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US 20130106684 A1 **US 20100076331 A1**
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(54) Title of the Invention: **An apparatus method and computer program for a wearable device**
Abstract Title: **Wrist-worn device with flexible PCB for carrying sensors**

(57) A flexible device for carrying one or more sensors and able to at least partially enclose an appendage of a user, preferably comprising a wrist device that wraps around and can be worn on a user's wrist. The device may include wireless communication means. The device has a support structure defining an inner (wearer contacting) side with a first section of flexible circuitry that can carry one or more sensors 105a. The sensors may include heat rate, blood pressure, blood glucose, temperature. An outer side of the support can carry more flexible circuitry and sensors 109a for an external environment. The sensors may include temperature, humidity, touch, strain. The device can comprise rigid portions and flexible portions A, B. The device may be controlled by user manipulation. The device may include accelerometers and GPS receivers.

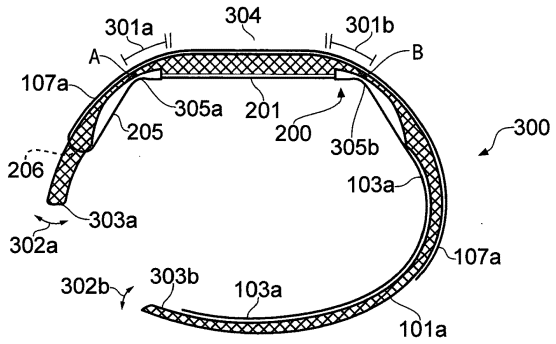

FIG. 3

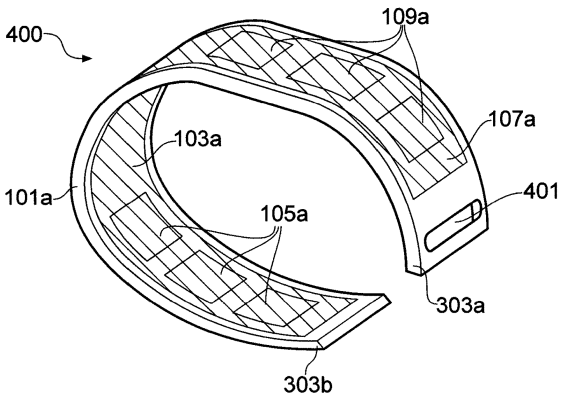

FIG. 4

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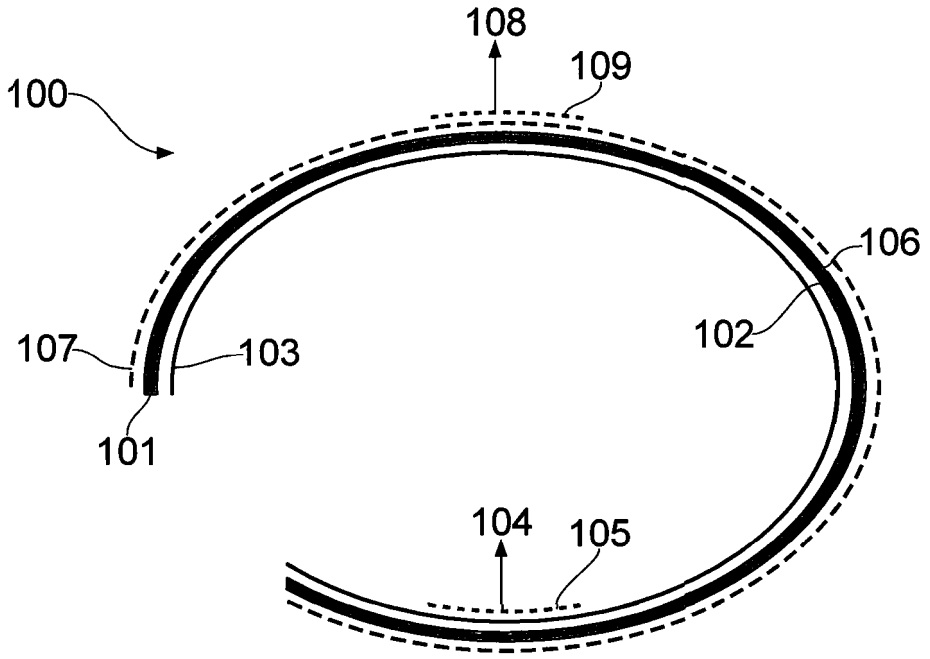
108
109
100
106
102
107
103
101
104
105

FIG. 1

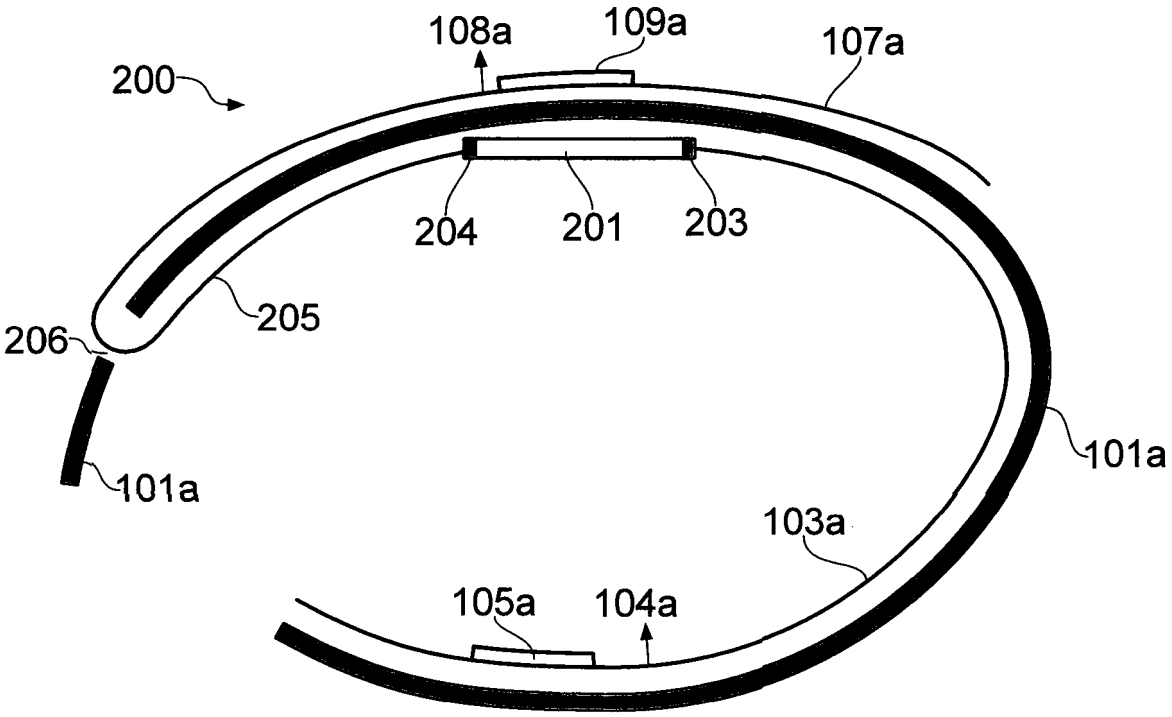
108a
109a
107a
200
204
201
203
205
206
101a
101a
103a
105a
104a

