] The inertial measurement unit 322 can include machine learning functionality, for example as provided in the ST LSM6DSOX. The machine learning functionality is implemented in a machine learning core (MLC). The machine earning processing capability uses decision-tree logic. The MLC is an embedded feature of the inertial measurement unit 322 and comprises a set of configurable parameters and decision trees. As is understood in the art, decision tree is a mathematical tool composed of a series of configurable nodes. Each node is

characterized by an "if-then-else" condition, where an input signal (represented by statistical parameters calculated from the sensor data) is evaluated against a threshold.

[0108] Decision trees are stored and generate results in the dedicated output registers. The results of the decision tree can be read from the application processor at any time. Furthermore, there is the possibility to generate an interrupt for every change in the result in the decision tree, which is beneficial in maintaining low-power consumption.

[0109] Decision trees can be generated using a known machine learning tool such as Waikato Environment for Knowledge Analysis software (Weka) developed by the University of Waikato or using MATLAB® or Python™.

[0110] In an example operation, the wearer 116 has positioned the electronics module 110 within the pocket 112 (Figure 1) of the garment 106 and is wearing the garment 106. The wearer 116 taps their hand or user electronic device 102 e.g. mobile phone, against the pocket 112 and this tap event is detected by the input unit of the electronics module 110, which in this exemplar embodiment is the inertial measurement unit 322. The inertial measurement unit 322 sends a signal to the controller 204 to wake-up the controller 204 from the low power mode.

[0111] A processor of the inertial measurement unit 322 may perform processing tasks to classify different types of detected motion. The processor of the inertial measurement unit 322 may use the machine-learning functions so as to perform this classification. Performing the processing operations on the inertial measurement unit 322 rather than the controller 204 is beneficial as it reduces power consumption and leaves the controller 204 free to perform other tasks. In addition, it allows for motion events to be detected even when the controller 103 is operating in a low power mode.

[0112] The inertial measurement unit 322 may be configured to detect when the electronics module 110 has been stationary but then begins to move, for example when left on a surface but then attached to the garment 106. The inertial measurement unit 322 may be configured to detect that the wearer 116 of the garment 106, with the electronics module 110 attached, is resting, or is moving, for example during exercise. The inertial measurement unit 322 may be configured to establish the level of activity, for example, whether the wearer 116 is walking or running.

[0113] The inertial measurement unit 322 communicates with the controller 204 over a serial protocol such as the Serial Peripheral , Inter-Integrated Circuit (I2C), Controller Area Network (CAN), and Recommended Standard 232 (RS-232). Other serial protocols are within the scope of the present disclosure. The inertial measurement unit 322 is also able to send interrupt signals to the controller 204 when required so as to transition the controller 204 from a low power model to a normal power mode when a motion event is detected, for example, or vice versa. The interrupt signals may be transmitted via one or more dedicated interrupt pins.

[0114] The user electronic device 102 in the example of Figure 5 is in the form of a mobile phone or tablet and comprises a controller 506, a memory 510, a wireless communicator 512, a display 504, a user input unit 508, a capturing device in the form of a camera 502 and an inertial measurement unit 514. The controller 506 provides overall control to the user electronic device 102.

[0115] The user input unit 508 receives inputs from the user such as a user credential.

[0116] The memory 510 stores information for the user electronic device 102.

[0117] The display 504 is arranged to display a user interface for applications operable on the user electronic device 102.

[0118] The inertial measurement unit 514 provides motion and/or orientation detection and may comprise an accelerometer and optionally one or both of a gyroscope and a magnetometer.

[0119] The user electronic device 102 may also include a biometric sensor. The biometric sensor may be used to identify a user or users of device based on unique physiological features. The biometric sensor may be: a fingerprint sensor used to capture an image of a user's fingerprint; an iris scanner or a retina scanner configured to capture an image of a user's iris or retina; an ECG module used to measure the user's ECG; or the camera 502 of the user electronic device 102 arranged to capture the face of the user. The biometric sensor may be an internal module of the user electronic device 102. The biometric module may be an external (stand-alone) device which may be coupled to the user electronic device by a wired or wireless link.

[0120] The controller 506 is configured to launch an application which is configured to display insights derived from the biosignal data processed by the ADC front end 214 of the electronics module 110, input to electronics module controller 204, and then transmitted from

the electronics module 110. The transmitted data is received by the wireless communicator 512 of the user electronic device 102 and input to the controller 506.

