PTO/AIA/15 (03-13)
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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	PM0002
First Named Inventor	von Badinski et al.
Title	WEARABLE COMPUTING DEVICE
Express Mail Label No.	N/A

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

1. [✓] **Fee Transmittal Form** (PTO/SB/17 or equivalent)
2. [ ] **Applicant asserts small entity status.** See 37 CFR 1.27
3. [ ] **Applicant certifies micro entity status.** See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
4. [✓] **Specification** [*Total Pages* 71] Both the claims and abstract must start on a new page. *(See MPEP § 608.01(a) for information on the preferred arrangement)*
5. [✓] **Drawing(s)** (35 U.S.C. 113) [*Total Sheets* 64]
6. **Inventor's Oath or Declaration** [*Total Pages* 3] *(including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e))*
   a. [ ] Newly executed (original or copy)
   b. [✓] A copy from a prior application (37 CFR 1.63(d))
7. [✓] **Application Data Sheet** ** See note below.* See 37 CFR 1.76 (PTO/AIA/14 or equivalent)
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ACCOMPANYING APPLICATION PAPERS

10. [ ] **Assignment Papers** (cover sheet & document(s))
    Name of Assignee _____
11. [ ] **37 CFR 3.73(c) Statement** (*when there is an assignee*) [✓] **Power of Attorney**
12. [ ] **English Translation Document** (*if applicable*)
13. [ ] **Information Disclosure Statement** (PTO/SB/08 or PTO-1449)
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14. [ ] **Preliminary Amendment**
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17. [ ] **Nonpublication Request** Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
18. [ ] **Other:** _____

***Note**: (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must** be included in an Application Data Sheet (ADS).
(2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

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WEARABLE COMPUTING DEVICE

CROSS REFERENCE

[0001] The present Application for Patent is a Continuation of U.S. Patent Application No. 18/179,272, by von Badinski et al., entitled "WEARABLE COMPUTING DEVICE," filed March 6, 2023, which is a Continuation of U.S. Patent Application No. 17/519,201, by von Badinski et al., entitled "WEARABLE COMPUTING DEVICE," filed November 4, 2021, which is a Continuation of U.S. Patent Application No. 17/013,348, by von Badinski et al., entitled "WEARABLE COMPUTING DEVICE," filed September 4, 2020, which is a Continuation of U.S. Patent Application No. 16/224,686, by von Badinski et al, entitled "WEARABLE COMPUTING DEVICE," filed December 18, 2018, which is a Division of U.S. Patent Application No. 15/444,217, by von Badinski et al., entitled "WEARABLE COMPUTING DEVICE," filed February 27, 2017, which is a Division of U.S. Patent Application No. 14/556,062, by von Badinski et al, entitled "WEARABLE COMPUTING DEVICE," filed November 28, 2014, which claims the benefit of United States Provisional Application Serial No. 62/006,835, by von Badinski et al., entitled "WEARABLE COMPUTING DEVICE," filed June 2, 2014, and United States Provisional Application Serial No. 61/910,201, by von Badinski et al., entitled "FINGER RING DEVICE FOR ACTIVITY MONITORING OR GESTURAL INPUT," filed November 29, 2013, each of which is expressly incorporated by reference herein.

FIELD OF TECHNOLOGY

[0002] This invention is in the field of wearable electronic devices.

BACKGROUND

[0003] Wearable electronics are an emerging technology with many applications for the wearer. They can improve lifestyles, ease access to technology and help monitor activity within the wearer's body. However, many current wearable electronics are bulky and can be intrusive or interfere with a person's daily life. In this regard, the wearer may not be comfortable wearing the device for extended periods of time.

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SUMMARY OF THE INVENTION

[0004] This invention overcomes the disadvantages of the prior art by providing a wearable computing device (WCD) in the shape of a ring. The wearable computing device can be worn for extended periods of time and can take many measurements and perform various functions because of its form factor and position on the finger of a user.

[0005] One aspect of the disclosure provides a wearable computing device, comprising: an interior wall; an exterior wall; a flexible printed circuit board disposed between the interior wall and the exterior wall; at least one component disposed on the flexible printed circuit board; and wherein at least one of the interior wall and the exterior wall defines a window that facilitates at least one of data transmission, battery recharge, and status indication.

[0006] In one example, the window comprises an internal window defined by the interior wall.

[0007] In one example, the window comprises an exterior window defined by the exterior wall.

[0008] In one example, the window comprises a plurality of exterior windows defined by the exterior wall.

[0009] In one example, the plurality of exterior windows comprises a first exterior window and a second exterior window, wherein the first exterior window facilities battery charging and the second exterior window facilities data transmission.

[0010] In one example, at least one concentrated photovoltaic cell, an antenna, and at least one LED are accessible via the window.

[0011] Another aspect of the disclosure provides a wearable computing device, comprising: an internal housing portion configured to be disposed near a finger of a user; a flexible printed circuit board arranged around a portion of a circumference of an interior surface of the internal housing; at least one component disposed on the flexible printed circuit board; and an external housing portion configured to seal the at least one component and the printed circuit board in an internal space defined by the interior surface of the internal housing.

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[0012] In one example, the external housing portion comprises a substantially transparent external potting.

[0013] In one example, the at least one component comprises at least one LED configured to emit at least one of visible light, infrared radiation, and ultraviolet radiation through the external potting.

[0014] In one example, the at least one component comprises a concentrated photovoltaic cell configured to receive concentrated light through the transparent external potting.

[0015] In one example, the flexible printed circuit board includes a plurality of stiffener elements configured to engage with a corresponding plurality of flanges disposed on the internal housing portion.

[0016] Another aspect of the disclosure provides a wearable computing device, comprising: an external housing portion; a flexible printed circuit board arranged around a portion of a circumference of an interior surface of the external housing; at least one component disposed on the flexible printed circuit board; and an internal housing portion configured to seal the at least one component and the printed circuit board in an internal space defined by the interior surface of the external housing.

[0017] In one example, the internal housing portion comprises a substantially transparent internal potting.

[0018] In one example, the at least one component comprises at least one LED configured to emit at least one of visible light, infrared radiation, and ultraviolet radiation through the internal potting.

[0019] In one example, the at least one component comprises a concentrated photovoltaic cell configured to receive concentrated light through the transparent internal potting.

[0020] In one example, the flexible printed circuit board includes a plurality of stiffener elements configured to engage with a corresponding plurality of flanges disposed on the external housing portion.

[0021] Another aspect of the disclosure provides a system, comprising: a wearable computing device, including a housing and a photovoltaic element disposed at least

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partially within the housing; and a base assembly, the base assembly including a concentrated light source directed at the photovoltaic element.

[0022] In one example, the wearable computing device includes at least one ferrous element disposed within the housing, and wherein the base assembly includes at least one magnetic element disposed therein.

[0023] In one example, the concentrated light source is arranged circumferentially around the wearable computing device when the wearable computing device is engaged with the base assembly.

[0024] In one example, the concentrated light source comprises at least one of a laser diode and a light emitting diode (LED).

[0025] In one example, a housing of the WCD defines an opening through which the WCD is configured to receive concentrated light.

[0026] In one example, the base assembly comprises an optical element for focusing concentrated light emitted from the concentrated light source.

[0027] In one example, the optical element comprises a lens and is selected from the group consisting of concave, convex, piano-concave, piano-convex.

[0028] In one example, the WCD comprises at least one transparent potting configured to allow concentrated light to pass therethrough.

[0029] In one example, the WCD is ring-shaped and the base assembly comprises at least one post configured to engaged with a finger space of the WCD.

[0030] In one example, the photovoltaic cell comprises a plurality of photovoltaic cells.

[0031] Another aspect of the disclosure provides an enclosure for a wearable computing device, the enclosure comprising: a base defining a receptacle for receiving the wearable computing; a lid configured to engage with the base to substantially enclose the wearable computing device, the lid having an optical element configured to direct incident electromagnetic radiation to photovoltaic cell disposed on the wearable computing device to allow charging thereof.

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[0032] In one example, the lid includes a plurality of vent holes that prevent overheating within the enclosure.

[0033] In one example, the optical element comprises a lens.

[0034] In one example, the lens has a focal length and wherein a distance between a central portion of the lens and the photovoltaic cell is greater than or less than the focal length.

[0035] Another aspect of the disclosure provides a timepiece system, comprising: a timepiece having a substantially planar under surface; and a timepiece computing device adhered to the planar under surface, the timepiece computing device being substantially cylindrical and comprising: a processor; a memory; and at least one sensor.

[0036] Another aspect of the disclosure provides a wearable computing device system, comprising: a wearable computing device; an attachment frame coupled to the wearable computing device; and an optical element removably coupled to the attachment frame, wherein the optical element is configured to direct electromagnetic radiation to a photovoltaic cell disposed on a surface of the wearable computing device to allow for charging of the wearable computing device.

[0037] In one example, the attachment frame is removably coupled to the wearable computing device.

[0038] In one example, the attachment frame engages with an inward-facing surface of the wearable computing device.

[0039] Another aspect of the disclosure provides a method of identifying an authorized user of a wearable computing device, comprising: illuminating a portion of a skin surface of the user; imaging the portion of the skin surface of the user to generate at least one first image; generating a reference capillary map corresponding to the user based at least in part on the at least one image.

[0040] In one example, the method further includes rotating the wearable computing device during the illuminating and imaging steps.

[0041] In one example, the method further includes imaging the portion of the skin surface of the user to generate at least one second image; and comparing the at least one second image to the reference capillary map in order to authenticate the user.

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[0042] Another aspect of the disclosure provides a method of navigating, comprising: gesturing in a first direction while wearing a wearable computing device; comparing the first direction to a predetermined direction in a predetermined set of directions; providing feedback based on the comparison of the first direction of the predetermined direction.

[0043] In one example, the gesture comprises pointing a finger and the first direction comprises a first heading.

[0044] Another aspect of the disclosure provides a method of regulating temperature, comprising: measuring a skin temperature of a user via a first temperature sensor; measuring an ambient temperature via a second temperature sensor; comparing the skin temperature to a predetermined threshold temperature; and adjusting the ambient temperature based in part on the comparison.

[0045] In one example, measuring the skin temperature comprises measuring the skin temperature via a first temperature sensor disposed at an inward facing surface of a wearable computing device.

[0046] In one example, measuring the ambient temperature comprises measuring the ambient temperature via a second temperature sensor disposed at an outward facing surface of the wearable computing device.

[0047] Another aspect of the disclosure provides a method for controlling appliances, comprising: identifying a position of a first appliance in a room; gesturing a first gesture in a direction of the first appliance; identifying the direction of the first direction via a wearable computing device; issuing a controlling command to the first appliance based in part on the identified direction of the gesture.

[0048] Another aspect of the disclosure provides a method of generating an alert, comprising: authenticating a first wearer of a first wearable computing device as a first authenticated user; transmitting first biometric data associated with the first wearer; associating the first biometric data with a first profile associated with the first wearer of the first wearable computing device; comparing the first biometric data with a group profile comprising aggregated biometric data from a plurality of distinct wearers of a plurality of distinct wearable computing devices; and generating an alert if the first

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biometric data falls outside of a predetermined threshold set by the aggregated biometric data.

[0049] In one example, the biometric data comprises at least one of heart rate; ECG profile; blood sugar, and blood pressure.

[0050] In one example, the plurality of distinct wearers share a common trait, resulting in their aggregation into the group profile.

[0051] In one example, the common trait comprises at least one of: age, gender, profession, and location.

[0052] Another aspect of the disclosure provides a method of determine a sampling rate of a wearable computing device, comprising: determining an activity level of a wearer of a wearable computing device based at least in part on data from at least one sensor disposed onboard the wearable computing device; comparing the activity level to a predetermined activity threshold; and increasing a first sensor sampling rate if the activity level is above a predetermined activity threshold.

[0053] In one example, the method further includes decreasing the first sensor sampling rate if the activity level is below a predetermined activity threshold.

[0054] In one example, the predetermined activity threshold comprises an acceleration measurement.

BRIEF DESCRIPTION OF THE DRAWINGS

[0055] The invention description below refers to the accompanying drawings, of which:

[0056] FIG. 1A is a perspective view of a WCD illustrating an exterior window in accordance with some embodiments;

[0057] FIG. 1B is a perspective view of the WCD of FIG. 1A illustrating an interior window in accordance with some embodiments;

[0058] FIG. 1C is a perspective view of an alternative WCD design of the ring of FIG. 1A in accordance with some embodiments;

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[0059] FIG. 2 is an abstract functional diagram illustrating example components within the WCD in accordance with some embodiments;

[0060] FIG. 3A is a view of an exterior window of a WCD with example components exposed in accordance with some embodiments;

[0061] FIG. 3B is a view of an interior window of a WCD with example components exposed in accordance with some embodiments;

[0062] FIG. 3C is a view of the exterior windows of an alternative WCD with example components exposed in accordance with some embodiments;

[0063] FIG. 4 is an exploded view of a WCD illustrating a battery and a flexible circuit which are configured to fit inside the housing of the WCD in accordance with some embodiments;

[0064] FIG. 5 is a perspective view of the flexible circuit of FIG. 4 in accordance with some embodiments;

[0065] FIG. 6 is an exploded view of a WCD with an alternative charging mechanism in accordance with some embodiments;

[0066] FIG. 7 is a perspective view of an alternative design of a WCD in accordance with some embodiments;

[0067] FIG. 8 is an exploded view of the WCD of FIG. 7 illustrating another alternative charging mechanism in accordance with some embodiments;

[0068] FIG. 9A is a perspective view of a charging device for the ring station in accordance with some embodiments;

[0069] FIG. 9B is an abstract diagram illustrating a partial structure of the charging station of FIG. 9A in accordance with some embodiments;

[0070] FIG. 10 is an example screenshot illustrating a user interface of a mobile application coupled to the WCD and displaying fitness monitoring readings in accordance with some embodiments;

[0071] FIG. 11 is an example screenshot illustrating a user interface of a mobile application coupled to the WCD and displaying sensor readings (e.g., for calibration purposes) in accordance with some embodiments;

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[0072] FIG. 12A is a perspective view of a wearable computing device (WCD) according to one or more aspects of the disclosure;

[0073] FIG. 12B is a side view of a WCD according to one or more aspects of the disclosure;

[0074] FIG. 12C is a front view of the WCD according to one or more aspects of the disclosure;

[0075] FIG. 12D is a cross section of the WCD along the line A-A of FIG. 12C;

[0076] FIG. 12E is a perspective view of the internal housing without external potting;

[0077] FIG. 12F is a perspective view of the internal housing with a portion of the external potting removed and showing one or more components and printed circuit board (PCB);

[0078] FIG. 13 is a cross section of a WCD according to another aspect of the disclosure;

[0079] FIG. 14A is a cross section of a WCD according to another aspect of the disclosure;

[0080] FIG. 14B is a perspective view of the PCB and stiffener element of FIG. 14A;

[0081] FIG. 14C is a perspective view of the PCB and stiffener element of FIG. 14A;

[0082] FIG. 14D shows a cross section of the WCD at a point in time when the PCB is being inserted into the internal space and prior to the application of potting;

[0083] FIG. 14E is a cross section of the WCD of after a potting material has been applied subsequent to the WCD of FIG. 14D;

[0084] FIG. 15A depicts a perspective view of a WCD according to another aspect of the disclosure;

[0085] FIG. 15B is a side view of the WCD of FIG. 15A;

[0086] FIG. 15C is an exploded view of the WCD;

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[0087] FIG. 16A is an exploded view of a housing and a PCB of a WCD according to one or more aspects of the disclosure;

[0088] FIG. 16B is a cross section of FIG. 16A along line B-B;

[0089] FIG. 16C is a perspective view of the WCD with potting material;

[0090] FIG. 17A depicts a cross section of a WCD employing charging by concentrated light source according to one or more aspects of the disclosure;

[0091] FIG. 17B depicts a cross section of a WCD employing charging by concentrated light source according to another aspect of the disclosure;

[0092] FIG. 17C is a perspective view of a base assembly and WCD 700 according to one or more aspects of the disclosure;

[0093] FIG. 17D depicts a perspective view of internal components of the base assembly 750 and WCD 700 according to another aspect of the disclosure;

[0094] FIGs. 17E-F depict other CPV configurations according to one or more aspects of the disclosure;

[0095] FIG. 17G is perspective view of a WCD and base assembly with a lx3 CPV arrangement;

[0096] FIG. 18A depicts a cross section of a WCD 800 employing charging by concentrated light source according to another of the disclosure;

[0097] FIG. 18B depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure;

[0098] FIG. 19A depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure;

[0099] FIG. 19B depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure;

[0100] FIG. 19C depicts a schematic diagram of magnets that can be used in a WCD and/or base assembly according to one or more aspects of the disclosure;

[0101] FIG. 19D depicts a schematic diagram of magnets that can be used in a WCD and/or base assembly according to one or more aspects of the disclosure;

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[0102] FIG. 19E is a perspective view of a WCD and a base assembly according to one or more aspects of the disclosure;

[0103] FIG. 20A is a cross section of a WCD engaged with a base assembly 1050 according to one or more aspects of the disclosure;

[0104] FIG. 20B is a perspective view of a PCB 1040b with a CPV 1030b and ferrous element 1020b configuration according to one or more aspects of the disclosure;

[0105] FIG. 20C is a perspective view of a PCB with a CPV 1030c and ferrous element 1020c configuration according to one or more aspects of the disclosure;