FIG. 2

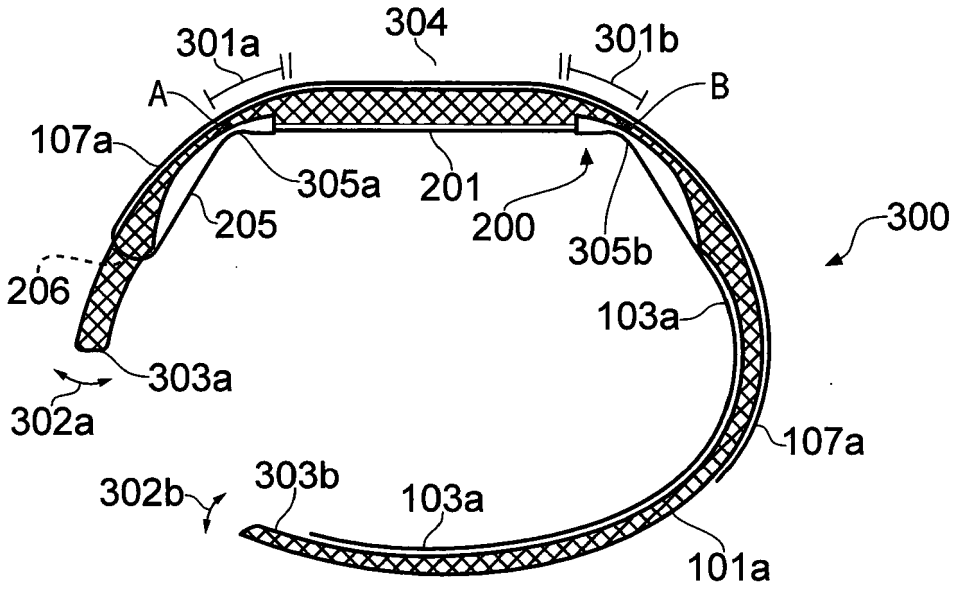
301a
304
301b
A
B
107a
305a
201
200
305b
300
205
206
103a
303a
302a
107a
302b
303b
103a
101a

FIG. 3

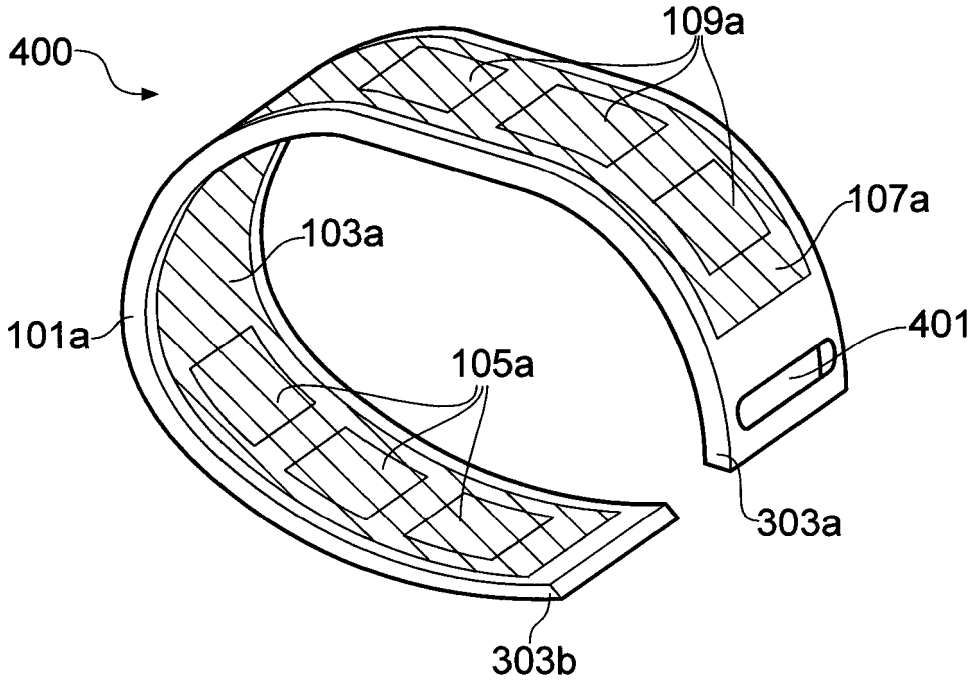
400
109a
107a
103a
101a
401
105a
303a
303b