[0121] Insights include, but are not limited to, heart rate, respiration rate, core temperature but can also include identification data for the wearer 116 using the wearable assembly 108.

[0122] The display 504 is also configured to display an ECG signal trace part of the user interface. To display a signal trace may require raw ECG data from the electronics module 110.

[0123] The display 504 may be a presence-sensitive display and therefore may comprise the user input unit 508. The presence-sensitive display may include a display component and a presence-sensitive input component. The presence sensitive display may be a touch-screen display arranged as part of the user interface.

[0124] User electronic devices in accordance with the present invention are not limited to mobile phones or tablets and may take the form of any electronic device which may be used by a user to perform the methods according to aspects of the present invention. The user electronic device 300 may be a electronics module such as a smartphone, tablet personal computer (PC), mobile phone, smart phone, video telephone, laptop PC, netbook computer, personal digital assistant (PDA), mobile medical device, camera or wearable device. The user electronic device 102 may include a head-mounted device such as an Augmented Reality, Virtual Reality or Mixed Reality head-mounted device. The user electronic device 102 may be desktop PC, workstations, television apparatus or a projector, e.g. arranged to project a display onto a surface.

[0125] In use, the electronics module 110 is configured to receive raw biosignal data from the sensor 218 and sensor 220 which are coupled to the controller 204 via the interface 202 and the ADC front end 214 for further processing and transmission to the user electronic device 102 as described above. The data transmitted to the user electronic device 102 includes raw or processed biosignal data such as ECG data, heart rate, respiration data, core temperature, IMU data and other insights as determined, and as required.

[0126] The controller 506 of the user electronics user electronic device 102 is also operable to launch an application which is configured to receive, process and display data, such as raw or processed biosignal data, from the electronics module 110. A user, such as the wearer 116, is

able to configure the application, using user inputs, to receive, process and display the received data in accordance with these user inputs.

[0127] The user electronic device 102 is arranged to receive the transmitted data from the electronics module 110 via the wireless communicator 512 and which are coupled to the controller 506, and then to process and display the data in accordance with the user configuration.

[0128] The controller 506 of the user electronics user electronic device 102 is operable to display information to a user on the display 504 as part of the user interface. Information displayed can be an ECG trace as well using raw data points transmitted from the electronics module 110. Other insights and data can be displayed on the display 504 as required. Examples might be a heart rate in beats per minute, core temperature data and respiration rate.

[0129] As mentioned above, the inertial measurement unit 322 of the electronics module 110 can be configured to use decision tree logic to determine the activity level of the wearer of the electronics module 100 and to provide an output to the controller 204. The inertial measurement unit 322 can also be configured to determine additional motion data in relation to the electronics module 110.

[0130] The location of the wearer can be established using the location device 306 which, as described above, is operable to provide location data to the controller 103.

[0131] The inertial measurement unit 322 of the electronics module 110 can include machine learning functionality that can be used to detect orientation and gestures with event-detection interrupts enabling motion tracking and contextual awareness. The inertial measurement unit 322 is able, for example, to detect free-fall events, tap and double-tap sensing events, activity or inactivity, stationary/motion detection, and wakeup events in addition to 6D orientation.

[0132] A combination of movement, orientation and gesture awareness along with contextual awareness can provide enhanced an improved outputs in terms of insights and information. For example, with a contextual awareness that the wearer 116 of the electronics module 110 is being used for a particular type of exercise or movement, or in a particular situation can enable the machine learning core of the inertial measurement unit 322, to better determine insights for the wearer 116. For example, if it is determined that the wearer 116 is in water and therefore

likely to be taking part in swimming or other watersports, then the detected motion or orientation can be adjusted accordingly. For example, the inertial measurement unit 322 can be set up to detect certain motion events as swimming strokes, or swimming pool laps.

[0133] An impedance check will determine that the electronics module 110 is in contact with a liquid such as water. The controller 204 is also operable to carry out a measurement of the impedance between the first contact 230 and the second contact 232 of the interface 202 using the ADC front end 214. A change in the expected impedance measurement of impedance compared with that in an expected ECG measurement is an indication of the presence of water or other substance. The first contact 230 and the second contact 232 therefore define a sensor arrangement which is configured to detect the presence of a liquid such as water in the environment of the electronics module 110. In another embodiment, other liquid detecting sensing arrangements such as liquid sensors or the humidity sensor 332 could be used.