[0106] FIG. 20D is a perspective view of a magnet and a concentrated light source 1070d according to one or more aspects of the disclosure;

[0107] FIG. 21A is a schematic view of a WCD showing components used for identifying the wearer of the WCD;

[0108] FIGs. 21B-C are perspective views of a skin surface according to one or more aspects of the disclosure;

[0109] FIG. 22A is a perspective view of a user employing ECG monitoring according to one or more aspects of the disclosure;

[0110] FIG. 22B is a view of a human with an electric pathway though his body according to one or more aspects of the disclosure;

[0111] FIG. 22C is a perspective view of a WCD that can employ ECG monitoring according to one aspect of the disclosure;

[0112] FIG. 23A is a perspective view of the hand of a user in various positions employing the navigational features of the WCD;

[0113] FIG. 23B is a flow chart depicting a method of providing feedback to a user according to one or more aspects of the disclosure;

[0114] FIG. 24A is a schematic diagram of a system 1400 for controlling an environment of a user according to one or more aspects of the disclosure;

[0115] FIG. 24B is a side view of a WCD showing one or more temperatures sensors according to one or more aspects of the disclosure;

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[0116] FIG. 24C is a system diagram of a system for controlling home appliances according to one or more aspects of the disclosure;

[0117] FIG. 24D is a flow chart depicting a method of controlling home appliances according to one or more aspects of the disclosure;

[0118] FIG. 25 is a perspective view of the hand of a user employing a two-factor authentication technique according to one or more aspects of the disclosure;

[0119] FIG. 26A is a schematic view of a charging apparatus for charging the WCD according to one or more aspects of the disclosure;

[0120] FIG. 26B shows a WCD including an RF antenna and charging circuitry;

[0121] FIG. 26C is a block diagram of the charging apparatus according to one aspect of the disclosure;

[0122] FIG. 27A is a pictorial diagram and FIG. 27B is a block diagram of a WCD employing flash storage according to one or more aspects of the disclosure;

[0123] FIG. 28A is a schematic diagram of one or more WCDs performing proximity functions according to one or more aspects of the disclosure;

[0124] FIG. 28B is a schematic diagram of one or more WCDs performing proximity functions according to one or more aspects of the disclosure;

[0125] FIG. 29A is a flow chart depicting a method of initiating gesture input according to one or more aspects of the disclosure;

[0126] FIG. 29B is a chart showing acceleration vs. time as measured by the accelerometer of the WCD;

[0127] FIG. 30 is a perspective view of a WCD 2000 employing a reset function;

[0128] FIG. 31A is a perspective view of a WCD including an LED indicator according to one or more aspects of the disclosure;

[0129] FIGs. 31B and 31C are cross sections along line C-C of a WCD employing an LED indicator according to one or more aspects of the disclosure;

[0130] FIG. 32 is flow chart depicting a method of communicating with a near field communication (NFC) device according to one or more aspects of the disclosure;

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[0131] FIG. 33A depicts a perspective view of a WCD assembly according to one or more aspects of the disclosure;

[0132] FIGs. 33B-D depict exploded views of the WCD assembly of FIG. 33A;

[0133] FIG. 33E depicts a cross sectional view of the WCD assembly along A-A;

[0134] FIGs. 34A-B depict a WCD assembly according to one or more aspects of the disclosure;

[0135] FIG. 35A depicts an enclosure or case for storing a WCD according to one or more aspects of the disclosure;

[0136] FIG. 35B is a cross sectional view of the assembled enclosure of FIG. 35A along the line B-B;

[0137] FIG. 35C depicts a cross sectional view of the assembled enclosure of FIG. 35B along line A-A;

[0138] FIG. 36 depicts an enclosure including air vents according to one or more aspects of the disclosure;

[0139] FIG. 37 depicts a method of sizing a finger according to one or more aspects of the disclosure;

[0140] FIG. 38 is a pictorial diagram showing a plurality of image perspectives of a user's hand;

[0141] FIG. 39 depicts a sizing tool for sizing the finger of a user;

[0142] FIG. 40 depicts a sizing tool for sizing the finger of a user according to an alternate example;

[0143] FIG. 41 depicts yet another alternate example of a sizing tool for sizing the finger of a user;

[0144] FIG. 42 depicts a method of monitoring activity according to one or more aspects of the disclosure;

[0145] FIG. 43 depicts a method of determining whether a user is wearing gloves according to one or more aspects of the disclosure;

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[0146] FIG. 44 depicts a method of securing data onboard the WCD according to one or more aspects of the disclosure;

[0147] FIG. 45A is a timepiece system according to one or more aspects of the disclosure;

[0148] FIG 45B is a bottom view of the TCD;

[0149] FIG. 46 depicts a WCD with a pair of LED indicators disposed at an inward-facing portion of the WCD;

[0150] FIG. 47A is a system for generating and managing alerts according to one or more aspects of the disclosure;

[0151] FIG. 47B depicts a block process diagram for generating and managing alerts according to one or more aspects of the disclosure;

[0152] FIG. 47C is a flow chart depicting a method for generating and managing alerts according to one or more aspects of the disclosure;

[0153] FIG. 48A is a method for variable sampling according to one or more aspects of the disclosure; FIG. 48B and 48c are graphs depicting one or more aspects of the sample method of FIG. 48A; and

[0154] FIG. 49 is a diagrammatic representation of a machine in the example form of a computer system within which a set of instructions, for causing the machine to perform any one or more of the methodologies discussed herein, may be executed.

DETAILED DESCRIPTION

[0155] The present disclosure describes a wearable computing device (WCD) that enables a wearable fitness monitor(s)/computer(s) which is suitable for prolonged usage with accurate results. The WCD can be in the form of a ring that can be worn on the finger of a human (or animal) user. Although the WCD of the present disclosure is depicted as a ring that can be worn on the finger of a user, other shapes, designs, and form factors can be utilized for the WCD. For example, the WCD can be in the form of a wrist band, bracelet, necklace, earring, or any other type of wearable accessory. In this regard, references to the finger of a user in the present application can be considered to

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apply to other portions of a human body depending on the form of the WCD, such as wrist, neck, ear, etc.

[0156] The term "coupled" as used herein means connected directly to or connected through one or more intervening components or circuits. Any of the signals provided over various buses described herein may be time-multiplexed with other signals and provided over one or more common buses. Additionally, the interconnection between circuit elements or software blocks may be shown as buses or as single signal lines. Each of the buses may alternatively be a single signal line, and each of the single signal lines may alternatively be buses, and a single line or bus might represent any one or more of a myriad of physical or logical mechanisms for communication (e.g., a network) between components. The present embodiments are not to be construed as limited to specific examples described herein but rather to include within their scope all embodiments defined by the appended claims.

[0157] FIG. 1A is a perspective view of 100 of a WCD 110 illustrating an exterior window 120 in accordance with some embodiments, and FIG. 1B is a perspective view 102 of the WCD 110 of FIG. 1A illustrating an interior window 130.

[0158] As previously mentioned, it is recognized in the present disclosure that conventional wearable fitness monitors such as clip-on devices, wristbands, or watch-type monitors still often suffer from inaccuracy mainly because they lack constant and consistent ways to read from the body areas they aim to monitor. It can also be an extra burden for the person to remember and wear such conventional fitness monitors each time the person perform exercises in order to create an accurate history tracking the exercise activities.

[0159] Accordingly, the present embodiments of the WCD 110 can function as fitness monitors/computer which is suitable for prolonged usage so as to create accurate results. In addition or as an alternative to fitness monitoring, as will be discussed in more detail below, the WCD 110 can function as a remote input device through, for example, gesture recognition. In some embodiments, the WCD 110 can further function as a sleep monitor, a heart rate sensor, a cardiac monitor a body temperature detector, or the like. It is noted that, for those embodiments which can function as a cardiac monitor (e.g., that measures electrocardiogram (EKG)), it may be necessary to establish a closed loop (e.g., for the electrical measurement of EKG) across the heart. As such, in some of

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those embodiments, a separate conductive pad can be coupled to the WCD 110 so that a user can pinch the pad with fingers on an opposite hand,

[0160] Specifically, in some embodiments of the present disclosure, the WCD 110 can be worn by the user (e.g., on a finger) for fitness, physical activity, biological data monitoring as well as for gestural input or other suitable purposes. As shown in FIGS. 1A and 1B, the WCD 110 can include the exterior window 120 on its exterior wall for input/output data transmission and reception, battery recharge, or status indication. The WCD 110 can also include the interior window 130 on its interior wall for various monitoring or sensing activities. The form factor of the WCD 110 allows it to be worn for prolonged hours with constant and consistent contact with the skin area, thereby creating a more reliable and extended recording (e.g., as compared to aforementioned conventional fitness monitors) of the user's fitness activity, physical exercise, as well as health information such as heart rates and body temperature. More implementation details regarding the WCD 110 are discussed below.

[0161] FIG. 1C is a perspective view of an alternative design of the WCD 110 of FIG. 1A in accordance with some embodiments. As shown in FIG. 1C, the WCD 112 includes a second exterior window 124 in addition to a first exterior window 122. The two exterior windows 122 and 124 can include spacing between the two windows 122 and 124 so that the mechanical strength of the housing structure of the WCD 112 may be stronger than that of the WCD 110, which is shown to include one single exterior window 120. Further, in some embodiments, radio antennas (e.g., Bluetooth) or other sensitive circuitry can be positioned in the second exterior window 124 away from the first exterior window 122 so that quality of reception may be improved.

[0162] FIG. 2 is an abstract functional diagram 200 illustrating example components within the WCD (e.g., WCD 110) in accordance with some embodiments. As shown in diagram 200, the WCD 110 can include a processor module 210, a plurality of sensor modules 220, a status indicator module 230, a power generation and management module 240, a communication module 250, a memory 260, and miscellaneous modules 270 (e.g., a real-time clock (RTC) crystal oscillator as illustrated in FIG. 2). The WCD 110 can also include a battery 280 module that provides electrical power for the WCD 110. In some embodiments, the battery 280 can be of a lithium-polymer type or a zinc-polymer type. It is noted that modules illustrated in diagram 200

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are for purposes of facilitating a better understanding of the present embodiments; other suitable modules may be included in the WCD 110 and are not shown for simplicity. As used herein, the term "components" is considered to generally include any of the modules depicted and/or described in FIG. 2, as well as any other modules described herein.

[0163] It is noted that the aforementioned modules are intended for purposes of enabling the present embodiments, rather than limiting. As such, a person of ordinary skill in the art will understand that the present disclosure covers apparent alternatives, modifications, and equivalents (e.g., combining or separating the modules) made to the techniques described herein. For example, in some embodiments, a portion of the communication module 250 (e.g., the Bluetooth Chip as shown in FIG. 2) can be combined into the processor module 210. For another example, one or more modules herein can be combined into one to form a system-on-the-chip (SOC).

[0164] The processor module 210 can have generic characteristics similar to general purpose processors or may be application specific integrated circuitry that provides arithmetic and control functions to the WCD 110. The processor can be any type of processor, such as a processor manufactured by AMtel, Freescale, Nordic Semiconductor, Intel®, AMD®, or an ARM® type processor. The processor module 210 can include a dedicated cache memory (not shown for simplicity). The processor module 210 is coupled to all modules 220-270 in the WCD 110, either directly or indirectly, for data and control signal transmission.

[0165] The memory 260 may include any suitable type of storage device including, for example, ROM, such as Mask ROM, PROM, EPROM, EEPROM; NVRAM, such as Flash memory; Early stage NVRAM, such as nvSRAM, FeRAM, MRAM, or PRAM, or any other type, such as, CBRAM, SONOS, RRAM, Racetrack memory, NRAM, Millipede memory, or FJG. Other types of data memory can be employed as such are available in the form factor desired.

[0166] In addition to storing instructions which can be executed by the processor module 210, the memory 260 can also store data generated from the processor module 210. It is noted that the memory 260 can be an abstract representation of a generic storage environment. According to some embodiments, the memory 260 may be comprised of one or more actual memory chips or modules. In some embodiments, the

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memory 260 can function as a temporary storage (e.g., for firmware updates, and/or for avoiding accidental malfunctions (such as so-called "bricking")).

[0167] In accordance with one or more embodiments, the sensor modules 220 can include various sub-modules for the WCD 110 to perform different monitoring or sensing activities. A view 302 of the interior window (e.g., window 130) of a WCD (e.g., WCD 110) with example components exposed is shown in FIG. 3B. As shown in the example of FIG. 3B, the sensor modules 220 can include a temperature sensor 320a, a red light emitting diode (LED) 320b, a light sensor 320c, and an infra-red LED 320d. Among the sensors in the sensor modules 220, those sensors (e.g., sensors 320a-320d) which are directly related to biological sign monitoring can be configured and positioned in a way that is close to the skin (e.g., facing the interior window 130 of the WCD 110). Although not shown in FIG. 3B for simplicity, the sensor modules 220 can further include sensors that are not directly related to biological sign monitoring; some examples of these sensors include accelerometers, gyroscopes, vibration, sensors (e.g., a magnetometer or a digital compass), or other suitable sensors (e.g., for gesture recognition). The magnetometer can measure the strength and/or direction of a prevailing magnetic field. In this regard, the magnetometer can be used during global positioning and/or navigation. In particular, the magnetometer can be used to measure a directional heading when the WCD is in motion and can supplement position data where the WCD is out of communication range. In one or more embodiments, the accelerometers in the sensor modules 220 can detect movements in multiple (e.g., 3) dimensions or axes. The accelerometer can measure force of acceleration of the WCD and can measure gestures performed by a user while wearing the WCD. In other examples, the accelerometer can detect acceleration of the user while wearing the WCD. This can permit tracking of activity level, such as steps taken or number of laps swum in a pool.

[0168] The temperature sensor can be any type of sensor that detects temperature, such as a thermistor, PTC, NTC, etc. In another example, the temperature sensor can use IR light emitted from an object to calculate a surface temperature of the object in a manner clear to those of ordinary skill in the art.

[0169] Together, the processor module 210 and the sensor modules 220 can enable the WCD 110 to perform multiple functions including, for example, pedometer, sleep

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monitor (e.g., which monitors sleep quality), heart rate sensor, pulse oximetry, skin (and in select embodiments, ambient) temperature. In addition, some embodiments of the WCD 110 can further function as a gesture input device. In particular, the present embodiments recognize that the WCD 110 can detect finger motions or gestures which may be difficult for conventional fitness sensors to detect, such as a tap, a snap, a knock on the table, and the like. In some embodiments, the WCD 110 can utilize the accelerometer to measure the activity level (e.g., arm movement) in conjunction with the measured heart rate to determine if the user is walking horizontally, running, swimming, or climbing stairs. Other activities can be identified by the WCD 110 may include biking or sleeping.

[0170] In some embodiments, the WCD 110 can also be programmed to learn particular gestures or physical exercise from the user using, for example, a training mode. For example, the user can instruct (e.g., using a computer or a mobile device of the user) the WCD 110 to enter the training mode and perform the gesture or physical exercise; the WCD 110 can record the readings from the sensor modules 220, recognize patterns therefrom, and store the result in, for example the memory 260, so that such gesture or exercise can be recognized by the WCD 110 after the training. The WCD 110 can be configured (e.g., via a mobile application running on a mobile device of the user) so that the recognized gestures can perform functions designated by the user, such as clicks, swipes, unlocks, or media player controls. In one embodiment, the WCD 110 can include near field communication (NFC) chips so that certain functions (e.g., unlocking a smart phone) can be performed when the WCD 110 touches upon or otherwise be detected by another NFC device. In some embodiments, the unlocking function of the WCD 110 can also unlock a user device (e.g., a phone) via the communication module 250 (e.g., Bluetooth) by the WCD 110 transmitting a proper unlock code.

[0171] Moreover, the WCD 110 can function as a key or a control device for keyless access to home, automobile, or other suitable user authentication processes. The WCD 110 can also be integrated with games and game consoles so that it can function as an input device to those games and consoles. In some embodiments, the WCD 110 can be adapted for use in medical and home health monitoring, or as a transportation safety device (e.g., that broadcasts emergency messages to relevant authorities). Additional examples of sensors/functionalities of the WCD 110 can include an inertial

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measurement unit (IMU) (e.g., for more complex gesture recognition, a near-infrared (NIR) spectrometer (e.g., for measuring light absorption and deriving blood glucose/ blood alcohol/ CO2 content), a Galvanic skin response sensor (e.g., for measuring sweat/ nervousness), an electrocardiogram (ECG or EKG), and so forth.

[0172] In some embodiments, the processor module 210 can determine (e.g., based on identified physical activities, routine pattern, and/or time) a frequency at which one or more sensors in the sensor modules 220 should operate. Because it is recognized in the present disclosure that the heart rate of a human being typically does not vary too widely (e.g., beyond a certain percentage of what has been previously measured), in some embodiments, the WCD 110 can automatically adjust the sensor modules 220 (e.g., to slow down) so as to save power. More specifically, some embodiments of the WCD 110 can include a phase-locked loop or logic to predict the pulse width by determining lower and upper ranges in which the heart rate is predicted to be, thus only powering up the sensor modules 220 at the time of the predicted heartbeats. For one example, if the WCD 110 determines that the user is at sleep (e.g., based on the heart rate, the body temperature, together with the movements detected by the accelerometer and/or the vibration detector), the WCD 110 can slow down its heart rate detection frequency (e.g., from 1 measurement per second to 1 measurement per 10 seconds) and skip the measurement of several heartbeats because it is unlikely that the heart rate will change drastically during that period. Conversely, if the WCD 110 determines that the user is performing a high intensity physical exercise, the WCD 110 can increase the frequency of monitoring and recording of the sensor modules 220.