FIG. 4

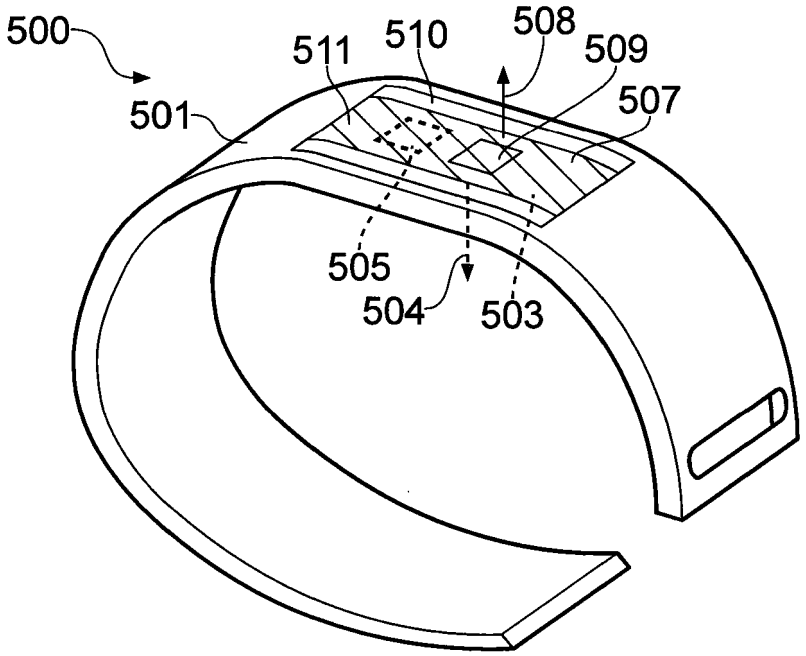

FIG. 5

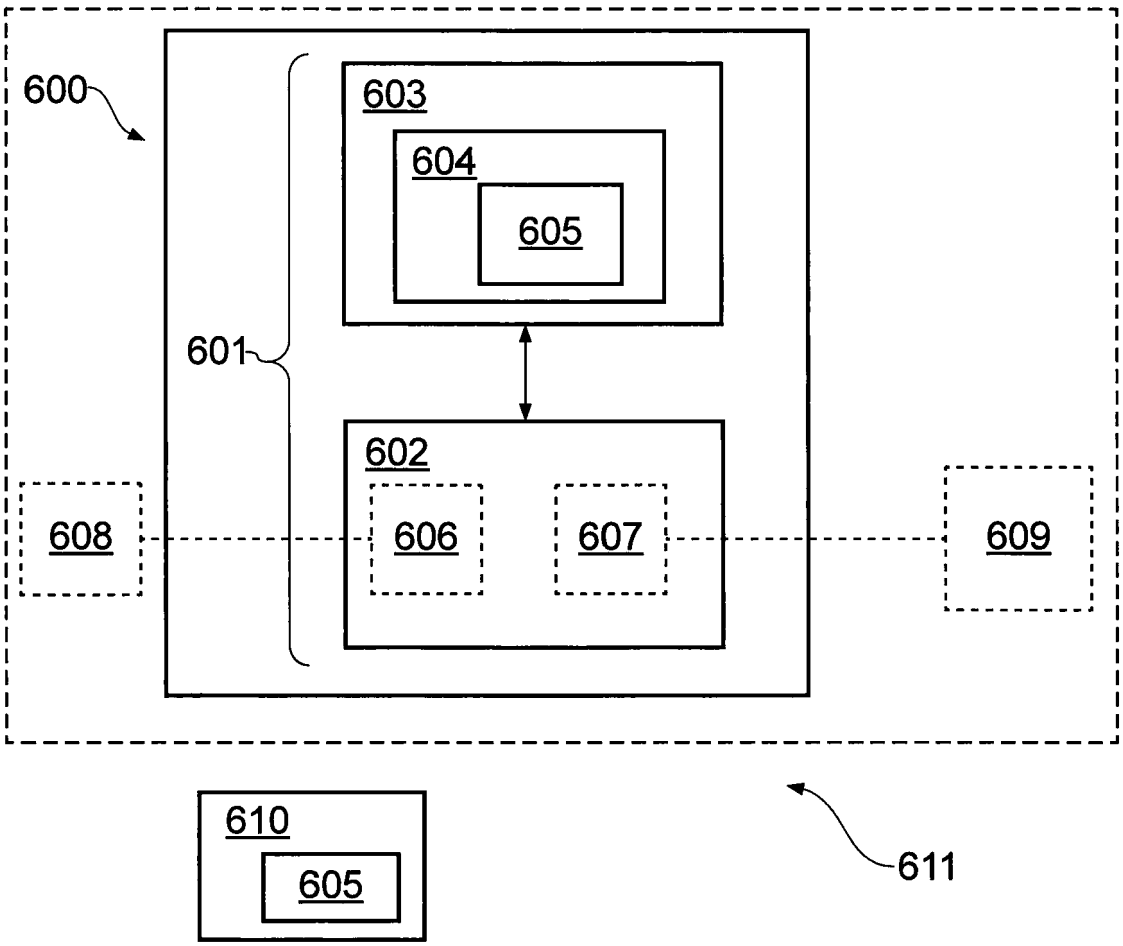
600
603
604
605
601
602
608
606
607
609
610
605
611

FIG. 6

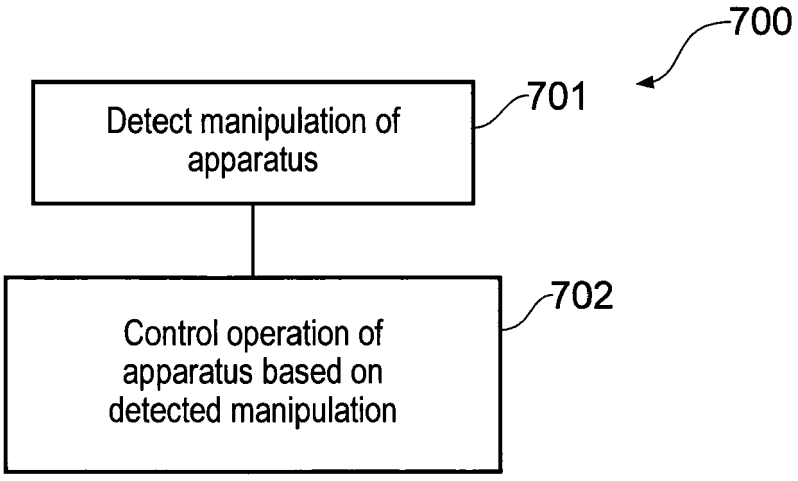
700
Detect manipulation of apparatus
701
Control operation of apparatus based on detected manipulation
702

FIG. 7

AN APPARATUS METHOD AND COMPUTER PROGRAM FOR A WEARABLE DEVICE

TECHNOLOGICAL FIELD

Examples of the present disclosure relate to an apparatus, method and computer program for a wearable device and method for the same. In particular, though without prejudice to the foregoing, certain examples relate to an apparatus, method and computer program for a wrist device.

BACKGROUND

Conventional wrist devices comprising electronic hardware including sensors are not always optimal. Difficulties can arise in providing electrical hardware and electronic components in a curved wrist device which is adequately robust as well as comfortable for prolonged wearable use. Typically, electrical hardware and electronic components such as sensors are mounted on rigid circuit boards and are thus limited in their position within the wrist device to rigid planar portions of the wrist device.

The listing or discussion of any prior-published document or any background in this specification should not necessarily be taken as an acknowledgement that the document or background is part of the state of the art or is common general knowledge. One or more aspects/examples of the present disclosure may or may not address one or more of the background issues.