[0134] The electronics module 110 may store impedance thresholds or ranges indicative of the electronics module 110 being in contact with water. The controller 204 may compare the measured impedance value with stored impedance thresholds or ranges to determine whether the electronics module 110 is in contact with water.

[0135] The impedance check comprises measuring the impedance between the first contact 230 and the second contact 232. Measuring the impedance may comprise measuring the resistance between the first contact 230 and the second contact 232. The impedance values would vary depending up the properties of the water, for example the salinity of the water.

[0136] The controller 204 may be operable to compare the measured impedance to one or more pre-stored values associated with certain environmental conditions such as the presence of a liquid, e.g. water. The electronics module 110 may thus compare the measured value with a dictionary of pre-stored values stored in the external memory 320. The dictionary may be received/updated by an external device in communication with the electronics module 110.

[0137] If the electronics module 110 is determined to be in water, the controller 204 is configured to send this data to the inertial measurement unit 322 where the machine learning core processes the data for further insight and the machine learning core would be updated accordingly.

[0138] In an alternative, and as discussed above, the optical sensor module 234 can be used to determine whether the electronics module 110 is in water, and the inertial measurement unit 322 will be updated accordingly in the same way.

[0139] Referring to FIG. 6, there is shown a flow diagram for an example method according to aspects of the present disclosure.

[0140] At step 602 the electronics module 110 is provided.

[0141] At step 604, the controller 204 monitors the output from the liquid-detecting sensor arrangement. In the embodiment described herein, the controller 204 measures the impedence across the first contact 230 and the second contact 232. As mentioned above, the controller 204 is operable to compare the measured impedance to one or more pre-stored values associated with certain environmental conditions such as the presence of a liquid such as water. The electronics module 110 may thus compare the measured value with a dictionary of pre-stored values stored in the external memory 320. The dictionary may be received/updated by an external device in communication with the electronics module 110.

[0142] At step 606, the controller 204 may determine that liquid is present in the environment of the electronics module 110, for example through measurement of impedance between the first contact 230 and the second first contact 230, or using the optical sensor module 234.

[0143] To differentiate between a form of insignificant exposure to liquid as opposed to the presence of a liquid indicating, for example, water-based activity, a time threshold could used to make sure its really inside water not just wet.

[0144] If, at step 606 the presence of liquid is detected, then the controller 204 is operable, at step 608, to monitor for inputs from an input unit such as the inertial measurement unit 322. In an example, the controller 204 may monitor for detected motion indicating a particular type of motion e.g., swimming strokes, or water polo moves. The input unit may be the location device 306, which may give an indication of a particular location, such as a beach or swimming pool or can provide data showing how far the wearer 116 of the wearable assembly 108 is travelling.

[0145] On the basis of the information from the input unit, the controller 204 is configured to generate insights and to send and present, at step 612, the insights to a presentation device. The presentation device, for example, could be the user electronic device 102, with the insights

being displayed on the display 504. The insights could be presented in other ways, for example, via audio information through speakers of the user electronic device 102.

[0146] Whilst the steps example embodiments described above are implemented on specific components of the system 10, it will be understood that other combinations are possible. For example, steps implemented on the wearable assembly 108, user electronic device 102 or remote server 114 could equally be carried out on another of the wearable assembly 108, user electronic device 102 or remote server 114.

[0147] In some embodiments, the described elements may be configured to reside on a tangible, persistent, addressable storage medium and may be configured to execute on one or more processors. These functional elements may in some embodiments include, by way of example, components, such as software components, object-oriented software components, class components and task components, processes, functions, attributes, procedures, subroutines, segments of program code, drivers, firmware, microcode, circuitry, data, databases, data structures, tables, arrays, and variables.

[0148] Although the example embodiments have been described with reference to the components, modules and units discussed herein, such functional elements may be combined into fewer elements or separated into additional elements. Various combinations of optional features have been described herein, and it will be appreciated that described features may be combined in any suitable combination. In particular, the features of any one example embodiment may be combined with features of any other embodiment, as appropriate, except where such combinations are mutually exclusive. Throughout this specification, the term "comprising" or "comprises" means including the component(s) specified but not to the exclusion of the presence of others.