[0173] In accordance with one or more embodiments, the WCD 110 also includes various modules coupled to the processor module 210 for, by way of example but not limitation, input/output data transmission, battery recharge, or status indication. A view 300 of the exterior window (e.g., window 120) of a WCD (e.g., WCD 110) with example components exposed is shown in FIG. 3A. As shown in the example of FIG. 3A, the modules configured to face the exterior window 120 of the WCD 110 can include parts from the status indicator module 230, the power generation and management module 240, and the communication module 250.

[0174] Specifically, one embodiment of the WCD 110 includes the status indicator module 230 coupled to the processor module 210 to indicate various statuses. In some

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embodiments, the status indicator module 230 includes a light emitting diode (LED) 330, such as shown in FIG. 3A. The LED 330 can be a single red/green/blue (RGB) LED. In other embodiments, the status indicator module 230 can include other suitable types of indicator devices including, for example, a single color LED, an electrophoretic ink (or "e-ink") display, a persistent display, or the like. In accordance with some embodiments, the WCD 110 can utilize the indicator module 230 (e.g., via the RGB LED 330 through the exterior window 120) to visually communicate with the user. For example, a red color can be displayed (e.g., for a predetermined period of time) by the LED 330 that the WCD 110 needs to be recharged, and a green color can be displayed to indicate that the WCD 110 is fully charged. For another example, a blue color can be displayed when the communication module 250 is in use. In one or more embodiments, the user can program a fitness goal (e.g., a target heart rate) to the WCD 110 so that, for example, a green color can be displayed when the heart rate is below the target, a yellow color can be displayed when the target is reached, and a red color can be displayed when the heart rate is above a certain percentage of the set target. Some embodiments of the WCD 110 include the communication module 250 for wireless data transmission. Particularly, in some embodiments, the communication module 250 includes one Bluetooth chip and a Bluetooth antenna 350, such as shown in FIG. 3A. One or more embodiments of the WCD 110 also provides the capability of storing activity logs (e.g., in the memory 260). More specifically, fitness activities, exercise histories, as well as recorded biological signs such as heart rate and body temperature, can be stored onboard in the memory 260 of the WCD 110. Each data entry in the activity logs can be time- stamped using, for example, an onboard real-time clock (e.g., which may be included in miscellaneous modules 270). For power saving and other purposes, the activity log can be downloaded (e.g., via the communication module 250) when requested by the user. In other embodiments, the activity log can be pushed (e.g., via email or other suitable means) by the WCD 110 to a user device at a time designated by the user. In some embodiments, the memory 260 can store up to a full week worth of activity logs.

[0175] The WCD 110 can include the power generation and management module 240 for recharging the battery 280 and for providing electrical power to various modules 210-270 in the WCD 110. Particularly, in some embodiments, the power generation and management module 240 includes one or more concentrated

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photovoltaic (CPV) cells 340, such as shown in FIG. 3A. The CPV cells 340 can be high-efficiency tandem solar cells and can be attached on the flexible printed circuit (e.g., circuit 415,515). Because the small form factor of the embodiments of the WCD 110, CPV cells 340, which can absorb more light energy from a wider spectrum of light than the traditional solar cells, are used. In some embodiments, multiple (e.g., 3) CPV cells 340 can be configured in series to provide sufficient voltage and/or current for charging the battery 280.

[0176] According to some embodiments, the WCD can include one or more sensing or imaging devices that can be any type of device capable of detecting electromagnetic radiation, such as visible light, IR, NIR, UV, etc. In one example, the device is an imaging device, such as a CMOS or CCD camera.

[0177] According to some embodiments, the WCD 110 can be placed or docked into a charging station for recharging. A perspective view 900 of an example charging station 910 for the WCD 110 is shown in FIG. 9A. The charging station 910 can have concentrated light source circumferentially around the WCD 110 so that the user does not have to be concerned with whether the WCD 110 is facing the right direction for charging. Some embodiments of the charging station 910 can include a light distribution means that takes a single light source and distributes the light all around. An abstract diagram illustrating a partial structure of the light distribution means inside the charging device of FIG. 9A is shown in FIG. 9B. It is noted that, even with the charging station 910, for some embodiments, regular outdoor sunlight or other ambient light source can still function as a secondary source of energy so that the CPV cells 340 on the WCD 110 can extend the operational time provided by the battery 280.

[0178] Additionally or alternatively, energy source attached to the power generation and management module 240 can be passive; for example, some embodiments provides that a clip with a concentrator lens can be attached to the WCD 110 in a way such that the power generation and management module 240 can charge the battery 280 using natural sunlight. In an alternative embodiment, gemstone(s) (e.g., sapphire, diamond, or other suitable materials) in the shape of a dome or with faceted protrusion can be configured to concentrate/magnify light energy while also serving as a decorative feature.

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[0179] In some alternative embodiments, the power generation and management module 240 can include electromagnetic induction charging coil so that a WCD (e.g., ring 610) can be charged using an inductive charger. FIG. 6 shows an exploded view 600 of such alternative embodiment of WCD with the inductive charging mechanism including the charging coil 640, as well as battery 680, housing 612, and rigid-flex PCBA 615. However, it is noted that there may be a need to manufacture the inductive charging coil 640 in different sizes that correspond to different ring sizes. Further, it is noted that the efficiency of the electromagnetic induction charging mechanism may be adversely affected by the adoption of a metallic housing. Additionally or alternatively, to avoid multiple sized coils mounted to the edge of the ring, the coil can be placed on the inner or outer sides of the ring by positioning the coil beneath a window in the metal housing of the ring.

[0180] In order to achieve optimal power management of the WCD, one or more of the components can be selected to minimize power usage. For example, a processor, memory, or any other component can be selected based on rated power usage. In one example, it may be desirable to select components that draw current on the order of microamps in order to extend the battery life of the WCD and to allow the WCD to perform health/activity monitoring functions between charging sessions.

[0181] In still some other alternative embodiments, the power generation and management module 240 can include thermoelectric generator (TEG) modules so that a WCD (e.g., WCD 710,810) can be charged by the difference between the body temperature and the ambient temperature. FIG. 7 is a perspective view 700 of such alternative design, and FIG. 8 is an exploded view 800 of the WCD 710 of FIG. 7. Also shown in FIGS. 7 and 8 is an alternative design of the housing for the WCD where the ring includes an outer ring 812a, an inner ring 812b, and insulators 814a and 814b. However, it is noted that utilizing TEGs for charging the battery may be less than ideal since the difference between body temperature and ambient temperature might not be great enough to fully charge the battery, and that in many occasions (e.g., during sleep), the temperature difference needed for TEG to generate electricity may quickly disappear (e.g., since the WCD 710, 810 may be covered inside the comforter).

[0182] The battery can be any type of battery, such as a rechargeable battery. The battery can be a thin, flexible lithium ceramic chemistry battery. In another example, the

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battery can be a circular formed lithium polymer or lithium ion battery. The battery can provide power to any of the components described above. In one example, the battery can be a lithium cell integrated directly with the flexible PCB described above. Other implementations can integrated the battery directly onto the housing to reduce the volume of space taken up by battery packaging.

[0183] The WCD can also include one or more polymer or piezo actuators for providing appropriate haptic or physical feedback and alerts to a user while the user is wearing the ring. The piezo actuator can also provide audible feedback to a user.

[0184] As previously mentioned, the WCD 110 can be used with a software application (e.g., a mobile phone application for the Apple iOS or the Google Android OS) which can run on the user's computing device (e.g., a mobile device such as a smart phone). Specifically, the software application can facilitate the mobile device of the user to couple to the WCD 110 (e.g., via the communication module 250) for data communication, such as downloading activity logs, changing configuration and preferences, training the WCD. The software application can also generate a user interface showing the results or readings from the health and fitness tracking performed by the WCD 110. FIG. 10 is an example screenshot illustrating such user interface 1000 displaying fitness monitoring readings in accordance with some embodiments.

[0185] Further, the WCD 110 can be used for gesture input, and the software application can facilitate the user to customize gesture input and control. FIG. 11 is an example screenshot illustrating such user interface 1100 displaying sensor readings (e.g., for calibration purposes) in accordance with some embodiments. In one or more embodiments, the WCD 110 can also be used directly with other Bluetooth enabled devices such as electronic locks or keyless car entry. In other examples, the WCD 110 can also control other devices via a smartphone and other Wireless LAN enabled devices such as home automation systems.

[0186] FIG. 3C is a view 304 of two exterior windows of an alternative WCD (e.g., WCD 112 of FIG. 3C) with example components exposed in accordance with some embodiments. The components 330, 340, and 350 shown in FIG. 3C function similarly to those components described in FIG. 3A. However, some components (e.g., antenna 350) can be positioned to face a different exterior window than the exterior window the

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rest of the components face. This may increase the mechanical strength of the housing structure of the ring, and/or may reduce signal interference among the components.

[0187] FIG. 4 is an exploded view 400 showing an exemplary WCD 410 (e.g., WCD 110) illustrating a battery 480 and a flexible circuit 415 which are configured to fit inside a housing 412 of the WCD 410. It is recognized by the present disclosure that a human being's finger can come in various different sizes and so should the WCD 410. In order to reduce the cost of manufacturing different sizes of printed circuits, in some embodiments, the modules 210-270 (of FIG. 2) are formed on a flexible or rigid-flex printed circuit (FPC) board, an example 500 of which is shown as FPC 515 in FIG. 5. In particular, one or more embodiments provide that the FPC 515 and the battery 480 are not specific to a ring size, and that the same circuitry and/or battery can fit a multitude of sizes.

[0188] According to some embodiments, the WCD 410 provides a desirable form factor for a user to wear it for a prolonged period of time. The edges and the shape of the WCD 410 can be configured in a way that is comfortable and ergonomic; for example, the finished parts of the embodiments are to be free from burrs and sharp edges. The material which forms the housing portion of the WCD 410 can include medical grade metallic alloys that reduce the likelihood of allergic reactions. Examples of the housing material include stainless steel, tungsten carbide, titanium alloy, silver, platinum or gold.

[0189] In the examples shown in FIG. 4, the U-shape of the ring housing 412 allows for the flexible PCB 415 to be inserted into the edge of the WCD 410. The windows (e.g., windows 120, 130) on the walls of the WCD 410 can align with the operating circuitry to allow, for example, battery charging, Bluetooth connection, and user feedback LED/micro display on the outer wall, and biological feedback sensors (e.g., pulse oximetry, temperature sensor) on the inner wall. In one or more embodiments, the WCD 410 can be completely sealed using potting epoxy. The sealing epoxy can be transparent to allow light to pass through for the CPVs and sensors. In some embodiments, the WCD 410 can be potted with two different compounds. In these embodiments, the body of the WCD 410 can be filled with clear material, and the edge of the WCD 410 can be filled with an opaque material so that different colors can be incorporated (e.g., as a decorative element). It is noted that sealing the assembly using

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potting epoxy can also bring the additional benefit of making the WCD 410 completely or almost completely waterproof as well as increasing the structural rigidity of the WCD 410.

[0190] **I. Internal Housing/External Potting**

[0191] FIG. 12A is a perspective view and FIG. 12B is a side view of a WCD 1200 according to one or more aspects of the disclosure. The WCD 1200 can be in the shape of a ring and can be worn on any of the five fingers (including the thumb) of (typically) a human user. In this regard, the WCD 1200 can define an interior diameter d1 and exterior diameter d2. The interior diameter d1 can be defined as the distance between opposing points on the interior surface of the ring, with the interior surface being the portion of the WCD facing the finger of a user while the device is worn by the user. The interior surface of the WCD can generally define a finger space for receiving the finger of the user. The exterior diameter d2 can be defined as the diameter between opposing points on the exterior surface of the ring, with the exterior surface being the portion of the WCD opposed to the interior surface and facing away from the finger of the user.

[0192] The interior diameter d1 and exterior diameter d2 can be any size to accommodate any finger size. In one example, d2 is determined by d1 plus a thickness of any components and/or flexible circuit boards disposed within the WCD. Additionally, although depicted as being circular, the finger space of the WCD 1200 can be any shape, such as ovular, elliptical, or the like, to accommodate users with atypical finger profiles. In these examples, the dimensions of the interior and/or exterior diameter may be measured according to other variables, such as length, width, major diameter, minor diameter, etc. By way of non-limiting example, the WCD interior diameter d1 (the diameter generally defining the ring size) can be in an approximate range of 12mm to 24mm so as to accommodate finger sizes ranging from a small child to a larger adult, and on any acceptable finger, including the thumb. The exterior diameter d2 can also be any reasonable size or shape, and can define an approximate range of between 18mm and 30mm. Likewise, the thickness between diameters d1 and d2 can vary widely, but can typically reside in an approximate range of 1.5mm to 3 mm. The width WR of the WCD along the direction of finger extension (finger longitudinal direction) is widely variable, and can be selected, in part to accommodate internal and

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external components. In a non-limiting example, the width WR is in a range of approximately 3mm to 8mm.

[0193] The WCD 1200 can include an overall housing 1210 that includes an internal housing 1212 and an external potting or encapsulant 1214. Together, the internal housing 1212 and external potting 1214 combine to form the overall form factor of the WCD 1200, in addition to providing a housing for one or more electronic components stored within the housing 1210 of the WCD 1200, as will be described in greater detail below.

[0194] The internal housing 1212 can be formed of any material, such as a nonconductive material, a conductive material, a ferrous material and/or a nonferrous metal, composite material (e.g. carbon-fiber and/or glass fiber composite) a dielectric material, or a combination of any of the above. In one example, the material of the inner housing 1212 is conductive and nonferrous, such as aluminum, titanium, or stainless steel. In other examples, the internal housing can be formed of a polymer, such as plastic. The external potting 1214 can be formed of any material, solid or gelatinous, that can provide resistance to shock and/or vibration and can prevent moisture and/or debris from entering the housing 1210 of the WCD 1200, such as silicone, epoxy, polyester resin or any other polymer.

[0195] In one example, the external potting 1214 can be transparent. In this regard, the transparent external potting can allow electromagnetic radiation, such as visible, IR, or UV light sources from inside the housing 1210 to pass through the external potting 1214 without the need of a window or discontinuity in the external potting 1214 and without changing the optical properties of the radiation. In the same vein, electromagnetic radiation sources, such as visible, IR, or UV light, external to the housing can pass through the external potting 1214 and can be detected by, sensed by, or fall incident upon internal components of the WCD 1200 without the need for a window or discontinuity in the housing and without changing the optical properties of the radiation. In another example, the external potting 1214 can be tinted. The tint can be cosmetic and can prevent the internal components of the WCD to be visible by the user. In this regard, depending on the tint, optical properties of light passing therethough may be slightly changed. For example, certain colors of the light can be filtered and can

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result in decreased power transmission. The above description regarding external potting 1214 can be applied to any of the pottings described below.

[0196] The internal housing 1212 can define a window 1216. In one example, the internal housing is formed of a material that completely or partially prevents light (or other electromagnetic radiation) from passing through the internal housing 1212. In this regard, the internal housing 1212 can define the window 1216 to allow for such radiation to pass through the housing 1212. As shown, the window 1216 can be generally elliptical-shaped, but can be any other suitable shape according to other examples, such as rectangular, circular, ovular, etc. Since the window 116 is defined by the internal housing 1212, the window 1216 can face the finger of the user while the user is wearing the WCD 1200, which can provide many advantageous features and implementations, as will be described in greater detail below.

[0197] FIG. 12C is a front view of the WCD and FIG. 12D is a cross section of the WCD 1200 along the line A-A of FIG. 12C. As shown, the internal housing 1212 can have a generally U-shaped internal surface 1212a to accommodate one or more internal components and can define a pair of flanges 1212b and 1212c. The external potting 1214 can extend between the flanges 1212b and 1212c of the internal housing to provide an internal space 1220 to accommodate one or more components. By virtue of the external potting 1214, the internal space 1220 defined by the internal surface 1212a and the external potting 1214 can be hermetically sealed, thereby preventing debris, dust, moisture, or any other unwanted fluids or materials from interacting with the internal components of the WCD 1200. Although not depicted, the internal components can reside within the internal space 1220, and the external potting 1214 can be disposed immediately atop the components to provide the seal.

[0198] FIG. 12E is a perspective view of the internal housing 1212 without external potting 1214. As shown, the internal surface 1212a defines a generally U- shaped surface for receiving the components.

[0199] FIG. 12F is a perspective view of the internal housing 1212 with a portion of the external potting 1214 removed and showing one or more components 1230 and printed circuit board (PCB) 1240. The components and PCB can be constructed as flex circuits, thereby allowing the components 1230 and PCB 1240 to be geometrically configured within the ring shaped internal space 1220. The PCB 1240 can be any type

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of flexible material clear to those of skill, such as polyimide, PEEK, etc. Additionally, the PCB could be rigid-flex whereby panels of RF4 are connected together with a flexible substrate.