BRIEF SUMMARY

According to at least some but not necessarily all examples of the disclosure there is provided an apparatus comprising:

a support structure configured to at least partially enclose an appendage of a user, said support structure defining an inner side and an outer side; and

a first section of flexible circuitry disposed towards the inner side of the support structure.

The apparatus may be configured for wearable use on the user's appendage, e.g. limb. For example, the apparatus may be configured as a wrist device that wraps around and can be worn on a user's wrist.

According to at least some but not necessarily all examples of the disclosure there is provided an apparatus comprising:

support means configured to at least partially enclose an appendage of a user, said support means defining an inner side and an outer side; and

first flexible circuitry means disposed towards the inner side of the support means.

According to at least some but not necessarily all examples of the disclosure there is provided a method for operating the apparatus, comprising:

detecting a manipulation of the apparatus; and

controlling operation of the apparatus in dependence on the detected manipulation.

According to at least some but not necessarily all examples of the disclosure there is provided a computer program that, when performed by at least one processor, causes the above method to be performed.

According to at least some but not necessarily all examples of the disclosure there is provided a non-transitory computer readable medium encoded with instructions that, when performed by at least one processor, cause the above method to be performed.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of various examples that are useful for understanding the detailed description reference will now be made by way of example only to the accompanying drawings in which:

Figure 1 schematically illustrates an example of an apparatus according to the present disclosure;

Figure 2 schematically illustrates an example of a circuitry arrangement for an apparatus according to the present disclosure;

Figure 3 schematically illustrates a further example of an apparatus according to the present disclosure;

Figure 4 schematically illustrates a yet further example of an apparatus according to the present disclosure;

Figure 5 schematically illustrates a yet further example of an apparatus according to the present disclosure;

Figure 6 schematically illustrates an example of a controller for an apparatus according to the present disclosure; and

Figure 7 illustrates a method according to an example of the present disclosure.

DETAILED DESCRIPTION

The Figures schematically illustrate an apparatus 100 comprising a support structure 101 configured to at least partially enclose an appendage of a user, e.g. a user's wrist. The support structure defines an inner side 102. The apparatus also comprises a first section of flexible circuitry 103, e.g. flexible wiring board, which is disposed towards the inner side 102 of the support structure.

In certain particular examples of the present disclosure, the first section of flexible circuitry 103 comprises circuitry mounted/printed/integrated thereon,

such as a first sensor 105 that is inwardly facing 104 on the inner side 102 of the support structure 101. Advantageously, the sensor 105 is not limited in its locations within the apparatus 100 to rigid/planar flat portions of the apparatus. Instead, the sensor 105 itself can be flexible/curved so as to conform to the shape of the support structure and the user's appendage and can be disposed anywhere along the length of the first section of flexible circuitry 103 which itself can be located anywhere along the curved inner side 102 of the support structure 101. The inner sensor 105 can be in direct physical contact with, or immediately proximal to, the user's skin/wrist. Advantageously, such examples provide improved integration of sensors in a curved device and also provide improved sensing/monitoring of the user.

In certain other particular examples of the present disclosure, a second section of flexible circuitry 107 is additionally provided which comprises circuitry mounted/printed/integrated thereon, such as a second sensor 109 that is outwardly facing 108 on the outer side 106 of the support structure 101. The sensor 109 itself can be flexible/curved and can be outwardly disposed anywhere along the length of the curved outer side 106 of the support structure 101. Thus the sensor 109 is not limited to locations within the apparatus 100 that are rigid and planar. Moreover, the outer sensor 109 could be directly exposed to the environment thereby being optimally arranged to monitor the external environment. Such examples again provide improved integration of sensors and electrical hardware in a curved device and also provide improved sensing/monitoring of both a user and the environment.

Certain other examples provide flexible inner 103 and outer 107 sensor circuitries that can be provided with an array of integrated/printed sensors thereon so as to substantially cover the inner 102 and outer sides 106 of the mechanical support 101 thereby increasing the sensing surface area of the device.

Examples of apparatuses according to the present disclosure will now be described with reference to the Figures. Similar reference numerals are used in the Figures to designate similar features. For clarity, all reference numerals are not necessarily displayed in all figures.

Figure 1 schematically illustrates a cross sectional view of an apparatus 100 according to an example of the present disclosure. Figure 1 focuses on the functional components necessary for describing the operation of the apparatus.

The apparatus 100 comprises: a support structure 101 and a first section of flexible circuitry 103.

The support structure 101 provides an overarching framework for the apparatus and mechanical support for components of the apparatus, e.g. electrical circuitry (including sensors) of the apparatus. The support structure may be: a mechanical architecture, support means, support member, a frame, a chassis or a skeleton structure which forms the back bone of the apparatus. The support structure 101 is configured to at least partially enclose, envelope or wrap around a user's appendage, e.g. a user's wrist (not shown), such that the apparatus may be worn by the user around the user's appendage. In this regard, the support structure 101 is curved, having a curvilinear cross section substantially of a generally oval/circular/band like shape. In the example shown, the apparatus has a bracelet/band like form-factor albeit not forming a closed loop so as to have a "C" shaped cross section.

The support structure 101 defines an inner side 102 / inward direction 104 and an outer side 106 / outward direction 108. When the device is worn by a user, the inner/interior side corresponds to a side which is proximal to the user's appendage whilst the outer/exterior side corresponds to a side which is distal from the user's appendage.

The first section of flexible circuitry 103 may comprise, for example: a flexible wired board, flexible circuit board or flexible printed circuit board. The first section of flexible circuitry 103 is disposed towards the inner side 102 of the support structure 101. For example the first section could be disposed on the inner side. The first section of flexible circuitry 103 is coupled to and supported by an inner surface of the support structure 101. The first section of flexible circuitry 103 extends around a substantial portion of the inner side of the support structure 101. In the example shown, the first section of flexible circuitry 103 covers the entirety of the inner surface of the support structure 101. In other examples, the first section of flexible circuitry may extend to cover at least a portion or full length of the inner circumference of the inner side 102.

The first section of flexible circuitry 103 may comprise circuitry mounted thereon, e.g. SMD components mounted thereon or circuitry printed or integrated thereon, such as at least a first sensor 105 or an array of sensors. Advantageously, such circuitry/sensors are themselves flexible and can be curved so as to conform to the curved shape of the support structure and the shape of the user's appendage so as to provide a comfortable wearable apparatus. Moreover, advantageously, since the sensor can be printed on the flexible circuitry, the location of the sensor is not limited to flat/planar sections of circuitry and the sensor could be located at any point on the flexible circuitry and any point on the inner side. Furthermore, the size and number of sensors are not limited to that able to be fitted into flat/planar sections. Thus, advantageously, examples of the present disclosure enable larger sensing surface areas and more numerous sensors to be used than typically possible for conventional wrist devices.