[0149] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

[0150] Each feature disclosed in this specification (including any accompanying claims, abstract and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[0151] The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

CLAIMS

1. An electronics module for a wearable article comprising a controller, at least one input unit and a liquid-detecting arrangement, the at least one input unit and the liquid-detecting arrangement being coupled to the controller, the liquid-detecting arrangement being arranged to provide a signal indicative of the presence of a liquid in the environment of the electronics module to the controller, and the input unit being arranged to provide an input to the controller providing contextual information for the controller, wherein the controller is further configured to monitor signals from the liquid-detecting sensor to determine if liquid is present in the environment of the electronics module, and to control operation of the controller in response to a determination of the presence of liquid in the environment of the electronics module and in response to any input received from the input unit.

2. The electronics module of claim 1, wherein the liquid-detection arrangement measures the impedance between a pair of electrical contacts provided on the electronics module.

3. The electronics module of claim 2, measuring the impedance may comprise measuring the resistance.

4. The electronics module of claim 2 or claim 3, further comprising an interface arranged to communicatively couple with a sensing unit of the wearable article, and wherein the pair of electrical contacts are part of the interface.

5. The electronics module of claim 1, wherein the liquid-detection arrangement comprises an optical sensor module configured to transmit an optical signal externally of the electronics module and to detect a change in the optical signal in response to the presence of a liquid external to the electronics module.

6. The electronics module of claim 5, wherein the optical sensor module comprises a photoplethysmography sensor.

7. The electronics module of any one of claims 1 to 6, wherein the input unit is a location device.

8. The electronics module of any one of claims 1 to 6, wherein the input unit is a motion detection device.

9. A method performed by an electronics module for a wearable article, the method comprising the steps of:

monitoring an environment of the electronics module for the presence of a liquid in the environment;

monitoring for contextual information indicative of the context of use or operation of the electronics module;

determining insights for a wearer of the wearable article depending upon whether liquid is present in the environment and any contextual information; and

presenting determined insights via a presentation device.

10. The method of claim 9, wherein the environment is monitored by measuring the impedance between a pair of electrical contacts provided on the electronics module.

11. The method of claim 10, wherein the step of measuring the impedance comprises measuring the resistance.

12. The method of claim 9, wherein the environment is monitored by transmitting an optical signal externally of the electronics module and detecting a change in the optical signal in response to the presence of liquid in the environment.

13. The method of claim 12, wherein the step of monitoring the environment comprises detecting a refracted optical signal using an optical sensor of the electronics module.

14. The method of any one of claims 9 to 12, wherein contextual information is derived from a location device of the electronics module.

15. The method of any one of claims 9 to 12, wherein the contextual information is derived from a motion device of the electronics module.

16. The method of any one of claims 9 to 12, wherein the contextual information is derived from a temperature sensor of the electronics module.

17. A system comprising a wearable article and an electronics module as claimed in any one of claims 1 to 8.

Intellectual Property Office

Application No:	GB2208114.5	**Examiner:**	Stephen Jennings
Claims searched:	1-17	**Date of search:**	26 January 2023

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1,8-9,15,17	WO2015/087330 A1 (SCHECHTER) see page 14 line 21 - page 15 line 4, page 15 line 22 - page 16 line 2, page 17 line 32 - page 18 line 25
X	1,6,8,9,14-17	US2014/278229 A1 (HONG) see paragraphs [0312]-[0313],[0325],[0435]
X	1-3,7-11,14-15,17	US2021/068713 A1 (DERVISOGLU) see paragraphs [0042],[0049],[0073]-[0076]
X	1,8,9,15,17	GB2591872 A (AMER SPORTS) see paragraphs [0033],[0034],[0039],[0066],[0075] and [0082]
X	1-4,7-11,14-17	WO2021/167385 A1 (SAMSUNG) see paragraphs [47],[66],[70],[79],[124]
X	1,8-9,15,17	US2017/274247 A1 (MIYASAKA) see figures 1,3, paragraphs [0079]-[0081],[0095]-[0099]
X	1-4,8-11,15,17	WO2015/021312 A1 (BASIS SCIENCE) see paragraphs [0010]-[0012],[0020]-[0022],[0026]
X	1-3,7-11,14-15,17	GB2528828 A (SPEEDO) see page 2 lines 19-29, page 3 lines 3-6, page 3 lines 19-22, page 9 line 32 - page 10 line 5
X	1 at least	US2015/119760 A1 (WISBEY) see paragraphs [0079]-[0080],[0084]
X	1 at least	US2014/197946 A1 (PARK) see paragraph [0035]
X	1 at least	US2022/036717 A1 (LOVETT) see paragraphs [0006],[0039],[0045]-[0047]

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International Classification:

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A61B	0005/00	01/01/2006
G06F	0001/16	01/01/2006