[0200] As shown, the PCB 1240 and the components 1230 can be disposed within the internal space 1220 generally defined by the internal surface 1220a and the flanges 1220b-c. The PCB 1240 can define one or more folding regions 1242 that allow the PCB 1240 to conform to the circumference and/or perimeter of the internal surface 1212a. The PCB 1240 can extend around at least a portion, or up to an entire circumference, of the internal surface 1212a. In one example, the size of the internal diameter d1 of the WCD can determine the portion of the internal surface 1212a around which the PCB 1240 extends. Illustratively, for a larger ring size and a larger internal diameter d1, the PCB 1240 can extend only a portion (an arc) of the overall circumference, while for smaller ring sizes a greater portion (arc) of the circumference can be employed to accommodate PCB 1240 and the internal components 1230. The adjacent portions of PCB can form an arc angle therebetween by virtue of the folding regions disposed therebetween, allowing for the PCB to be conform to the internal surface 1212a.

[0201] **II. External Housing/Internal Potting**

[0202] FIG. 13 is a cross section of a WCD 1300 according to another aspect of the disclosure and illustrative embodiments. In this example, the WCD 1300 includes a housing 1310 that includes an external housing 1312 and an internal potting or encapsulant 1314. The external housing 1312 includes an internal surface 1312a that has a generally C-shaped cross section-but alternate cross section shapes, such shapes with an external notch or groove. The external housing includes flanges 1312b-c that extend toward each other, beyond portions of the internal surface 1312a, to define a partially enclosed internal space 1320. In an assembled state, the WCD 1300 can include a battery 1330, a PCB 1340, and components 1350, which can be at least partially or completely disposed within the partially enclosed internal space 1320. The internal potting 1314 can extend between the flanges 1312b-c and can seal the partially enclosed internal space 1320. The components can be encapsulated by the internal potting 1314. The PCB 1340 and components 1350 can extend along an inner circumference of the internal surface 1312a.

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[0203] Illustratively, the external housing 1312 can be formed of the same materials as the internal housing 1212 described above, and the internal potting 1314 can be formed of the same materials as the external potting 1214 described above. As also described above, the internal potting 1314 can be transparent and the external housing 1312 can define one or more windows according to one or more aspects of the disclosure.

[0204] FIG. 14A is a cross section of a WCD according to another aspect of the disclosure and illustrative embodiment. In this example, the WCD 1400 includes a housing 1410,internal surface 1412a, an internal or external housing 1412, an internal or external potting 1414, an internal space 1420, a battery 1430, a flexible circuit 1440, and one or more components 1450. This example is similar to the examples described above with respect to FIGs. 12 and 13, except the addition of a stiffener element 1442 and the flanges 1412b-c extend further into the space 1420 toward one another such that the flanges 1412b-c overlap with the stiffener element 1442.

[0205] FIG. 14B is a perspective view of the PCB and stiffener element of FIG. 14A. As shown in FIG. 14B, the stiffener element 1442 extends beyond an overall width w of the PCB 1440 and extends wider than a distance between flanges 1412b-c. The stiffener element is disposed between folding regions 1444. The PCB 1440 can include one or more stiffener elements 1442 attached thereto, and the elements 1442 can be disposed periodically (in separated intervals) along a length l of the PCB 1440. As shown in FIG. 14C, the stiffener element 1442 can be disposed underneath the flexible circuit 1440, e.g., on a face of the flexible circuit 1440 opposed to the face on which the components 1450 are disposed, and can be permanently or semi-permanently attached thereto. The stiffener element can be implemented in any of the configurations described, and in particular, with either the internal housing/external potting arrangement or the external housing/internal potting arrangement.

[0206] The stiffener element 1442 can be formed of any material, such as polyamide or thin FR4, depending on construction of the PCB 1440. In particular, the material of the stiffener can be chosen to be more or less flexible than the PCB 1440. In one example, the stiffener element 1442 can be a polyamide stiffener disposed on a back surface of a flexible PCB. In another example, the stiffener element 1442 can be FR4 and can be substantially flush with respect to the flanges 1412b-c. In this regard,

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the stiffener element can extend substantially the distance between flanges 1412b-c and may not deform upon insertion into the space 1420. The stiffener element can include surface features disposed on an edge thereof, with the edge facing one of the flanges 1412b-c. The surface features can include a sawtooth profile (e.g., intersecting straight lines at acute angles), or any other type of feature capable of providing an interference fit between flanges 1412b-c.

[0207] FIG. 14D shows a cross section of the WCD at a point in time during assembly/manufacture when the PCB 1440 is being inserted into the internal space 1420 and prior to the application of potting 1414. As shown, the stiffener 1442 contacts the flanges 1412b-c of the housing 1410 by virtue of the width w of the stiffener element 1442. Upon an application of force, the PCB 1440 and stiffener 1442 assembly can be inserted into the internal space 1420. In this regard, the stiffener element has a predetermined flexibility that allows for a certain amount of flexion, as shown in FIG. 14D. The flexion allows for the flexible circuit 1440 to be inserted within the internal space 1420 and can prevent the flexible circuit 1440 from being removed or from accidentally falling out once inserted. In this regard, the flexible circuit 1440 is held in place within the space 1420 by virtue of the width of the stiffener element 1442 and the distance between the flanges 1412b-c. Once inserted, the potting 1414 can be applied free of the concern of improper positioning of the flexible circuit 1440.

[0208] FIG. 14E is a cross section of the WCD of after a potting material 1414 has been applied subsequent to the WCD of FIG. 14D.

[0209] **III. Inner/outer bands**

[0210] FIG. 15A depicts a perspective view of a WCD 1500 according to another aspect of the disclosure. In this example, the WCD includes a housing 1510 that includes an internal housing 1512 and an external housing 1514. The internal housing 1512 can be similar to the internal housing described above with respect to internal housing 1212, and the external housing can be similar to the external housing described above with respect to external housing 1312. The internal housing 1512 can include one or more windows 1516 that can allow electromagnetic radiation (e.g. visible and near-visible light) to pass therethrough, allowing it to fall incident upon components disposed within the housing 1510 and allowing EM radiation sources (e.g. visible light, RF, IR, etc.) within the housing to exit the housing.

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[0211] FIG.15B is an exploded view of the WCD 1500. As shown, the WCD can include internal housing and external housing 1512 and1514. The WCD can further include a PCB 1540 and components 1550. Once the housings 1512-1514 are assembled and the PCB 1540 and components 1550 are assembled within space defined between the housings 1512-414, potting layers 1502 and 1504 can be applied to seal the WCD at both sides thereof to ensure a secure seal.

[0212] **IV. Inner/outer bands with U shaped window**

[0213] FIG. 16A is an exploded view of a housing 1610 and a PCB of a WCD according to one or more aspects of the disclosure. The WCD 1600 comprises a housing 1610 with an integral inner wall and outer wall 1612 and 1614. The housing can be made of any material, such as any material described above with respect to the internal/external housing structures. In this example, the inner and outer walls 1612,1614 each define a window in the shape cutaway portions 1616. The cutaway portions are bounded on three sides by the walls 1612 and 1614 and unbounded at the other side thereof. The cutaway portions 1616 can be aligned with one another to ensure transmission of radiation into/out of the housing 1610. The space1620 between the inner and outer walls 1612,1614 can receive a PCB 1640, battery, components, etc.

[0214] FIG.16B is a cross section ofFIG.16A along line B-B. As shown, the inner and outer walls 1612,1614 are directly connected by a floor 1618. The space 1620 is defined by the space between the inner and outer walls 1612,1614 and the floor 1618.

[0215] FIG.16C is a perspective view of the WCD with potting material 1630. As described above, the PCB, battery, and components can be disposed within the space. Once disposed therein, a potting 1630 can be provided atop the components and within the cutaway portion 1616. The potting 1630 can be transparent to allow for transmission of light through the cutaway portions 1616.

[0216] **V. Charging By Concentrated Light Source**

[0217] According to one aspect of the disclosure, the WCD can be charged by an external concentrated light source, e.g., laser light, laser diode, etc. In this regard, the photovoltaic device described above can include a concentrated photovoltaic element (CPV) that is constructed and arranged to receive concentrated light from the concentrated light source, e.g., laser light from a laser diode, light from a light emitting

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diode (LED), etc., and converting the received concentrated light into an electric current. The photovoltaic device can also generate power from nonconcentrated light sources, such as office lighting and ambient sunlight. The electric current can be used to charge one or more batteries stored within the housing of the WCD.

[0218] FIG.17A depicts a cross section of a WCD employing charging by concentrated light source according to one or more aspects of the disclosure. In this example, the WCD 1700 can include a housing material 1710. The WCD can include a PCB 1720 and a concentrated photovoltaic cell 1730. The WCD can be positioned adjacent a base assembly or base station 1750. The base assembly 1750 can be connected to an external power source 1765 and can have internal circuitry 1760 to power one or more concentrated light sources 1770, e.g., one or more laser diodes and/or one or more LEDs, disposed within the base assembly 1750. In this example, the concentrated light source 1770 comprises one or more laser diodes.

[0219] The base assembly 1750 can define a first opening 1752 at one portion thereof to allow the concentrated light 1780 to exit the housing of the base assembly I 750. As shown in the diagram of FIG.17A, the concentrated light 1780 is generated by the concentrated light source 1770 and exits the housing of the base assembly 1750 via a first opening 1752. The concentrated light 1780 then enters into the WCD by a second opening 1712 in the housing of the WCD 1700 where it can fall upon the CPV 1730. Once the concentrated laser light falls upon the CPV 1730, the CPV 1730 can convert the incident concentrated light into a current that can be used to directly power one or more components within the WCD and/or can be used to charge one or more rechargeable batteries onboard the WCD.

[0220] The concentrated light source 1770, as described above, can be any type of light source that is arranged to generate concentrated light, such as an LED or a laser diode. The concentrated light can be any type of concentrated and/or coherent electromagnetic radiation, such as laser light and/or LED light. The concentrated light can have any desired intensity or wavelength, according to the characteristics of the CPV 1730.

[0221] In one example, the source 1770 can be a 200 mW laser diode that produces red or green laser light. This can generate approximately 80mW (or typically less) of power in the WCD where the CPV 1730 includes a plurality of groups of photovoltaics

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configured in series or in parallel with one another. Each group of photovoltaics can include one or more CPV cells. In another example, the CPV can include a single group of photovoltaics.

[0222] The base assembly 1750 described above can include additional components that can interact with the WCD 1700. For example, the base assembly can include one or more antennas that can communicate according to one or more wireless protocols, such as 3G, 4G, WiFi, Bluetooth®, NFC, or the like, for direct or indirect wired or wireless communication with the WCD or mobile device. In addition to the charging methods above, the base assembly can employ inductive charging techniques.

[0223] FIG.17B depicts a cross section of a WCD employing charging by concentrated light source according to another aspect of the disclosure. In this example, the concentrated light source 1770 comprises an LED. Further, the base assembly comprises an optical element 1790 positioned adjacent to the concentrated light source I 770 for focusing the LED light onto the CPV inside the WCD. The optical element 1790 can be any type of optical element, such as a lens. The lens can be formed of any material, such as glass, plastic, etc., and can be any type of lens, such as concave, convex, piano-concave, piano-convex, etc. In this example, the optical element 1790 includes a piano-concave, with the concave portion facing the concentrated light source 1770. In the example where the source 1770 is an LED, the LED emits light in many directions. The optical element 1790 can focus the emitted LED light to focus as much of the LED light as possible onto the CPV of the WCD. The optical element 1790 can be disposed at least partially or completely within the first opening 1752. In some implementations, the optical element may not be necessary due to LEDs with substantially focused light.

[0224] FIG.17C is a perspective view of a base assembly 1750 and WCD 1700 according to one or more aspects of the disclosure. As shown, the WCD 1700 is in the shape of a ring and the base assembly 1750 includes a post 1754 for receiving the ring. The post 1754 can be cylindrical and can be sized and shaped according to an internal diameter of the WCD in order for the WCD to be received on an external surface of the post. The first opening 1752 of the base assembly 1750 is formed on a portion of the post 1754 such that, when the WCD 1700 is stored on the post, the second opening 1712 can be aligned with the first opening 1752 to ensure alignment of the CPV and the

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concentrated light source. The base assembly can receive/transmit power and/or data via external input/output 1795, which can be a DC power input, a USB input connection or any other acceptable connection/form factor.

[0225] FIG.17D depicts a perspective view of internal components of the base assembly 1750 and WCD 1700 according to another aspect of the disclosure. In this figure, the respective housings of the base assembly and WCD have been omitted, thereby showing a plurality of concentrated light sources 1770, optical elements 1790, and a plurality of CPVs 1730 disposed on mounting substrates 1775 on a PCB. In this example, the WCD can include a plurality of CPVs and the base assembly can include a plurality of sources. This allows for a greater current to be generated during charging and for faster charging times of the WCD. The CPVs and concentrated light sources can correspondingly be disposed in a line, with a constant or variable pitch between respective elements. In this regard, the optical element can include corresponding concavities with the same pitch.

[0226] FIGs.17E-F depicts other CPV configurations according to one or more aspects of the disclosure. As shown in FIG.17E, the CPVs 1730 can be arranged in a lx4 array, while FIG.17F depicts the CPVs arranged in a 2x2 array. In addition to the examples shown in the above figures, the WCD can include any number of CPVs according to any number of geometric configurations.

[0227] FIG.17G is perspective view of a WCD and base assembly with a lx3 CPV arrangement. As shown, the WCD can include a lx3 array of CPVs and the base assembly can include a corresponding lx3 array of concentrated light sources. As indicated by the arrow, a user can then rotate the WCD on the base assembly in order to align the respective first and second openings, as well as the CPV and concentrated light sources.

[0228] FIG.18A depicts a cross section of a WCD 1800 employing charging by concentrated light source 1870 according to another aspect of the disclosure. In this example, the WCD includes an internal/external housing portion 1810 and an internal/external potting portion 1820, as described above. In this regard, the base assembly 1850 includes a first opening 1852, but is free of a second opening on the WCD. The concentrated light 1880 passes through the transparent potting portion and falls incident upon the CPV cell 1830. In this example, the source can be a laser diode.

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[0229] FIG.18B depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure. In this example, the concentrated light source 1870 includes one or more LEDs and the base includes one or more optical elements 1890 for focusing the concentrated light 1880. The LEDs may be of different wavelengths to provide power to two or more junctions in the triple junction CPV cell.

[0230] FIG.19A depicts a cross section of a WCD 1900 employing charging by concentrated light source 1970 according to another of the disclosure. In this example, the WCD and/or the base assembly 1950 can employ one or more magnetic and/or ferrous materials to ensure alignment between the concentrated light source and the CPV cell. Such alignment can improve charging efficiency of the WCD.

[0231] The base assembly includes a first opening 1952 and the WCD includes a second opening 1912 to allow for concentrated light to fall incident upon the CPV 1930. In this example, the second opening is formed on an external housing portion of the WCD. In this arrangement, the base assembly can charge the WCD from an exterior of the WCD, rather than an internal charging method as identified above.

[0232] The WCD can include a ferrous or other suitable (e.g. ferromagnetic) material 1920, such as steel, disposed within the housing 1910. In this example, the ferrous material is disposed in a space defined between an internal housing and an external housing. The ferrous material can surround the CPV.

[0233] The base assembly can include corresponding magnets 1960 that can cause an attractive force between the WCD and the base assembly into an optimal configuration for charging. The magnets can be disposed within the base assembly and can surround the concentrated light source. The magnets 1960 can be formed of a rare earth material, such as neodymium or any other acceptable material that provides a requisite magnetic field strength.

[0234] FIG.19B depicts a cross section of a WCD 1900b employing charging by concentrated light source 1980b according to another of the disclosure. The CPV 1930b of the WCD1900 is charged from an interior portion, such as by a base assembly 1950b with a post 1954b. Similarly, the WCD can include a ferrous material 1920b disposed within the housing1910b and the base assembly1950b can include a magnet 1960b.

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[0235] FIG.19C depicts a schematic diagram of magnets 1920c,1960c that can be used in a WCD and/or base assembly, including a CPV 1930d and concentrated light source 1930d, according to one or more aspects of the disclosure. As shown, the magnets and/or ferrous/ferromagnetic materials can be axially polarized, with each having a respective north pole and south pole. In this regard, the WCD can have axially polarized magnets 1920c with a south pole S facing toward the base assembly, and the base assembly can have axially polarized magnets 1960c with a north pole N facing toward the WCD. The attractive force between the north and south poles can ensure alignment of the CPV 1930c of the WCD and the source 1970c base.

[0236] FIG.19D depicts a schematic diagram of magnets that can be used in a WCD and/or base assembly according to one or more aspects of the disclosure. In this example, the base assembly includes axially polarized magnet 1960d, with a north pole N facing toward the WCD. The WCD can include ferrous steel 1920d, with an attractive force between the ferrous steel and the north pole of the base assembly magnet.

[0237] FIG.19E is a perspective view of a WCD and a base assembly according to one or more aspects of the disclosure. As shown, the WCD 1900e can be received by a post 1954e of a base assembly 1950e. The respective magnets 1960e and/or ferrous materials 1920e are shown in phantom to illustrate their positioning with respect to the WCD and base assembly devices and the CPV1930e as well as the concentrated light source 1970e.

[0238] FIG. 20A is a cross section of a WCD 2000 engaged with a base assembly 2050 according to one or more aspects of the disclosure. In this example, the magnets 2060 can surround the concentrated light source 2070, and the WCD can include a ferrous steel 2020, CPV 2022, and battery 2024 disposed within an internal/external potting 2014 of the WCD. The ferrous steel 2020 can be disposed on a face of the PCB 2040 and can be encapsulated by the internal/external potting 2014. The base assembly can include one or more optical elements 2090 for focusing the concentrated light 2080.