The sensors may be configured so as to be able to be in direct physical contact with the user's appendage/skin (or at least immediately proximal to

the user's skin, i.e. with merely a thin protective layer covering the sensor). The at least first sensor 105 may be inwardly disposed 104 an inner/innermost side of the apparatus 100. The at least first sensor 105 is thus optimally arranged to sense conditions on an inner side of the apparatus 100 proximal to the user's appendage and monitoring the user, i.e. measure and detect conditions on an internal side of the apparatus 100.

The at least first sensor 105 or array of sensors may be configured to extend/ be disposed along a substantial portion of the first flexible circuitry section 103. The at least first sensor 105 or array of sensors may comprise a plurality of the same type of sensor or differing types of sensor. Types of first sensors that may be used include, but are not limited to: heart rate, blood pressure, blood glucose, humidity, temperature or other sensors to monitor the user.

A second section of flexible circuitry 107 (shown in outline) may additionally be provided that is disposed towards the outer side 106 of the support structure 101. The second section of flexible circuitry 107 is coupled to and supported by an outer surface of the support structure 101. The second section of flexible circuitry 107 may extend around a substantial portion of the outer side 106 of the support structure 101. In the example shown, the second section of flexible circuitry 107 covers the entirety of the outer surface of the support structure 101. In other examples, the second section of flexible circuitry may extend to cover at least a portion or full length of the outer circumference of the outer side.

The second section of flexible circuitry 107 may comprise circuitry mounted thereon, e.g. SMD components mounted thereon or circuitry printed or integrated thereon, such as at least a second sensor 109 or an array of sensors. The at least second sensor 109 may be outwardly disposed 108 on an outer/outermost side of the apparatus 100 so as to be directly exposed to the external environment (or at least merely covered by a protective layer). The

at least second sensor 109 is thus optimally arranged to sense external conditions on an outer side of the apparatus 100 distal from user's appendage and thus monitor the external environment, i.e. measure and detect conditions external of the apparatus 100 or other sensors to monitor an external environment (cf. monitoring the user).

The at least second sensor 109 or array of sensors may be configured to extend/ be disposed along a substantial portion of the second flexible circuitry section 107. The at least second sensor 109 or array of sensors may comprise a plurality of the same type of sensor or differing types of sensor. Types of second sensors that may be used include, but are not limited to: humidity, temperature, touch, strain, stretch, bend, compression, as well as contortion or user manipulation of the apparatus 100.

Advantageously, certain examples of the present disclosure provide a wrist device comprising at least a first sensor optimally arranged to monitor a user of the apparatus, and at least a second sensor optimally arranged to monitor an external environment.

The apparatus 100 may be provided in a module. As used here 'module' refers to a unit or apparatus that excludes certain parts/components that would be added by an end manufacturer or a user.

Figure 2 illustrates a cross sectional view of an example of a circuitry arrangement 200 for an apparatus according to the present disclosure (in this figure, a support structure is not illustrated).

The circuitry arrangement 200 comprises a first flexible circuitry section 103a, which is disposed towards an inner side of a support structure 101a, and a second flexible circuitry section 107a, which is disposed towards an outer side of the support structure.

Circuitry 105a, such as at least a first sensor, may be printed onto or integrated into the first flexible circuitry section 103a and disposed towards an inwardly facing side of the first flexible circuitry section, e.g. as indicated at 104a. Such a first flexible circuitry section 103a comprising at least a first sensor may be referred to as an inner sensor foil. Likewise, circuitry 109a, such as at least a second sensor, may be printed onto or integrated into the second flexible circuitry section 107a and disposed towards an outwardly facing side of the second flexible circuitry section, e.g. as indicated at 108a. Such a second flexible circuitry section 107a comprising at least a second sensor may be referred to as an outer sensor foil.

Although in Figure 2 a gap is shown between the inner sensor foil and the support structure and a gap is shown between the outer sensor foil and the support structure, it is to be appreciated that in embodiments of the apparatus the inner sensor foil may be disposed on and in contact with the inner surface of the support structure, e.g. supported there on and adhered thereto. Similarly the outer sensor foil may be disposed on and supported by an outer surface of the support structure.

The first flexible circuitry section 103a is electrically connected to circuitry 201 via electrical connector 203. The second flexible circuitry section 107a, which is disposed towards an outer side of the support member, is electrically connected to the circuitry 201 via a portion of second flexible circuitry 205 which passes through an aperture, slot or opening 206 in the support structure, such that the portion of the second flexible circuitry 205 is disposed on the inner side of the support structure) and electrical connector 204, such that the circuitry 201 is interposed between the first and second flexible circuits. The circuitry 201 may be inherently rigid, i.e. a rigid: circuit board, printed circuit board or printed wired board. Alternatively, instead of having a rigid planar flat substrate, the circuitry could be rigidly supported by a rigid planar flat surface of the support structure. Advantageously, providing a rigid flat/planar circuitry section facilitates the mounting and integration of

electrical hardware and components, for example for electrical hardware, such as a controller as discussed with reference to Figure 6 or other circuitry, components, devices and sensors (e.g. accelerometers, GPS receivers), not suitable for printing on the flexible circuitry.

The first and second flexible circuitry sections could correspond to separate / different flexible circuits. The material of the flexible substrate of the first flexible circuitry section may be different to the material of the flexible substrate of the second flexible circuitry section. The substrate materials may include: Polymethyl methacrylate (PMMA), Polyethylene terephthalate (PET) and other low temperature process plastics which would be well suited for accommodating printed electronics.

Alternatively, the first and second flexible circuitry sections along with an intermediate circuitry section could be integrally formed as a single unit, with the intermediate circuitry section being provided by rigid support from the support structure or by the provision of a rigid substrate. The rigid support may be in the form of a flat planar rigid support. In such an example where the first and second flexible circuitry portions 103a and 109a are integrally formed as a single unit with circuitry 201, the connectors 203 and 204 are not required.

In a yet further example, the first and second flexible circuitry sections could correspond to first and second sides of the same single flexible circuit, which is appropriately wrapped around the support structure so as to have a first section disposed towards an inner side and a second portion disposed towards an outer side.