[0239] FIG. 20B is a perspective view of a PCB 2040b with a CPV 2030b and ferrous element 2020b configuration according to one or more aspects of the disclosure. In this example, the ferrous element 2020b comprises a steel ring that can surround a CPV 2030b and can be disposed on the PCB 2040b.

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[0240] FIG.20C is a perspective view of a PCB 2040c with a CPV 2030c and ferrous element 2020c configuration according to one or more aspects of the disclosure. In this example, the ferrous element 2020c comprises a plurality of rectangular bars disposed on the PCB. In this way, the ferrous element 2020c can be coated to be reflowed onto the PCB.

[0241] FIG.20D is a perspective view of a magnet 2060d and a concentrated light source 2070d according to one or more aspects of the disclosure. As shown, the magnet 2060d can include a ring that can extend around a circumference of the concentrated light source 2070d. The magnetic ring can be attracted to the ferrous steel ring and/or the rectangular ferrous steel examples set forth in 20A-C above.

[0242] In some examples, the WCD can be adapted to uniquely identify the wearer of the WCD using, for example biometric features unique to the user.

[0243] FIG.21A is a schematic view of a WCD 2100 showing components used for identifying the wearer of the WCD. As shown, the WCD2100 can include one or more infrared illumination sources 2110 and an infrared CMOS imaging device 2120. The finger 2190 can extend through the finger space of the WCD and the IR source 2110 can illuminate a portion of the skin of the finger 2190. The IR CMOS imaging device 2120 can receive light that has been reflected from the skin surface and produce an image of the skin of the finger 2190. As shown, the IR source2110 and the imaging device 2120 are positioned near the interior surface of the WCD, e.g., the surface facing the skin of the finger. The IR illumination can pass through a window provided on the interior housing or can pass through a transparent potting material.

[0244] During the imaging process, the WCD 2100 can be rotated about an axis passing through the center of the finger space and along the longitudinal direction of the finger. In this regard, the imager 2120 can capture a larger swath of the skin surface than if the WCD 2100 were held stationary with respect to the finger during the imaging process.

[0245] At the time of first use, or any time thereafter, the user can generate a reference capillary map in order to identify himself/herself as the authorized user of the WCD. As described above, the user can rotate the WCD around the finger to capture image data of an analyzed section of skin 2192 and on or more capillaries 2194 of the

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user currently wearing the WCD. The image data can correspond to an overall analyzed section of the skin 2196 of the wearer. The image data of the capillaries can be used to generate a reference capillary map of the wearer, which can be stored in the memory, such as flash memory or EEPROM, of the WCD.

[0246] When the same user puts the WCD on his or her finger after generation of the reference capillary map, the WCD can capture image data of the wearer's skin surface that can be compared to the reference capillary map stored in the memory. In this regard, the user need not rotate the device around the finger. Instead, the WCD can compare a subset of the gathered image data to a corresponding subset of reference capillary map. If there a match, within a predetermine error tolerance, the WCD can uniquely identify the wearer as an authorized user of the WCD and as the unique individual who generated the reference capillary map. Once authorized, the wearer can have access to certain functions, features, data, or other content that is not otherwise available without authorization. In another example, the identification can be a step in a transaction or other type of authorization, such as an electronic payment, bank transaction, etc. If the gathered data does not match the reference capillary map, then the user may be prevented from accessing certain features on the WCD.

[0247] Illustratively, the comparison process between sensed capillaries and some or all of the capillary map can be implemented using basic pattern recognition algorithms (processes) instantiated in the electronics of the WCD. Such processes can rely on edge detection and similar techniques that should be clear to those of skill in the art and can be sourced from various commercial vendors of biometric recognition software.

[0248] In another example, the illumination can include NIR illumination and can project radiation into the skin of the finger. The reflected NIR illumination can then be analyzed to determine one or more characteristics of the blood, such as blood alcohol levels, blood glucose levels, and blood oxygenation levels. In this regard, the WCD analyzes the reflected radiation to identify wavelengths that were absorbed from the projected radiation by the blood of the user. Techniques and processed used in conjunction with commercially available venous oximeters (for example) can be employed to undertake certain readings.

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[0249] FIG. 22A is a perspective view of a user employing ECG monitoring according to one or more aspects of the disclosure. In this example, the user can wear the WCD2200 on a first finger 2210 of first hand 2220, and can touch a second finger 2230 of a second hand 2240 to an exterior surface of the WCD 2200. This can provide an electric pathway 2250 through the body, as shown in FIG. 22B, allowing for the transmission of electrical current between distant portions of the body.

[0250] FIG. 22C is a perspective view of a WCD that can employ ECG monitoring according to one aspect of the disclosure. In this example, the WCD 2200 includes an internal/external housing 2250 with a conductive pad2260. The conductive pad 2260 can be electrically isolated from the external/internal housing 2250 of the WCD, thereby providing distinct and isolated electrical contacts on the WCD. The internal/external housing 2250 can be in electrical communication with the first finger2210 of the first hand, while the conductive pad 2260 can be in electrical communication with the second finger 2230 of the second hand. In this regard, an electrical path 2250 is formed through the respective hands 2220, 2240 and through the rest of the user's body, particularly through the chest. In this regard, the WCD can take various electrical measurements of the user, such as ECG. The ECG measurement can include measurements of the various waveforms, such as P-U waveforms. The WCD can store such ECG data in a memory and/or can communicate the data to a wirelessly connected mobile device. In another example, the WCD can employ electrically isolated internal and external housings, such as those described above. In this regard, the conductive pad may not be utilized, and the user can wear the WCD on a first finger and apply the second finger anywhere on the external housing.

[0251] The WCD can also serve as a monitor for those who are mobility impaired or who are prone to falls, such as disabled persons and/or retired persons. The accelerometer onboard the WCD detect a fall of the user via a sudden change in acceleration data. The WCD, in conjunction with a mobile device and/or one or more base stations positioned around the home of the user, can determine the position of the user within the house. For example, the mobile device can employ GPS capabilities, and either the mobile device or the base stations can use GPS in combination with WiFi signal strengths to determine the location of the user within the house. The WCD can then issue an alert, either directly or indirectly (via the mobile device or base station) to

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a third party that a fall has occurred. The alert can be a phone call, text message, e-mail, or any other type of communication. The third party can then take appropriate measures to aid the fallen user.

[0252] The WCD can also monitor heart rate and/or temperature, in addition to the other monitored characteristics described above. If any of the monitored characteristics is abnormal, e.g., measured parameters outside of a predetermined threshold range, an alert can be sent to a third party. In some examples, the third party can be a medical health professional, such as a doctor, nurse, caretaker, etc. It is noted that, for those embodiments which can function as a cardiac monitor (e.g., that measures electrocardiogram (EKG)), it can be necessary to establish a closed loop (e.g., for the electrical measurement of EKG) across the heart. As such, in some of those embodiments, a separate conductive pad or other skin-contacting structure/probe can be coupled to the WCD so that a user can pinch the pad with fingers on an opposite hand.

[0253] Since the WCD has the form factor of a ring, the WCD is designed to be worn over long periods of time by a user with little to no discomfort or interference. In this regard, the WCD can monitor the above-described, monitored characteristics over long periods of time (e.g. weeks, months, etc.), and determine trends in the data. For example, the WCD can measure heart rate over a long period of time and determine a unique resting heart rate for a user. If the user's heart rate deviates from the resting heart rate, the WCD can be arranged to issue an alert to a third party. In one specific example, the WCD can use appropriate processes to analyze both the trends of monitored characteristics, as well as current accelerometer data. In this way, if a person's heart rate deviates from a resting heart rate, but the accelerometer indicates that the user is exercising and/or engaging in strenuous activity that provides an equivalent workout, then the WCD may not issue an alert in this circumstance.

[0254] FIG.23A is a perspective view of the hand of a user in various positions employing the navigational features of the WCD. As described above, the WCD can communicate with a mobile device though one or more wireless communication protocols. The mobile device can include a processor and a memory and can execute a map application/process that can provide tum-by-tum walking or driving directions to the user based on the user's GPS location. A portion of those directions can include information regarding heading, distance to travel at that heading, waypoints, and the

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direction of next tum. By way of the wireless communication, the mobile device can communicate one or more of pieces of information relating to directions, such as the heading. Once the heading is received the WCD, the WCD can give feedback to the user regarding the actual heading measured by the onboard magnetometer and the heading set forth in the direction information. In one example, the feedback can be haptic or physical feedback provided by one or more actuators, such as the actuators 670 described above.

[0255] FIG. 23A depicts a user's hand in various positions of navigation, each hand including a WCD worn thereon. In this example, the heading provided by the mobile device is the heading 2335, which represents the direction in front of the hand position2330. In this regard, if the user gestures, e.g., points a ring finger, in the direction of the correct heading, the WCD 2300 can give feedback to the user indicating the correct heading. The feedback can include, for example, an LED indicator 2310 showing a green visible light. In the example of hand position2320, the finger is gesturing in a direction to the left of the correct course 2325. In this way, the WCD 2300 can provide feedback to correct the heading of the user. Such feedback can include illumination of an LED indicator showing (e.g.) a red visible light. Similarly, hand 2340 is gesturing in direction 2345, which is to the right of the correct/appropriate direction. The WCD can provide (e.g.) a blue indicator informing the user to change heading.

[0256] FIG.23B is a flow chart 2300B depicting a method of providing feedback to a user according to one or more aspects of the disclosure. At block 231OB, a user can establish a communication link between a WCD and a mobile device. At block2320B, the user can generate or request a set of directions at the mobile device, including information/data regarding heading, distance to travel at that heading, and the direction of next tum. At block 2330B, the mobile device can transmit at least one of the information items/datum regarding heading, distance to travel at that heading, and the direction of next tum. At 2340B, the WCD can take a measurement of heading by measuring a heading associated with an explicit gesture by the user's finger donning the ring. Such gesture can include pointing in a proposed heading of travel. At block 2350B, the WCD can compare the measured or proposed heading to the correct heading provided by the mobile device. At 2360B, the WCD can provide feedback to the user based on the comparison at 2350B, e.g., if the user is gesturing in the correct direction, a

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green LED indicator may appear. In other examples, if the gesture is in a direction that does not correspond with the correct direction, a (e.g.) blue or red indicator can appear. In one specific example, indicators representing left and right course alterations can be different so a user can easily discern a correct direction of travel.

[0257] FIG. 24A is a schematic diagram of a system 2400 for controlling an environment of a user according to one or more aspects of the disclosure. As shown, the WCD can be connected, wired or wirelessly, to one or more appliances in the home of a user. The system 2400 can include a WCD 2410, a thermostat 2420, a wireless access point (e.g., WiFi router) 2430, and a mobile device 2440. The WCD can be wirelessly connected (e.g., link 2415) to both the thermostat and the mobile device by any type of wireless communication protocol, such as Bluetooth. The access point can be wirelessly connected to the thermostat and the mobile device by any type of wireless communication protocol, such as WiFi. It is noted that a wide range of commercially available appliances, thermostats, lighting controllers, home controllers, and the like, can interface with the WCD using WiFi or another conventional/proprietary communication protocol, as described further below.

[0258] The WCD 2410 can include one or more temperature sensors. In one example, the WCD can include at least one internal facing temperature sensor 2410a and an at least one outward facing temperature sensor 2410b, as shown at FIG. 24B. The inward facing temperature sensor 2410a can be near the skin of a user when the user is wearing the ring, and can therefore measure the skin temperature of the user. The outward facing temperature sensors 2410b can be disposed away from the finger of the user, and can therefore be arranged to measure an ambient temperature of the room in which the user currently resides with sufficient thermal isolation from the user's hand and his/her body heat. In particular, in order to ensure accurate ambient temperature measurements, the WCD can employ a combination of multiple light sensors 2410c and outward facing temperature sensors 2410b. In this regard, the temperature sensor 2410b associated with the light sensor 2410c that receives the most light can be the most accurate, as it is most likely that this sensor is furthest from the finger or palm of the user. In another example, the WCD can employ multiple outwardly facing temperature sensors 2410b and compare the temperature values of each to the inward facing sensor

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2410a. The WCD can then select the most accurate temperature value from the outward facing sensors.

[0259] Based on the measured skin temperature and measured ambient temperature, the WCD can automatically adjust the thermostat 2420 to alter the ambient temperature of the room. In this regard, if a user's skin temperature is too high, the WCD can instruct the thermostat 2420 to lower the ambient temperature. Similarly, if the user's skin temperature is too cold, the WCD can instruct the thermostat 2420 to raise the temperature. The WCD 2410 can instruct the thermostat (and/or an HVAC controller) directly, e.g., via a direct wireless link 2415, or indirectly, e.g., via one or more of the mobile device 2440 and the access point 2430. The WCD can also use historic temperature data to develop trend temperature data.

[0260] In another example, the WCD can be part of a system 2400C for controlling home appliances. The system 2400C can include a WCD 2410C, one or more home appliances 2420C, and an access point 2430C. Such home appliances 2420C can include, for example, a television, lights, speakers, microwave, range, stove, oven, etc. Each of the home appliances can include an antenna that allows the respective home appliances to communicate wirelessly with one or more access points 2430C. In one example, the appliances can include a ScenSor DWIO00 chip provided by DecaWave. In this way, the locations of the appliances in the room can be determined to an accuracy of approximately 10 cm. The location of the WCD 2410C can also be determined, using the above-referenced chip, or by using signal strengths of one or more base stations.

[0261] Having established the position of one or more home appliances and the user in a room, the user can make a gesture to control such home appliances 2420C. For example, the user can point at the TV (while wearing the WCD) in order to turn it on/off. Knowing the position of the user and the position of the TV, the direction of the gesture and the type of gesture can indicate what action to take on which device. The accelerometer and/or magnetometer on the WCD can be used to create a vector to the object to control, and a wireless packet can bet sent to a wireless access point to control the respective appliance.

[0262] FIG. 24D is a flow chart depicting a method 2400D of controlling home appliances according to one or more aspects of the disclosure. At block 2410D, the

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locations of one or more home appliances in a room and/or house can be ascertained/determined. As described above, the appliances can include a processor configured to identify location within a room. At block 2420D, the location of the WCD is determined. At block 2430D, the user can make a gesture toward a home appliance to exert control over the home appliance. Such gesture can include a snap, a point, etc. At block 2440D, the accelerometer and/or magnetometer on the WCD can be used to create a vector to the object to control. At block 2450D, a wireless packet can bet sent to a wireless access point to control the respective appliance. The access point can then issue the command to the respective appliance.

[0263] FIG.25 is a perspective view of the hand of a user employing a two-factor authentication technique according to one or more aspects of the disclosure.

[0264] As shown, the user 2500 is wearing a WCD 2510 and is approaching a locked door 2520 with an access node 2530 associated therewith. The access node 2530 can be a wireless access node of a conventional or custom arrangement, and can communicate wirelessly according to any type of wireless protocol, such as WiFi or Bluetooth. As the user approaches the door 2520, the WCD 2510 can initiate a communication link, e.g., Bluetooth or WiFi, with the access node 2530. In this way, the WCD and the access node can engage in one or more handshaking or query procedures to verify the WCD. For example, the access node 2530 can detect a MAC address, IP address, or other alphanumeric identifier associated with the WCD and compare it to a list of authorized users. Such network-based communication processes should also be clear to those of skill.

[0265] Once the MAC address or other identifier is verified, the user can engage in a pre-defined gesture 2550 to complete the authentication procedure. The gesture 2550 can be any type of hand and/or finger motion that can be performed by the user. In this regard, the accelerometer or magnetometer can detect the gesture 2550 performed by the user and provide the gesture information to the access node. If the provided gesture information corresponds with an authorized gesture stored at or accessible by the access node, then the user may be granted authorization and the door can be unlocked. The authorized gesture can be a general authorized gesture for all users, or can be a specific gesture authorized only for the particular MAC address.

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[0266] In addition to a door, the method above can be used to gain access to other features, such as unlocking a mobile phone, unlocking a car door, starting a car. The authentication technique above is advantageous in that it can eliminate extraneous authentication devices, such as key fobs for a car, a door, keypads for entry control, etc., and can provide a secure two-factor authentication technique to avoid unwanted access. More generally any type of keyless entry system (e.g. a keypad, card-reader, keyless lock, etc.) can be equipped with appropriate communication interfaces (RF, IR, etc.) to communicate with the WCD and operate based on a gesture and/or proximity of the user using the techniques described above. The WCD can also be employed generally in this manner to activate or deactivate a residential or commercial alarm system-substituting, for example, for a key fob used for this purpose.

[0267] FIG. 26A is a schematic view of a charging apparatus for charging the WCD according to one or more aspects of the disclosure. As shown, a mobile device 2610 can be received within a case 2620. The mobile device 2610 can be electrically connected to the case 2620 via a port 2610a on the mobile device 2610 and a connector 2620a on the case 2620. As shown in phantom, the case 2620 can include an integrated battery 2630 within the case that can charge the mobile device via the connector or can charge a WCD, as will be described in greater detail below.

[0268] The integrated battery can be connected to an antenna 2640 disposed on or within the case 2620 that can emit an RF signal, as shown in the block diagram in FIG. 26C. The RF signal can have a power of less than 500mW and a frequency of 13.56MHz. The RF signal can be emitted in all directions around the case such that it can be received by a WCD in proximity to the case.

[0269] FIG. 26B shows a WCD 2650 including an RF antenna 2660 and charging circuitry 2670. The RF antenna 2640 can be disposed within the housing 2680 and can receive the RF signal emitted by the case 2620 and convert it to a current that can be used to charge the WCD battery (not shown). This can advantageously allow the user to charge the WCD without removing the WCD from the finger. As shown in FIG. 26D, the charging can occur whenever the WCD is in close proximity to the case, such as when a user talking on the phone or merely handling the phone. In another implementation, the case can utilize inductive charging to charge the WCD. In this regard, the case can include an induction coil subjected to a predetermined current to

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produce a magnetic field. A corresponding induction coil within the housing of the WCD can be subjected to the magnetic field to produce a current that can charge the onboard battery in accordance with known electromagnetic principles.

[0270] FIG. 27A is a pictorial diagram and FIG. 27B is a block diagram of a WCD employing flash storage according to one or more aspects of the disclosure. As described above, the WCD 2700 can include a housing 2710, an antenna 2720, and an integrated circuit (IC) 2730 including a flash memory 2740. The IC and the flash memory can be disposed within the housing 2710. The flash memory 2740 can be powered by a battery 2750 and connected to the IC 2730, which can be implemented as a system-on-a-chip (SoC) IC 2760. The IC can include Bluetooth Low Energy (BLE) capability to allow for communication with another device. The flash memory can be used to store data, or can be used in any of the authentication techniques described above. The WCD can transmit data stored on the flash memory to another device 2780 via the BLE connection, or can receive data and store the data on the flash memory.

[0271] FIG. 28A is a schematic diagram of one or more WCDs performing proximity functions according to one or more aspects of the disclosure. The WCD can detect a strength of an RF signal received by its antenna, and calculate a distance to the source of the RF signal using a Received Signal Strength Indicator (RSSI). In one example, the RF signal can be from a mobile device, an access point, or another WCD. The use of RSSI can have many applications in proximity detection. For example, the WCD can be placed on a child and can be connected to mobile device held by a parent. If the WCD travels a predetermined distance from the mobile device, the WCD can issue an alert to the mobile device, thereby alerting the parent that the child has wandered too far. In another example, the parent can wear a first WCD and the child can wear a second WCD. The first WCD can alert the parent that a child has wandered too far.

[0272] A single user can wear a first WCD 2800 on a first finger on a first hand and a second WCD 2810 on a second finger on a second hand. In this regard, the user can measure the relative distance between the first and second fingers using an RSSI via a wireless link 2830 between the WCDs 2800, 2810, such as a BLE connection. This can be used to measure an approximate dimension of an object held in both hands or to estimate a mid-air measurement.

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[0273] In some examples, a first user can wear a first WCD 2800 and a second user can wear a second WCD 2810. The RSSI can be collected over a period of time and the processor can analyze the data to develop trends or statistics. For example, the RSSI data can indicate that the first and second users have spent a certain amount of time together and can serve as a relationship monitor.

[0274] The WCD can also detect when the first user and second user are holding hands. FIG. 28B is a schematic diagram of one or more WCDs 2800, 2810 performing proximity functions according to one or more aspects of the disclosure. Similar to the ECG monitoring techniques described above, a circuit can be formed when the users hold hands 2840 (with the respective hands wearing the WCDs). The circuit can be used to transmit data and/or electrical impulses between the respective WCDs via the circuit. The WCDs can collect data regarding the length of time that the users are holding hands and, in combination with the amount of time spent together, monitor the relationship of the two users. In addition, the WCD can collect data regarding communication between the users, e.g., e-mail, social media, etc. Based on all of the above factors, the WCD can develop a relationship score between respective WCD users, with a higher relationship score indicating more and more frequent interactions.

[0275] FIG.29A is a flow chart depicting a method of initiating gesture input according to one or more aspects of the disclosure. The WCD can be used to perform one or more commands, or to instruct another device, such as a mobile device, to perform one or more commands. Such commands can include, initiate sleep state of WCD, initiate sleep mode or default mode of WCD, powering off/on of the WCD, turning on/off an LED light of the WCD, powering on/off of a mobile device, placing a phone call on the mobile device, etc. The user can establish one or more custom gestures to initiate any of the commands above. For example, the user can select a command to be customized from a number of commands. Once selected, the user can perform a custom gesture to be associated with that command. In some examples, the user can perform the custom gesture multiple times to allow the WCD to better identify the gesture and to develop error tolerances for registering the gesture.

[0276] At block 2910, the user can perform a first gesture. In this example, the user can perform a finger snap. At block 2920, WCD can register the gesture, via the accelerometer and/or the magnetometer. At block 2930, the accelerometer can send an

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interrupt signal to the processor. At block 2940, the processor can wake from a sleep or default system state. At block 2950, the processor can monitor the accelerometer for a second gesture, at which point the user can perform a second gesture. If the second gesture matches a gesture in the gesture command database, then the WCD can perform the associated command. If not, the WCD can return to the sleep state.

[0277] FIG.29B is a chart 2900B showing an exemplary graph of acceleration vs. time as measured by the accelerometer of the WCD. As shown at peak2910B, the gesture can only be registered if it reaches a predetermined acceleration threshold. If the gesture performed at 2910 meets the threshold, it can proceed to block2930 where the interrupt procedure is performed.

[0278] FIG. 30 is a perspective view of a WCD 3000 employing an illustrative reset function and associated procedure/process. As shown, the WCD 3000 can be removed from the finger of the user in order to initiate a system reset of the WCD. In one example, the system reset can be initiated by spinning about a rotation axis R at a predetermined speed. The predetermined speed can be any value, and in one example is a rotational velocity. Upon performing the reset procedure at the predetermined speed, operation of the WCD 3000 can be interrupted and the onboard components of the 3000 can power off, and revert to factory default settings. Additionally, a series of movements can initiate a rest, such as putting the ring on a table and turning it over several times.

[0279] FIG. 3lA is a perspective view of a WCD including an LED indicator according to one or more aspects of the disclosure. As shown, the WCD 3100 can include an internal/external housing 3112 and an internal/external potting 3114. The WCD can include an LED 3120 that can be visible through the internal/external potting 3114.

[0280] FIGs. 31B and 31C are cross sections along line C-C of a WCD employing an LED indicator according to one or more aspects of the disclosure. As described above, the WCD 3100 can have an internal and/or external potting 3114 that can be transparent. This allows light sources within the housing to pass through the potting without changing, or with minimal change to, the optical properties of the light. In this way, a light source 3120, such as an LED, can be disposed on the PCB 3140 and can be powered at least partially by battery 3130. The LED can be encapsulated by the potting

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3112 and can project light through the potting 3112. As shown in FIG. 31B, the LED 3120 can include a vertical LED, while 31C depicts a right angle LED. The vertical LED can project light along direction L1, while the right angle LED can project light along direction L2. When light is projected along L2, the light can travel around a circumference of the finger of the user.. Note that, according to aspects of the disclosure, the potting can be generally adapted in whole or in part to condition, filter or modify the wavelengths and/or projection qualities of light by for example, embedding lensmatic components, applying light-diffusive additives, light attenuating filter materials, etc.

[0281] FIG. 32 is flow chart depicting a method 3200 of communicating with a near field communication (NFC) device according to one or more aspects of the disclosure.

[0282] In some examples, the WCD can enable or disable NFC or change the functionality of a NFC device. For example, the WCD can itself engage in NFC with another computing device, or the WCD can be connected via wireless link to a computing device that engages in NFC with a different computing device. In certain existing NFC devices, NFC will connect and begin transmitting data as soon as it is queried. In the present example, NFC is enabled or begin transmitting data exclusively upon performing of a pre-determined gesture. However, a variety of other transmission processes can be implemented-for example a periodic chirp or handshake request by the WCD for communication with appropriate devices.

[0283] At block 3210, a NFC capable device is provided. The device can be any type of device, such as a laptop, tablet, mobile device, or dedicated NFC device.

[0284] At block 3220, the WCD initiates a connection with the NFC device. The connection can be a direct connection via NFC, or an indirection connection via an intermediate device. At this point, no data has yet been transmitted between the WCD and the NFC device.

[0285] At block 3230, a user performs a predetermined gesture that is registered by the WCD. The gesture can be any type of gesture, such as a point, a snap, waving the hand, etc.

[0286] At block 3240, data transmission begins between the NFC device and the WCD.

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[0287] In other examples, the user can perform another gesture to cease NFC communication. The gesture can be the same gesture as described above or a different gesture. Additionally, the user can remove the ring to disable the NFC. Upon donning the ring the user will be prompted by the application on the mobile device to re-authenticate by entering a PIN, whereby the proper PIN results in re-enabling the NFC functionality.

[0288] In yet another example, the WCD device employing NFC can be configured on the fly to map to different data sets stored thereon. For example, the WCD device employing NFC can employ data thereon to make purchases, e.g., account information, data to access a building, e.g., a key fob, and data thereon to board public transportation, e.g., smart card, metro card, etc. A user can perform a predetermined different gesture for each of the above data sets to access the data. Once accessed, the WCD device employing NFC can initiate a link with another computing device to initiate a transaction, to open a door, or to board public transportation, etc.

[0289] **VI. Optical Element and Attachment Frame**

[0290] FIG. 33A depicts a perspective view of a WCD assembly 3300 according to one or more aspects of the disclosure, while FIGs. 33B-D depict exploded views of the WCD assembly and 33E depicts a cross sectional view of the WCD assembly along A-A. In this example, the WCD assembly 3300 includes a WCD 3310, an attachment frame 3320, and an optical element 3330. The WCD 3310 can be any of the WCD examples described above or below in the present application.

[0291] The attachment frame 3320 is releasably attached to the WCD3310. The optical element 3330 is itself releasably attachable to the attachment frame 3320. In this regard, the attachment frame 3320 provides an attachment interface between the WCD 3310 and the optical element 3330, thereby allowing the optical element 3330 to be at a fixed position in space with respect to the WCD 3310 or any portion thereof. The attachment frame3320 can be made of any material, such as a metal, polymer, etc. Any type of polymer can be used, such as thermosetting plastics, thermoplastics, PETE, polycarbonate, polyethylene, LDPE, or any other type of plastic.

[0292] The attachment frame can be sized and shaped to fit along the curved surface of the WCD. For example, the attachment frame can have a curved undersurface to

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allow a flush fit with the curved surface of the WCD. The attachment frame can have any shape, size, or radius of curvature depending on the size and shape of the WCD.

[0293] The attachment frame 3320 includes a first retaining a portion 3322 and a pair of second retaining portions 3324. The first retaining portion 3322 defines a conical recess 3322a configured to receive the optical element 3330, and provides a generally unoccluded pathway for light to pass through the optical element and onto the WCD. Although depicted as defining a conical or frustoconical shape, the recess 3322a can be any other shape depending on the shape of the optical element 3330. Each of the second retaining portions3324 includes a respective locking feature 3324a. The respective locking features3324 and a extend from the second it retaining portion3324 toward one another such that a distance between the respective locking features is greater than a distance between the remaining portions of the second retaining portions. As shown in FIG. 33E, the locking features engage with an inward-facing surface 3350 of the WCD to ensure a secure fit. In one example, the inward-facing surface of the WCD may itself have one or more features 3360 to engage with the locking features of the second retaining portions. Such one or more WCD features can include projected surfaces, recesses, or any other type a feature to allow for engagement with the attachment frame.

[0294] The optical element 3330 can be made of any material capable of modifying, e.g., focusing, incident electromagnetic radiation, such as visible light, ultraviolet light, infrared light, or any other type of electromagnetic radiation. In some examples, the optical element 3330 can be constructed from a polymer, such as any of the polymers identified above. In another example, the optical element can be made of glass, quartz, diamond, zirconium, or any other material capable of focusing light. More generally, the optical element 3330 is formed with a general outward appearance simulative of a faceted jewel with an appropriate tint or coloration (including clear/white). The term "jewel" can also be used in the alternative to describe the optical element 3330 herein.

[0295] The WCD can include CPV cell 3312 that can be disposed directly underneath the attachment frame 3320 and optical element 3330 when assembled. In other examples, the CPV can be positioned within the housing and can receive electromagnetic radiation via a transparent potting material. In this regard, incident light striking the optical element 3330 can be focused on to the CPV cell to allow for charging of the internal battery of the WCD. The optical element 3330 provides an

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increased charging efficiency when compared to the CPV exclusively receiving ambient light, since the ambient light is collected/gathered from a wider field, and then focused onto the CPV by the optical element 3330. In one example, a focal length of the optical element 3330 is different than a distance between the optical element and the CPV. For example, the focal length can be greater than or less than the distance between the optical element and the CPV. This can be advantageous in various aspects of the disclosure so as to avoid the light from focusing at a focal point directly on the CPV, which could cause damage to the CPV itself by over-concentrating the light at that single point of the overall CPV surface.

[0296] FIGs.34A-B depict a WCD assembly 3400 according to one or more aspects of the disclosure. In this example, the attachment frame 3420 does not extend to an inward-facing surface of the WCD 3410, but is instead form entirely on the outside-facing surface of the WCD. In some examples, the attachment frame 3420 can be semi-permanently or permanently affixed to the outward-facing surface of the WCD and can have a plurality of retaining portions (mounting prongs) 3422 that at least partially define a recess 3422a for receiving the optical element. As shown in FIG.34B, the optical element 3430 is releasably attached to the attachment frame 3420. This configuration can be particularly desirable, as it exhibits ornamental similarities to a traditional engagement ring while still having the increased functionality of the WCD. Note that while not shown, the mounting prongs can include small hook ends that springably retain the optical element 3430 when attached, but that can release the optical element based upon a prying motion. A customized grasping tool (not shown) can also be employed to remove (and attach) the optical element in this example.

[0297] **VII. Enclosure/Packaging**

[0298] FIG. 35A depicts an enclosure or case 3500 for storing a WCD according to one or more aspects of the disclosure. As shown, the enclosure3500 includes a lid 3510 and a base 3520. The lid 3510 and base 3520 can engage via a recessed portion 3522 formed in the base 3520 to provide a substantially sealed interior environment.

[0299] The lid 3510 can be cuboidal in external dimensions, or define any other type of geometric shape that allows sufficient internal volume to contain the WCD. For example a custom design shape (polyhedral, etc.) can be employed. In this example, the top portion3510 is substantially cuboidal as shown, including rounded edges rather than

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vertices. The lid can be substantially transparent to allow viewing of the WCD while enclosed therein, and can be made of any type of material, such as a polymer, glass, etc. The lid can also be mounted with pins on a hinge.

[0300] The base 3520 can be cuboidal, or any other type of geometric shape. In this example, the bottom portion is substantially cuboidal, including rounded edges rather than vertices as shown. The bottom portion can be made of any material and can be transparent or opaque.

[0301] The base 3520 can define a receptacle 3524 for receiving the WCD3505. The receptacle 3524 can be sized and shaped to receive the WCD 3505 and in this example is semicylindrical, e.g., a portion of a cylinder. The radius of the semicylinder can be slightly larger than a radius of the WCD in order to accommodate the WCD securely. The receptacle can lined with a soft material to allow for a soft, safe material to receive the WCD, such as a silicone, thermoplastic, fabric, felt, or other material.

[0302] FIG.35B is a cross sectional view of the assembled enclosure3500 shown above along the line B-B. As shown, when assembled, the WCD 3505 fits securely within the receptacle 3524. The interior of the lid3510 can be sized and shaped to conform to the shape of the WCD such that the WCD is completely surrounded and enclosed by the lid 3510, while in other examples, the lid3510 can be sized and shaped to allow for airspace 3514 between the lid surface and the WCD.

[0303] FIG.35C is a cross section of the enclosure along line A-A. As shown, the lid 3510 can include an integral optical element 3512. The optical element3512 can be a lens or any other device to modify, e.g. focus, light that passes therethrough. In this example, the optical element 3512 can be disposed at a predetermined distance away from one or more CPV cells 3507 disposed on the WCD 3505. This distance d can be measured from the center of the optical element to the CPV cells 3507, and the optical element can itself have a focal length f. In one example, the distance d can be greater than the focal length f, such that the optical element focuses light at a point above the WCD in the enclosure. In this regard, the light will not focus directly on the CPV cells disposed at the surface of the WCD, thereby avoiding overheating or damage to the CPV cells. In other examples, the distance d can be less than the focal length, which can also prevent light from focusing at a surface of the WCD.

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[0304] FIG. 36 depicts an enclosure 3600 including air vents 3650 according to one or more aspects of the disclosure. In this example, the enclosure 3600 includes a plurality of vent holes 3650. The vent holes can be arranged on one or more faces of the lid. The vent holes 3650 can prevent overheating within the enclosure during charging of the WCD by allowing for circulation of convective air current. During shipping, the vent holes3650 can be covered by an adhesive and/or adhering (peel-off) polymer sheet of conventional arrangement to prevent debris or moisture from entering the enclosure. The enclosure can include a lid 3610, base 3620, receptacle 3624, and optical element 3612 as in the examples set forth above.

[0305] **VIII. Sizing**

[0306] FIG. 37 depicts a method 3700 of sizing a finger according to one or more aspects of the disclosure. At block 3710, the hand of a user can be provided. The hand can be held still in mid-air or alternatively can be resting on a surface.

[0307] At block 3720, a first image is taken of the user's hand from a first perspective. The image can be taken by any type of imaging apparatus, such as a CCD or CMOS camera, a digital camera, a camera associated with a mobile phone, etc. The first image can be stored in a memory.