Figure 3 illustrates a cross sectional view of a further example of an apparatus 300 according to the present disclosure. The apparatus 300 comprises a support structure 101a, and the circuitry arrangement 200 of Figure 2 comprising an inner sensor foil, i.e. first flexible circuitry portion 103a, an outer

sensor foil, i.e. second flexible circuitry section 107a, and an interposing rigid circuitry section 201. Electrical components and electrical hardware, such as a controller, processor and memory, may be mounted and integrated in the rigid circuitry portion.

The inner and outer sensor foils can be coupled to the support structure via any suitable means, for example adhered by double sided adhesive tape. The support structure is configured such that has portions of varying rigidity. The support structure 101a has flexible portions 301a and 301b which may be bent upon user actuation, e.g. a user squeezing the apparatus between thumb and forefinger, so as to enable movement of the limb/end portions 303a and 303b of the support structure as represented with double headed arrows 302a and 302b. The flexible portions may also allow rotation of the limb/end portions 303a and 303b about points A and B respectively. Such flexibility provides improved user comfort, but can also be used for user input.

One of the sensor foils, e.g. the outer sensor foil, may comprise one or more sensors, such as a strain sensor to detect such user actuation/manipulation of a part of the apparatus such as the support structure, namely the user: squeezing or flexing the apparatus to cause relative movement or rotation of parts of the support structure. A signal from such a sensor, indicative of such user manipulation of the apparatus/support, could be used for a user input or user interface command. For example, the signal from such a sensor could be provided to a controller circuitry mounted on the rigid circuitry 201 and used as an input command for a user interface or to control the apparatus in dependence on detection of user actuation of the bendable section.

The apparatus 300 is provided with means configured to withstand a degree of bending applied by the user to the support structure. In the example of Figure 3, such means correspond to the provision of an extra length, i.e. slack 305a and 305b, in the first and second flexible circuitries to allow for/accommodate bending of sections of the support structure. Means

configured to withstand a degree of bending of the apparatus could relate to the selection of materials for parts of the apparatus, e.g. resilient materials, or the structure of the apparatus, e.g. sections of reduced width 301a and 301b to permit a degree of bending.

Means configured to limit a degree of bending able to be applied to the support structure could also be provided. For example, the rigid section of the support structure could be provided with a protruding member configured to mate/engage with a corresponding recession in the flexible section such that bending of the apparatus causes the protrusion to enter into and engage with the recession. A gap is provided between the recession and the protrusion to permit a degree of movement/bending of the apparatus, but limit the degree of bending i.e. when the protrusion fully engages with and abuts against recession thereby preventing any further movement and bending.

The two flexible/user manipulable sections are located on either side of a rigid section 304. The rigid section 304 provides a rigid and non-flexible support area for the rigid circuitry 201. This provides a secure and robust housing for electrical components and hardware mounted therein to protect delicate circuitry and main electronic components, such as control circuitry of the apparatus.

The rigid, bendable and flexible portions could be achieved by any suitable means, e.g. providing relatively thicker and thinner portions of the support structure or making such portions of the support structure from materials having the appropriate mechanical characteristics. Alternatively a mechanism could be provided to enable bending, such as a hinge.

Figure 4 illustrates a yet further example of an apparatus 400 according to the present disclosure. The apparatus broadly corresponds to the apparatus

300 of Figure 3, i.e. comprising a support structure 101a, inner sensor flex 103a on an inner side of the support structure and an outer sensor flex 107a on an outer side of the support structure. Figure 4 also shows a plurality of printed sensors 105a on the inner surface of the inner sensor flex and a plurality of printed sensors 109a on the outer surface of the outer sensor flex. The inner and outer sensor flexes may be provided with sensors substantially covering their respective surfaces.

The printed sensors and the inner and outer sensor flexes may be provided with a protective layer. I.e. a protective layer overlying the inner surface of the inner sensor flex and protective layer overlying the outer surface of the outer sensor flex.

A fastening device may be used to secure and tighten the apparatus around the user's limb. In the example of Figure 4, an aperture 401 is provided in one of the limb end portions 303a of the apparatus. A strap (not shown), which is secured to the other limb end portion 303b, can be passed through the aperture 401 and used to fasten and tighten the apparatus around the user's appendage. For example a hook and loop based fastening strap may be used in this regard. Alternatively, other fastening and/or clasping means may be used.

The second flexible circuitry section 107a, which is disposed on an outer side of the support structure 101a, may be electrically connected to the other circuitry (e.g. circuitry 201 not shown in Figure 4) which is disposed on the inner side of the support structure. Such electrical connection is provided via a portion of second flexible circuitry (e.g. portion 205 not shown in figure 4) which is disposed on an inner side of the support structure. The support structure may comprise an aperture (e.g. aperture 206 not shown in Figure 4) through which the second flexible circuitry can pass to enable the second flexible circuitry to wrap around the support structure and thereby have a section of the second flexible circuitry which is disposed on the outer side of

the support structure as well as a portion disposed on the inner side of the support structure for electrical connection to other circuitry.

Advantageously, placing the other circuitry 201 on an inner side of the support structure helps protect the circuitry and the main electrical components of the apparatus from the external environment. However, in an alternative example, the circuitry 201 may be provided on the outer side of the support structure, such that an equivalent aperture and wrap around arrangement would be provided for the first flexible circuitry to enable the first section of flexible circuitry section 103a, disposed on an inner side of the support structure 101a, to be electrically connected to circuitry 201 disposed on the outer side of the support structure.

In yet a further example, the support member may be provided with an aperture/window within which the circuitry 201 is disposed and the first flexible circuitry attached thereto may be bent, folded or passed through the aperture to the inner side of the support structure whilst the second flexible circuitry attached to the circuitry 201 may be bent, folded or passed through the aperture to the outer side of the support structure.

Figure 5 illustrates a yet further example of an apparatus 500 according to the present disclosure. The apparatus 500 comprises a support structure 501 having an aperture or window therethrough 510. The aperture is configured such that flexible circuitry can be disposed therein.

In this example, the first and second flexible circuitry sections 503 and 507 correspond to first and second major surfaces/sides of the same single flexible circuitry or substrate 511 which is disposed and mounted within the aperture 510. In effect, a double sided flexible circuitry 511 is provided with first flexible circuitry section 503 on one side disposed towards an inwards direction 504 and second flexible circuitry section 507 on the other side disposed towards an outward direction 508.

One or more first sensor(s) 505 (shown in outline) may be mounted/printed on a first under side of the double sided flexible circuitry 511 and disposed towards an inner side 504 of the support structure. One or more second sensor(s) 509 may be mounted on an opposing second upper side of the double sided flexible circuitry 511 and disposed towards an outer side 508 of the support structure.