[0308] At block 3730, a second image is taken of the user's hand at a second perspective. In this regard, the second perspective is different from the first perspective so as to provide a distinct view in the second image of the user's hand. Block 3730 can be repeated any number of times. For example, a third image can be taken of the user's hand at a third perspective. In this regard, the third perspective is different from both the first and second perspectives so as to provide a distinct view in the third image of the user's hand, and so on.

[0309] At block 3740, a size of the user's finger can be derived from the plurality of images taken above. In some examples, as few as two images may be required, while in other scenarios, more than three images may be required, depending on a number of circumstances including image quality, selected perspectives, etc. The size can be derived from the plurality of images by any number of techniques, such as stitching the plurality of images together to generate a 3D typography of the fingers, then using photogrammetry algorithms to identify features on the fingers to determine the

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appropriate ring size. Furthermore, the touch screen of the smart phone can be used to measure the hardness of tissue by measuring the footprint/impression the fingers make while pressing a finger against the touch screen of a mobile phone.

[0310] FIG. 38 is a pictorial diagram showing a plurality of image perspectives of a user's hand 3802. As shown, perspectives 3810, 3820, and 3830, as well as the other perspectives, produce corresponding images (in a strip) 3812, 3822, and 3832. The images can be used to derive a size of the user's finger according to the methods described above.

[0311] FIG. 39 depicts a sizing tool for sizing the finger of a user. As shown, the tool 2900 can include a plurality of finger holes 3910-3950. The tool 3900 can be made of any material, such as plastic, metal, or cardboard.

[0312] FIG. 40 depicts a sizing tool for sizing the finger of a user according to an alternate example. As shown, the tool 4000 can include a plurality of finger holes 4010-4050. The tool 4000 can be made of any material, such as plastic, metal, or cardboard.

[0313] FIG. 41 depicts yet another alternate example of a sizing tool for sizing the finger of a user. As shown, the tool 4100 can include a plurality of finger holes 4110-4150. The tool 4100 can be made of any material, such as plastic, metal, or cardboard. The thickness of the card reflects the thickness of the ring to ensure proper fit. Additionally, the sizing tool is designed such that it can be easily mailed to the user with a standard mail service such as USPS.

[0314] Any of the tools 3900, 4000, or 4100 can be provided to a user prior to purchase of the ring in order to obtain accurate sizing information prior to purchase. The tools include holes, as shown above, that can come in a plurality of predetermined finger sizes to allow a user to match his or her finger size with the tool. The best match, e.g., closest size that ensures a comfortable fit, can be identified using the tools. Alternatively, the tools can be provided at retail locations to size the finger of the user on site prior to purchase. More generally, a variety of other sizing techniques, such as those employed by conventional jewelers can be employed according to further aspects of the disclosure.

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[0315] In another embodiment, a packaging or enclosure of the WCD can include a sizing diagram or interface embodied therein to allow a user to size a finger during the purchase process.

[0316] FIG. 42 depicts a method 4200 of monitoring activity according to one or more aspects of the disclosure.

[0317] At block 4210, a user can don or place the WCD onto the finger to secure it in the wearing position.

[0318] At block 4220, a user can perform any number of daily activities, such as running on a treadmill, walking, exercising, typing, etc.

[0319] At block 4230, the WCD, contemporaneous with block 3220, can use one or more sensors to sense the activities of the user. For example, the sensors can detect location, speed, acceleration, orientation, heart rate, etc.

[0320] At block 4240, the WCD, or another computing device, can generate an entry in an activity log at the conclusion of a detected activity. If the activity detected by the sensors has a profile that has not yet been identified, the WCD can prompt the user to identify the activity. For example, the user can identify profiles such as "Run in Central Park," "Typing," "Run on Treadmill," etc. The WCD can associate the identity provided by the user with the activity profile identified by the sensors and store the identified activity in the WCD memory, or any other memory. Later, if the user performs the same activity and the WCD detects the activity profile as being similar to a saved activity, the WCD can identify the activity while the user is performing the activity and save the activity in the activity log. Each of the activities performed can be saved in the overall activity log and can be stored in a memory on the WCD, or other device, for later v1ewmg.

[0321] FIG.43 depicts a method 4300 of determining whether a user is wearing gloves according to one or more aspects of the disclosure. At block 4310, a user is provided while wearing the WCD, where such user may or may not be wearing gloves.

[0322] At block 4320, one or more light sensors on board the WCD can detect surrounding ambient light. Such light sensors could include, for example, a CPV or other light sensitive element.

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[0323] At block 4330, one or more additional measurements maybe made. Such additional measurements can include, for example, an ambient temperature measurement and or a proximity measurement, e.g., detecting proximity of an object to the WCD via reflected electromagnetic radiation in the form of IR light.

[0324] At block 4340, a measured ambient temperature and ambient light measurements are compared to predetermined thresholds. If the ambient temperature measurement is above a certain predetermined temperature threshold and the ambient light measurement is below a certain threshold, it can be determined that the user is wearing a glove over the WCD.

[0325] At block 4350, a measured proximity and ambient light measurements are compared to respective predetermined thresholds. If the proximity measurement is below a certain distance threshold (e.g., determines an item is in close proximity to the WCD) and the ambient light measurement is below threshold, it can determined that the user is wearing a glove over the WCD. In any of the above examples, an intensity of LED indicators of the WCD can be adjusted according to a detected ambient light using an appropriate algorithm or process that compares the ambient light to a scale and adjusts a desired driving current/voltage for the LEDs according to a predetermined formula (e.g. a proportional adjustment using an adjustment coefficient) or scale (e.g. a lookup table). For example, where there is abundant ambient light (e.g., detected ambient light above a predetermined threshold), the intensity of the LED indicators can be increased. In the same way, where there is little ambient light (detected ambient light below a predetermined threshold), the intensity of the LED indicators can be decreased.

[0326] In one example, the WCD can detect whether it is removed and or installed on the finger of the user. In this regard, as mentioned above, the WCD can have inward-facing light sensors, CPV, or temperature sensors. When a user installs a ring on his finger the measure of ambient light may decrease or the temperature may increase. Such changes in ambient light and/or temperature can be detected by one or more sensors onboard the WCD and a determination can be made that the user has removed and or installed the ring on his finger.

[0327] FIG.44 depicts a method 4400 of securing data onboard the WCD according to one or more aspects of the disclosure. At block 4410, a user may don the WCD on the finger. At block 4420, a user may execute an application on a mobile device, or other

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computing device, that can be previously associated and authenticated with the WCD. At block 4430, the user can enter an authorization code into the application running on the mobile device, such as a PIN code. At block 4440 the mobile device may transmit the authorization code to the WCD by any means of communication, such as, wired, wireless, Bluetooth, NFC, etc. At block 4450, the user wearing the WCD can now be again authenticated and associated with the WCD and can be granted access to certain functions and/or data storage of the WCD. At block 4460 a user may remove the WCD. At block4470 the WCD can detect that it is removed such as bio detection (including e.g., biometric identification) techniques described above with respect to inward facing sensor changes, temperature changes, or heart rate decreasing to zero. At block 4480, the authorization code previously stored on the WCD can be automatically deleted upon detection of removal to avoid unauthorized access to such information by a subsequent wearer or other querying party. Further or alternatively, additional information can be automatically deleted upon removal of the WCD, for example any data and or instructions stored on the onboard memory of the WCD such as personal information, banking information, confidential information, or other sensitive data.

[0328] **IX. Timepiece System**

[0329] FIG. 45A is a timepiece system 4500 according to one or more aspects of the disclosure. As shown, the timepiece system 4500 can include a conventional timepiece 4510 and a timepiece computing device (TCD) 4520. The TCD can be any shape, and in this example is in the shape of a cylinder. The radius can be significantly greater than a height of the TCD to provide the shape of a puck. The TCD can have one or more structural and/or functional components, and can be similar to the WCD described above with respect to hardware features, components, sensors, etc. Although depicted as cylindrical, the TCD can have any shape depending on the shape of the conventional timepiece. For example, where the timepiece has a rectangular or square face, the TCD can similarly have a rectangular or square profile.

[0330] A top surface 4520a of the TCD can include a pressure sensitive adhesive (PSA) layer 4522 to allow for adhesion of the TCD to the under surface of the timepiece 4510. The TCD 4520 can have a radius or circumference that does not exceed radius or circumference of the face of the conventional timepiece so as not to be seen when a user is wearing the timepiece system 4500. The TCD can enhance the conventional

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timepiece with many of the features described above with respect to the WCD such as, heart rate sensing, temperature sensing pedometer, activity sensing, gesture sensing and control, without having to alter the look of the conventional timepiece.

[0331] Fig 45B is a bottom view of the TCD. As shown, the TCD can include a battery 4540, any printed circuit board 4550 with one or more components attached thereto (not shown) such as motion sensors, power management circuitry, charging circuitry, etc. As with the WCD, the printed circuit board of the TCD can be overmolded 4560. The overmold can be transparent or substantially transparent to allow electromagnetic radiation to pass through to be incident upon one or more components of the TCD.

[0332] As shown, the TCD can include a light pipe 4524 around the perimeter thereof. The light pipe 4524 can be substantially annular in shape and can be formed in part by the overmold of the TCD. The light pipe can be constructed from a conventional transparent or translucent moldable material (e.g. acrylic, polycarbonate, etc.), and can be arranged to focus ambient light onto a CPV disposed onboard the TCD for additional charging capability. The optical arrangement/geometry of the light pipe can be implemented using skill in the art to achieve the desired optical characteristics. In another example, excess heat generated by the TCD or excess body heat emitted from the skin of the user can be converted to electrical energy via a thermoelectric (TEG) module, such as a Peltier module, disposed onboard the TCD.

[0333] The TCD can also include any number of CPV cells, either on a top surface or bottom surface, to allow for charging. For example, a CPV cell can be placed on the underside of the TCD to allow for docking with a charging/docking station.

[0334] FIG.46 depicts a WCD 4600 with a pair of LED indicators 4610-4620 disposed at an inward-facing portion of the WCD. As shown, the WCD 4600 can include a pair of transparent regions 4640-3650 and an opaque region 4630. The LEDs 4610- 3620 can be positioned under the transparent regions 4640-3650 to allow light from the LEDs to exit the WCD. In one example, the LEDs 4610-3620 can create a subtle diffuse glow to the skin to provide a desirable visual effect to user. In another example, a user feedback LED can be placed at an inward facing surface and a second can be placed at an outward facing surface of the WCD. Depending on the circumstances, one of the LEDs may be disabled to save battery life. For example,

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LEDs that are facing away from a user e.g. facing down or away from user's line of sight, may be disabled. As described above, the WCD can determine its orientation based on onboard sensors, such as the magnetometer, accelerometer, GPS, etc.

[0335] FIG. 47A is a system for generating and managing alerts according to one or more aspects of the disclosure. As shown, the system can include a WCD 4710A, one or more networks 4720A, and one or more server computers 4730A according to one or more aspects of the disclosure. The WCD 4710A can communicate directly and/or indirectly with the server 4730A via the network 4720A. In this regard, data generated and/or stored at the WCD 4710A can be transmitted to the server 4730A and vice versa. In one example, such data can include biometric data pertaining to a user wearing the WCD that is detected and stored by the WCD.

[0336] FIG. 47B depicts a block process diagram for generating and managing alerts according to one or more aspects of the disclosure and FIG. 47C is a flow chart depicting a method for generating and managing alerts according to one or more aspects of the disclosure.

[0337] At block 4710C, and as shown at process block 4710B, the user is authenticated with respect to the WCD. In this regard, a single user can be associated with a single WCD and can be associated with a predetermine identifier, such as an alphanumeric number. If the user is not authenticated or the authentication process is not conclusive, the WCD may invite the user to retry authentication at block 4715C until the user is successfully authenticated. In some examples, the WCD may timeout the authentication process, lock the WCD, or place the WCD in safe mode in the event of too many unsuccessful authentication attempts as a security measure.

[0338] The user can be authenticated according to any of the authentication methods described in the present application, such as via a unique capillary map, a unique ECG profile, etc.

[0339] If the user is authenticated, biometric data can be transmitted to the server at block 4720C. The captured biometric data 4720B can be transmitted to the server via network 4720A, 47222B

[0340] Once received at the server, the biometric data can be aggregated, sorted, categorized, or profiled at block 4730C and as shown at process block 4730B. In this

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regard, a profile (corresponding to the alphanumeric identifier) may be created at a database at the server that stores data for a particular user. The profile can store transmitted biometric data, as well as other data, such as user gender, height, weight, age, family history, disease information, location, etc.

[0341] In some examples, identifying information may be removed from the data and/or not transmitted to allow for anonymity and/or to comply with regulations regarding transmission of medical data. The transmitted biometric data can be normalized in order to comply with predetermined data requirements in order to be added to the profile. In one example, a minimum amount of data may be required in order to be considered viable for association with the profile. The biometric data of a single profile can be aggregated, or in other examples multiple profiles can be aggregated simultaneously.

[0342] Aggregation of the user's biometric data into a single profile allows for the profile to be visualized or analyzed according to any number of methods. For example, a timeline can be created showing biometric data over a period of time. The data can also be synthesized or analyzed to calculate trend data, or other mathematical features.

[0343] Although only one WCD is depicted, it is contemplated that a plurality of WCDs can exist, with each WCD corresponding to a distinct user (and distinct alphanumeric identifier) and therefore resulting in a plurality of distinct profiles at the server. Accordingly, each of the distinct users/WCDs may be authenticated separately according to the methods described herein.

[0344] At block 4740C, once the transmitted data has been associated with the user profile, the updated profile can be correlated with one or more other profiles stored at the server as shown as process block 4740B. The profiles may be correlated according to any number of correlation standards, such as correlating users with similar traits such as age, gender, location, profession, or by any other data stored at the server. In some examples, one or more of the traits can be used to make such a correlation. The biometric data from the one or more users that are correlated with one another can be combined to form a group profile. The group profile can be the aggregation, average, range, or sum of individual profiles that form the group profile. For example, for a particular group profile, a range of resting heart can be generated by taking the maximum and minimum values of resting heart from the individual profiles. In other

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examples, an average (and standard deviation or standard deviation of the mean) can be generated for each trait, such as average resting heart rate, average active heart rate, average blood pressure, average blood sugar, average skin temperature, ECG profiles, as well as any other features capable of being detected by the WCD as described above.

[0345] At block 4750C, transmitted biometric data can be compared to the established values from the group profile. In this way, if a user's heart rate deviates by a predetermined threshold (such as by predetermined magnitude or standard deviation), an alert can be generated at process block 4750B. The comparison process can occur at the server after transmission of the biometric data. In another example, the group profile data can be transmitted to the WCD for comparison at the WCD. This advantageously allows the comparison to be made where the WCD cannot establish a network link. The group profile can be updated on a continuous basis or a predetermined time interval or at each transmission of biometric data.

[0346] At block 4760C, the alert is transmitted to the WCD and displayed to the user at process block 4760B. The alert can indicate that the user's biometric data has deviated from the profile group and may advise the user to seek medical attention. In another example, the server can directly contact a medical health professional. In the example where block 4750C occurs at the WCD, transmission of alert information from the server may not be necessary.

[0347] The alert at the WCD can be any type of audio or visual indicator, such as an LED, haptic feedback, audible alarm, etc. The indicator may also invite the user to rest, make an appointment with a medical health professional, recommend a particular medication, or suggest certain physical activities that may health condition that caused the alert.

[0348] As shown in FIG. 47B, the authentication 4710B, aggregation 4730B, and correlation 4740B can occur at server 4730A, which can include a process, memory, and any other features of a general purpose computer. The authentication 4710B, aggregation 4730B, and correlation 4740B can access a database stored at the memory, where profiles, group profiles, and biometric data can be stored.

[0349] FIG. 48A is a method for variable sampling according to one or more aspects of the disclosure. As described above, the processor module of the WCD can determine

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(e.g., based on identified physical activities, routine pattern, and/or time) a frequency at which one or more sensors in the sensor modules should operate.

[0350] At block 4810A, one or more sensors of the WCD may take one or more measurements. For example, the WCD can detect temperature, heart rate, acceleration, as described above.

[0351] At block 4820A, the WCD can calculate an activity level of a user. For example, the WCD can compare to a number of stored activity profiles (as described above) stored by the user, or can compare the sensor measurements to sensor threshold values corresponding to different activities, such as sitting, running, sleeping etc. In one example, the WCD detect acceleration values over time to generate an activity level for a particular time period.

[0352] At block 4830A, the WCD may compare the identified activity level to a predetermine activity threshold value. In one example, the WCD may categorize the detected activity as either a high level activity or a low level activity. High level activities can include running, swimming, biking etc., while low level activities may include sitting, standing still, or sleeping.

[0353] At block 4840A, the WCD can set a first sample rate for high level activities and at block 4850A, the WCD can set a second sample rate for low level activities. The first sample rate can be a shorter time interval than the second sample rate, resulting in more data being detected and generated during a set amount of time while the user is active. This allows for increased power efficiency of the WCD while also providing the advantage of generating more data when a user is more active, thereby providing added biometric data for later analysis.

[0354] In another example, the sample rate can be scaled according to activity level. For example, the sample rate can be scaled to be directly proportional to heart rate. This results in a shorter time interval for sampling (more frequent data gather) for running than for walking.

[0355] As activity level changes, the method above can be repeated a plurality of times at certain intervals in order to quick or abrupt activity changes.