The aperture, window or opening 510 could be provided through the support structure 501 such that the first sensor on the first side is exposed to the user's appendage. Also, the first sensor may be configured to monitor the user. Whereas the second sensor on the second side may be exposed to the external environment and the second sensor may be configured so as to monitor the external environment.

Although not shown, it is to be appreciated that one or more further first flexible circuitry sections (with one or more first sensor(s) thereon) may additionally be provide which extend beyond the aperture and disposed on the inner side of the support structure. Similarly, one or more further second flexible circuitry sections (with one or more second sensor(s) thereon) could be provided disposed on the outer side of the support structure. In a yet further example, the double sided circuitry/substrate 511 may be rigid.

Although examples of the apparatus have been described above in terms of comprising various components, it should be understood that the components may be embodied as or otherwise controlled by a corresponding processing element or processor of the apparatus. In this regard, each of the components described above may be one of more of any device, means or circuitry embodied in hardware, software or a combination of hardware and software that is configured to perform the corresponding functions of the respective components.

Apparatuses in accordance with certain examples of the present disclosure may be configured for: portable use, wearable use (e.g. on a limb portion such as a: wrist, bicep, ankle ...) and wired or wireless communication (e.g. via a cellular network, WAN or short range wireless communication protocol). The apparatus may have additional functions beside communication and comprise:

user input interfaces (e.g. buttons, voice control, touch screen, as well as user input by user manipulation of the overall apparatus, e.g. squeezing the apparatus between thumb and forefinger as discussed above) and

user output interfaces (e.g. audio-visual and haptic output devices).

In addition to providing sensor measurements and readings, examples of the apparatuses according to the present disclosure may additionally provide one or more audio/text/video communication functions (e.g. tele-communication, video-communication, and/or text transmission (Short Message Service (SMS)/ Multimedia Message Service (MMS)/emailing) functions), interactive/non-interactive viewing functions (e.g. web-browsing, navigation, TV/program viewing functions), music recording/playing functions (e.g. Moving Picture Experts Group-1 Audio Layer 3 (MP3) or other formats and/or (frequency modulation/amplitude modulation) radio broadcast recording/playing), downloading/sending of data functions, image capture function (e.g. using a (e.g. in-built) digital camera), and gaming functions. Electrical hardware and electrical components to effect such functionality may be provided in rigid circuitry 201 housed in the rigid section 304 of the apparatus.

Control of such functionality and other functionality of the apparatus may be provided by a controller.

Figure 6 schematically illustrates an example of a controller 600, i.e. to control the sensors and/or other functionality of apparatuses according to the

present disclosure. The controller may be integrated in rigid circuitry 201 housed in the rigid section 304 of the apparatus.

Implementation of the controller 600 can be in hardware alone (e.g. processing circuitry 601 comprising one or more processors 602 and memory circuitry comprising one or more memory elements 603), have certain aspects in software including firmware alone or can be a combination of hardware and software (including firmware).

The controller 600 may be implemented using instructions 605 that enable hardware functionality, for example, by using executable computer program instructions 605 in a general-purpose or special-purpose processor that may be stored on a computer readable storage medium 603 (e.g. memory) or carried by a signal carrier, to be performed by such a processor.

In the illustrated example, the controller 600 is provided by a processor 602 and memory 603. Although a single processor and a single memory are illustrated in other implementations there may be multiple processors and/or there may be multiple memories some or all of which may be integrated/removable and/or may provide permanent/semi-permanent/ dynamic/cached storage.

The processor 602 is configured to read from and write to the memory 603. The processor 602 may also comprise an input interface 606 via which data, such as sensor signals and/or commands, are input to the processor 602 from at least one input device 608 (e.g. the at least first and second sensors) and an output interface 607 via which data and/or commands are output by the processor 602 to output device 609. The output device may comprise:

a transceiver via which data may be wirelessly communicated to other devices,

an audio output device such as a speaker

a visual output device such as a display, lights or other visual indication means

a haptic output device such as a vibrator.

The memory 603 stores a computer program 604 comprising computer program instructions 605 that control the operation of the apparatus when loaded into the processor 602. The computer program instructions provide the logic and routines that enable the apparatus to effect functionality, not least such as controlling the sensors, user input/output, wireless communication and also the method 700 discussed below with respect to Figure 7.

The computer program instructions 605 may arrive at the controller 600 via any suitable delivery mechanism. The delivery mechanism may be, for example, a non-transitory computer-readable storage medium 610, a computer program product, a memory device, a record medium such as a compact disc read-only memory or digital versatile disc, or an article of manufacture that tangibly embodies the computer program. The delivery mechanism may be a signal configured to reliably transfer the computer program.

Figure 7 illustrates a method 700 according to an example of the present disclosure.

In block 701, a manipulation of the apparatus 100 is detected. For example the outer sensor flex 107a could comprise a strain sensor printed thereon configured to detect bending and relative movement of the rigid section 304 and the flexible section 301a. Such an arrangement would be able to recognise user actuated manipulation of the support structure, e.g. a user squeezing the apparatus between his/her thumb and forefinger.

In block 702, operation of the apparatus is controlled in dependence on the detected manipulation. Such control may correspond to a user input or command to effect the operation of the apparatus.

The blocks may represent steps in a method and/or sections of instructions/code 605 in the computer program 604, i.e. such that the controller might be configured to cause the method 700 to be performed.

It will be understood that each block and combinations of blocks, can be implemented by various means, such as hardware, firmware, and/or software including one or more computer program instructions. For example, one or more of the procedures described above may be embodied by computer program instructions 605. In this regard, the computer program instructions which embody the procedures described above may be stored in the memory storage device 603 and performed by the processor 602.

As will be appreciated, any such computer program instructions may be loaded onto a computer or other programmable apparatus (i.e., hardware) to produce a machine, such that the instructions, when performed on the programmable apparatus, create means for implementing the functions specified in the blocks.

The computer program instructions may also be loaded onto a programmable apparatus to cause a series of operational steps to be performed on the programmable apparatus to produce a computer-implemented process such that the instructions which are performed on the programmable apparatus provide steps for implementing the functions specified in the blocks.

In the above description, the wording 'connect', 'couple' and 'communication' and their derivatives mean operationally connected/coupled/in communication. It should be appreciated that any

number or combination of intervening components can exist (including no intervening components).

Features described in the preceding description may be used in combinations other than the combinations explicitly described. Although functions have been described with reference to certain features, those functions may be performable by other features whether described or not. Although features have been described with reference to certain examples, those features may also be present in other examples whether described or not.

The term 'comprise' is used in this document with an inclusive not an exclusive meaning. That is any reference to X comprising Y indicates that X may comprise only one Y or may comprise more than one Y. If it is intended to use 'comprise' with an exclusive meaning then it will be made clear in the context by referring to "comprising only one ..." or by using "consisting".

In this description, reference has been made to various examples. The description of features or functions in relation to an example indicates that those features or functions are present in that example. The use of the term 'example' or 'for example' or 'may' in the text denotes, whether explicitly stated or not, that such features or functions are present in at least the described example, whether described as an example or not, and that they can be, but are not necessarily, present in some or all other examples. Thus 'example', 'for example' or 'may' refers to a particular instance in a class of examples. A property of the instance can be a property of only that instance or a property of the class or a property of a sub-class of the class that includes some but not all of the instances in the class.

Whilst endeavouring in the foregoing specification to draw attention to those features of the invention believed to be of particular importance it should be understood that the applicant claims protection in respect of any patentable

feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis has been placed thereon.

The above description describes some examples of apparatuses according to the present disclosure. However those of ordinary skill in the art will be aware of possible alternative structures and method features which offer equivalent functionality to the specific examples of such structures and features described herein above and which for the sake of brevity and clarity have been omitted from the above description. Nonetheless, the above description should be read as implicitly including reference to such alternative structures and method features which provide equivalent functionality unless such alternative structures or method features are explicitly excluded in the above description.

It should be appreciated that modifications to the examples presently described given can be made without departing from the scope of the invention as set out in the following claims.

CLAIMS

We claim:

1. An apparatus comprising:

a support structure configured to at least partially enclose an appendage of a user, said support structure defining an inner side and an outer side; and

a first section of flexible circuitry disposed towards the inner side of the support structure.

2. The apparatus of claim 1, wherein the first section of flexible circuitry comprises at least a first sensor mounted thereon.

3. The apparatus of claim 1 or 2, wherein the first section of flexible circuitry at least one of:

comprises circuitry printed thereon;

comprises at least a first sensor;

comprises an array of sensors disposed along the length of the first section of flexible circuitry;

comprises at least a first sensor, disposed towards one side of the first section of flexible circuitry, configured to monitor the user;

comprises at least a second sensor, disposed towards another side of the first section of flexible circuitry, configured to monitor an external environment; and

extends around a substantial portion of the inner side of the support structure.

4. The apparatus of any one or more of the previous claims, wherein the apparatus comprises a second section of flexible circuitry disposed towards the outer side of the support structure.

5. The apparatus of claim 4, wherein the second section of flexible circuitry comprises at least a second sensor mounted thereon.

6. The apparatus of claim 4 or 5 wherein the second section of flexible circuitry at least one of:

comprises circuitry printed thereon;

comprises at least a second sensor;

comprises an array of sensors disposed along the length of the second section of flexible circuitry;

comprises at least a second sensor, disposed towards one side of the second section of flexible circuitry, configured to monitor an external environment; and

comprises at least a first sensor, disposed towards another side of the second section of flexible circuitry, configured to monitor the user; and

extends around a significant portion of the outer side of the support structure.

7. The apparatus of any one or more of previous claims 4 to 6, wherein the first section of flexible circuitry is a portion of a first side of flexible circuitry and the second section of flexible circuitry is a portion of a second side of the flexible circuitry.

8. The apparatus of any one or more of previous claims 4 to 6, wherein a substrate of the first section of flexible circuitry is different to a substrate of the second section of flexible circuitry.

9. The apparatus of any one or more of the previous claims, further comprising electronic hardware mounted in a rigid circuitry section.

10. The apparatus of claim 9, wherein the first section of flexible circuitry, a second section of flexible circuitry and the rigid circuitry section are integrally formed as a single unit.

11. The apparatus of any one or more of the previous claims, wherein the support structure comprises at least one of the following:

a rigid section,

a flexible section,

a user manipulable section, and

an aperture through which at least a portion of the first section of flexible circuitry can pass.

12. The apparatus of any one or more of the previous claims, further comprising at least one sensor configured to detect user manipulation of a part of the apparatus.

13. The apparatus of claim 12 wherein a sensor signal from the at least one sensor is configured to control the apparatus.

14. The apparatus of any one or more of the previous claims, wherein the apparatus is configured to withstand a degree of bending that can be applied to the support structure.

15. The apparatus of any one or more of the previous claims, wherein the apparatus is configured to limit a degree of bending that can be applied to the support structure.

16. The apparatus of any one or more of the previous claims, wherein the apparatus is at least one of the following:

a wireless communication device, a portable device, a wearable device and a wrist device.

17. An apparatus comprising:

support means configured to at least partially enclose an appendage of a user, said support means defining an inner side and an outer side; and

first flexible circuitry means disposed towards the inner side of the support means.

18. A module comprising the apparatus of any one or more of the previous claims 1 to 17.

19. The module of previous claim 18, wherein the module is configured for use in a wrist device.

20. A method for operating the apparatus of any one or more of previous claims 1 to 17, the method comprising:

detecting a user manipulation of the apparatus; and

controlling operation of the apparatus in dependence on the detected user manipulation.

21. A computer program that, when performed by at least one processor, causes the method claimed in claim 20 to be performed.

Application No:	GB1408635.9	**Examiner:**	Gareth Lewis
Claims searched:	All	**Date of search:**	22 December 2014

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	1-7, 9-21	US2013/106684 A1 (WEAST) See figures 1-23, 145-150 and paragraphs 155-156, 161, 164-170, 179, 182, 203-204, 405-411
X	1-20	WO2005/083546 A1 (DANIEL) See all figures, pages 11-12, 16-17, 21, 23
X,A	X 1, 17 at least	US2014/073486 A1 (BOBO) See figures 5-8 and paragraphs65-58 and 95-96
X	1-3, 9, 11-17, 19 at least	US2010/076331 A1 (CHANG GUNG) See figure 1-3b, claims and paragraphs 19-23
A	-	US2008/117039 A1 (NOKIA) See paragraphs 27, 29-31, 37

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

A61B; A63B; H05K

The following online and other databases have been used in the preparation of this search report

Online : EPODOC WPI

International Classification:

Subclass	Subgroup	Valid From
H05K	0001/03	01/01/2006
A61B	0005/00	01/01/2006