[0356] FIG. 48B and 48c are graphs depicting one or more aspects of the sample method of FIG. 48A. As shown in FIG. 48B, the WCD may determine a user is

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engaging in a high level activity by detecting acceleration values that are above a predetermined threshold value. In this regard, a shorter time interval (more frequent data gathering) can be set. As shown in FIG. 48C, the user is engaging in a low level activity since the acceleration values are below a predetermined threshold. A longer sample rate (less frequent data gathering) can be set in this instance.

[0357] FIG. 49 a diagrammatic representation of a machine in the example form of a computer system 4900 within which a set of instructions, for causing the machine to perform any one or more of the methodologies discussed herein, may be executed. Specifically, FIG. 49 shows a diagrammatic representation of a machine in the example form of a computer system within which instructions (e.g., software or program code) for causing the machine to perform any one or more of the methodologies discussed herein may be executed. In alternative embodiments, the machine operates as a standalone device or may be connected (e.g., networked) to other machines. In a networked deployment, the machine may operate in the capacity of a server machine or a client machine in a server-client network environment, or as a peer machine in a peer-to-peer (or distributed) network environment.

[0358] The machine may be a server computer, a client computer, a personal computer (PC), a tablet PC, a set-top box (STB), a personal digital assistant (PDA), a cellular telephone, a smartphone, a web appliance, a network router, switch or bridge, or any machine capable of executing instructions (sequential or otherwise) that specify actions to be taken by that machine. Further, while only a single machine is illustrated, the term "machine" shall also be taken to include any collection of machines that individually or jointly execute instructions to perform any one or more of the methodologies discussed herein.

[0359] The example computer system includes a processor (e.g., a central processing unit (CPU), a graphics processing unit (GPU), a digital signal processor (DSP), one or more application specific integrated circuits (ASICs), one or more radio-frequency integrated circuits (RFICs), or any combination of these), a main memory, and a non-volatile memory, which are configured to communicate with each other via a bus. The computer system may further include graphics display unit (e.g., a plasma display panel (PDP), a liquid crystal display (LCD), a projector, or a cathode ray tube (CRT)). The computer system may also include alphanumeric input device (e.g., a

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keyboard), a cursor control device (e.g., a mouse, a trackball, a joystick, a motion sensor, a touch screen, or other pointing instrument), a storage unit, a signal generation device (e.g., a speaker), and a network interface device, which also are configured to communicate via the bus.

[0360] The storage unit includes a non-transitory machine-readable medium on which is stored instructions embodying any one or more of the methodologies or functions described herein. The instructions may also reside, completely or at least partially, within the main memory or within the processor (e.g., within a processor's cache memory) during execution thereof by the computer system, the main memory and the processor also constituting machine-readable media. The instructions may be transmitted or received over a network via the network interface device.

[0361] While machine-readable medium is shown in an example embodiment to be a single medium, the term "machine-readable medium" should be taken to include a single medium or multiple media (e.g., a centralized or distributed database, or associated caches and servers) able to store instructions. The term "machine-readable medium" shall also be taken to include any medium that is capable of storing instructions for execution by the machine and that cause the machine to perform any one or more of the methodologies disclosed herein. The term "machine-readable medium" includes, but not be limited to, data repositories in the form of solid-state memories, optical media, magnetic media, or other non-transitory machine readable medium.

[0362] **X. Conclusion**

[0363] It should be clear that the WCD and TCD arrangements described according to various aspects of the disclosure provide a highly versatile and useful item of wearable electronics that is comfortable and convenient to wear, conveniently charged, and weatherproof for all-purpose and all-condition wearing. Various options for style and appearance can be implemented, as well as a variety of storage options. The functions and structure of the device lend themselves to both a ring version and a wrist-worn version. All versions are designed for long-life with minimal maintenance, and are adaptable to interoperate with a variety of networked devices including computers, smartphones, home controllers, security systems, and virtually any other device capable of communicating over a wireless link-including another WCD or TCD.

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[0364] The foregoing has been a detailed description of illustrative embodiments of the invention. Various modifications and additions can be made without departing from the spirit and scope of this invention. Features of each of the various embodiments described above may be combined with features of other described embodiments as appropriate in order to provide a multiplicity of feature combinations in associated new embodiments. Furthermore, while the foregoing describes a number of separate embodiments of the apparatus and method of the present invention, what has been described herein is merely illustrative of the application of the principles of the present invention. For example, as used herein various directional and orientational terms such as "vertical", "horizontal", "up", "down", "bottom", "top", "side", "front", "rear", "left", "right", and the like, are used only as relative conventions and not as absolute orientations with respect to a fixed coordinate system, such as the acting direction of gravity. Note also, as used herein the terms "process" and/or "processor" should be taken broadly to include a variety of electronic hardware and/or software based functions and components. Moreover, a depicted process or processor can be combined with other processes and/or processors or divided into various sub-processes or processors. Such sub-processes and/or sub-processors can be variously combined according to embodiments herein. Likewise, it is expressly contemplated that any function, process, application, and/or processor here herein can be implemented using electronic hardware, software consisting of a non-transitory computer-readable medium of program instructions, or a combination of hardware and software. Also, while a variety of visible and near-visible radiation sources are described as LEDs, it is expressly contemplated that other types of sources can be employed according to aspects of the disclosure-for example plasma discharge sources and bioluminescent sources, as well as sources that are based upon developing technologies. Electronic circuits and RF components can similarly be based on alternate and/or developing technologies. Accordingly, this description is meant to be taken only by way of example, and not to otherwise limit the scope of this invention.

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CLAIMS

What is claimed is:

1. A finger-worn wearable ring device, comprising:

an external housing component defining an outer circumferential surface of the finger-worn wearable ring device;

an internal housing component defining an inner circumferential surface of the finger-worn wearable ring device, the internal housing component coupled with the external housing component, wherein at least a portion of the inner circumferential surface of the internal housing component is configured to contact a tissue of a user when the finger-worn wearable ring device is being worn by the user;

a battery positioned within a cavity formed between the internal housing component and the external housing component, wherein the battery comprises a shape and size configured to fit within the cavity between the outer circumferential surface of the external housing component and the inner circumferential surface of the internal housing component, and wherein the battery extends through at least a first portion of the cavity of the finger-worn wearable ring device;

a printed circuit board disposed between the internal housing component and the external housing component, wherein the printed circuit board extends through at least a second portion of the cavity of the finger-worn wearable ring device different from the first portion; and

one or more sensors electrically coupled with the printed circuit board and the battery and configured to acquire data from the user through the internal housing component.

2. The finger-worn wearable ring device of claim 1, wherein the first portion of the cavity of the finger-worn wearable ring device is non-overlapping with the second portion of the cavity of the finger-worn wearable ring device.

3. The finger-worn wearable ring device of claim 1, wherein the first portion of the cavity of the finger-worn wearable ring device at least partially overlaps with the second portion of the cavity of the finger-worn wearable ring device.

4. The finger-worn wearable ring device of claim 1, further comprising:

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one or more magnetic components configured to magnetically interact with one or more additional magnetic components of a charger device to orient the finger-worn wearable ring device within a charging position on or within the charger device to facilitate charging of the finger-worn wearable ring device.

5. The finger-worn wearable ring device of claim 4, further comprising:

a charging component configured to wirelessly transfer energy from an additional charging component of the charger device to the battery when the finger-worn wearable ring device is oriented in the charging position.

6. The finger-worn wearable ring device of claim 1, further comprising:

one or more processors communicatively coupled to the battery and the one or more sensors, wherein the one or more processors are configured to:

selectively adjust one or more operational parameters of the one or more sensors based at least in part on the data acquired by the one or more sensors.

7. The finger-worn wearable ring device of claim 6, wherein the data acquired by the one or more sensors comprises heart rate data associated with a heart rate of the user, wherein the one or more processors are further configured to:

selectively adjust a measurement periodicity used by the one or more sensors to acquire the heart rate data based at least in part on the heart rate of the user.

8. The finger-worn wearable ring device of claim 6, wherein the data acquired by the one or more sensors comprises activity data associated with one or more activities engaged in by the user, wherein the one or more processors are further configured to:

selectively adjust a measurement periodicity used by the one or more sensors to acquire the activity data based at least in part on the one or more activities engaged in by the user.

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9. The finger-worn wearable ring device of claim 6, wherein the data acquired by the one or more sensors is associated with one or more sleep states of the user, wherein the one or more processors are further configured to:

selectively adjust a measurement periodicity used by the one or more sensors to acquire the data based at least in part on the one or more sleep states of the user.

10. The finger-worn wearable ring device of claim 1, further comprising:

one or more processors communicatively coupled to the battery and the one or more sensors, wherein the one or more processors are configured to:

selectively adjust one or more operational parameters of the one or more sensors based at least in part on a power level of the battery, a power usage of the one or more sensors, or both.

11. The finger-worn wearable ring device of claim 1, further comprising:

one or more processors communicatively coupled to the battery and the one or more sensors, wherein the one or more processors are configured to:

selectively adjust one or more operational parameters of the one or more sensors based at least in part on a power level of the battery, a power usage of the one or more sensors, or both.

12. The finger-worn wearable ring device of claim 1, wherein the battery comprises a curved battery, wherein an arc of the curved battery approximates a corresponding arc of the external housing component.

13. The finger-worn wearable ring device of claim 1, wherein the one or more sensors comprise a first light-emitting component configured to emit light associated with a first wavelength, and a second light-emitting component configured to emit light associated with a second wavelength different from the first wavelength.

14. The finger-worn wearable ring device of claim 13, wherein the first wavelength is associated with visible light, and wherein the second wavelength is associated with infrared light.

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15. The finger-worn wearable ring device of claim 13, wherein the first light-emitting component is positioned within the finger-worn wearable ring device at a first radial position, and the second light-emitting component is positioned within the finger-worn wearable ring device at a second radial position different from the first radial position.

16. The finger-worn wearable ring device of claim 15, wherein the one or more sensors further comprise a photodetector positioned within the finger-worn wearable ring device at a third radial position that is between the first radial position and the second radial position.

17. The finger-worn wearable ring device of claim 1, wherein the external housing component and the internal housing component define a cavity configured to at least partially surround the battery, and the printed circuit board, wherein one of the external housing component or the internal housing component comprises:

a first side wall and a second side wall that extend between the internal housing component and the external housing component, wherein the cavity is defined at least in part by the outer circumferential surface, the inner circumferential surface, the first side wall, and the second side wall.

18. The finger-worn wearable ring device of claim 17, wherein the first side wall, the second side wall, or both, are substantially perpendicular to the inner circumferential surface, the outer circumferential surface, or both.

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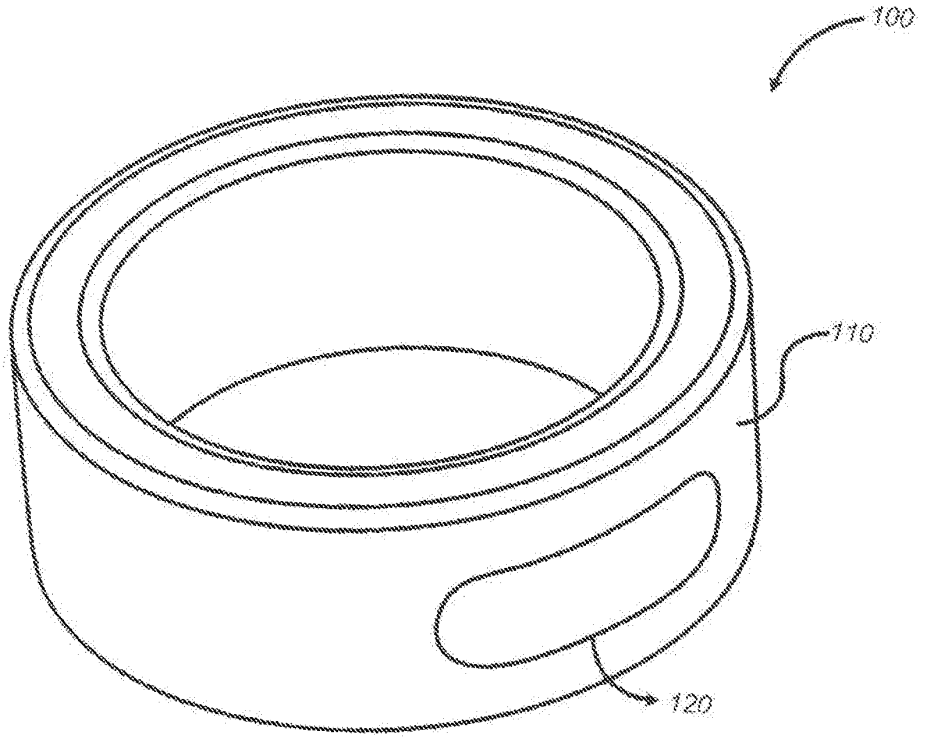


FIG. 1A

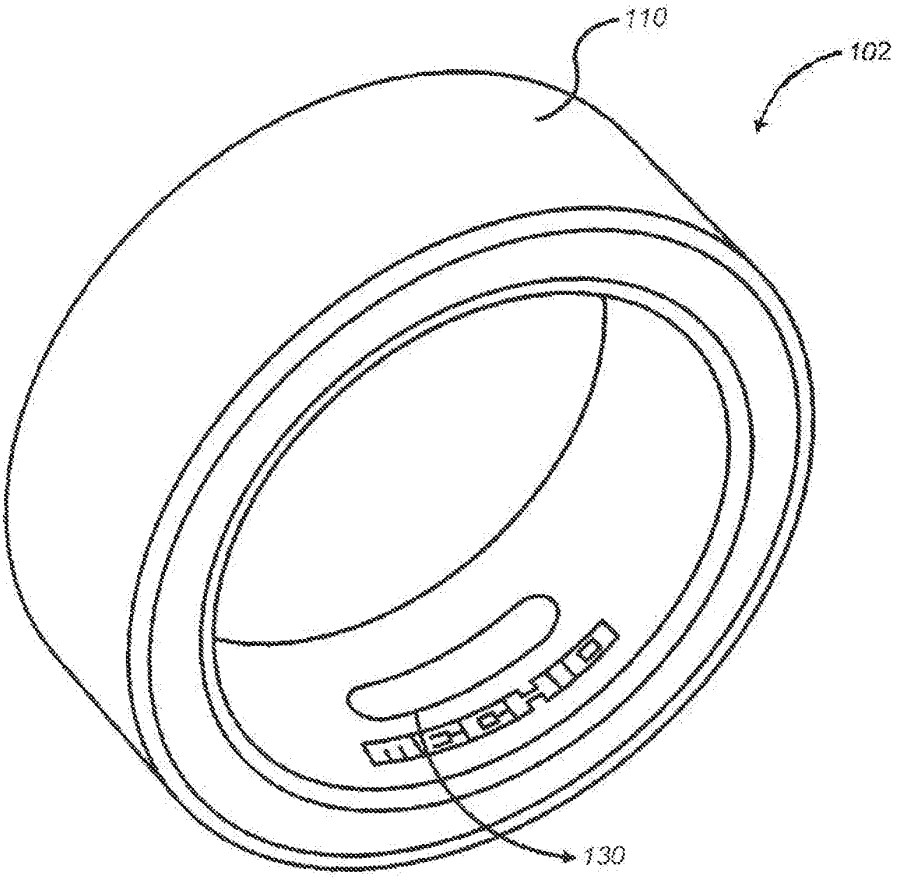


FIG. 1B

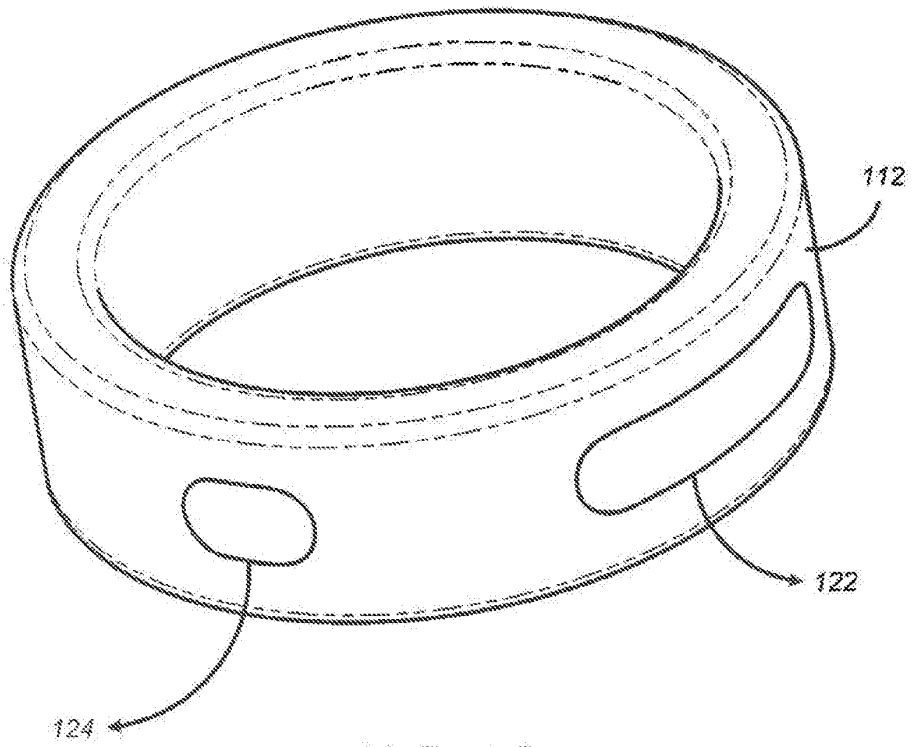


FIG. 1C

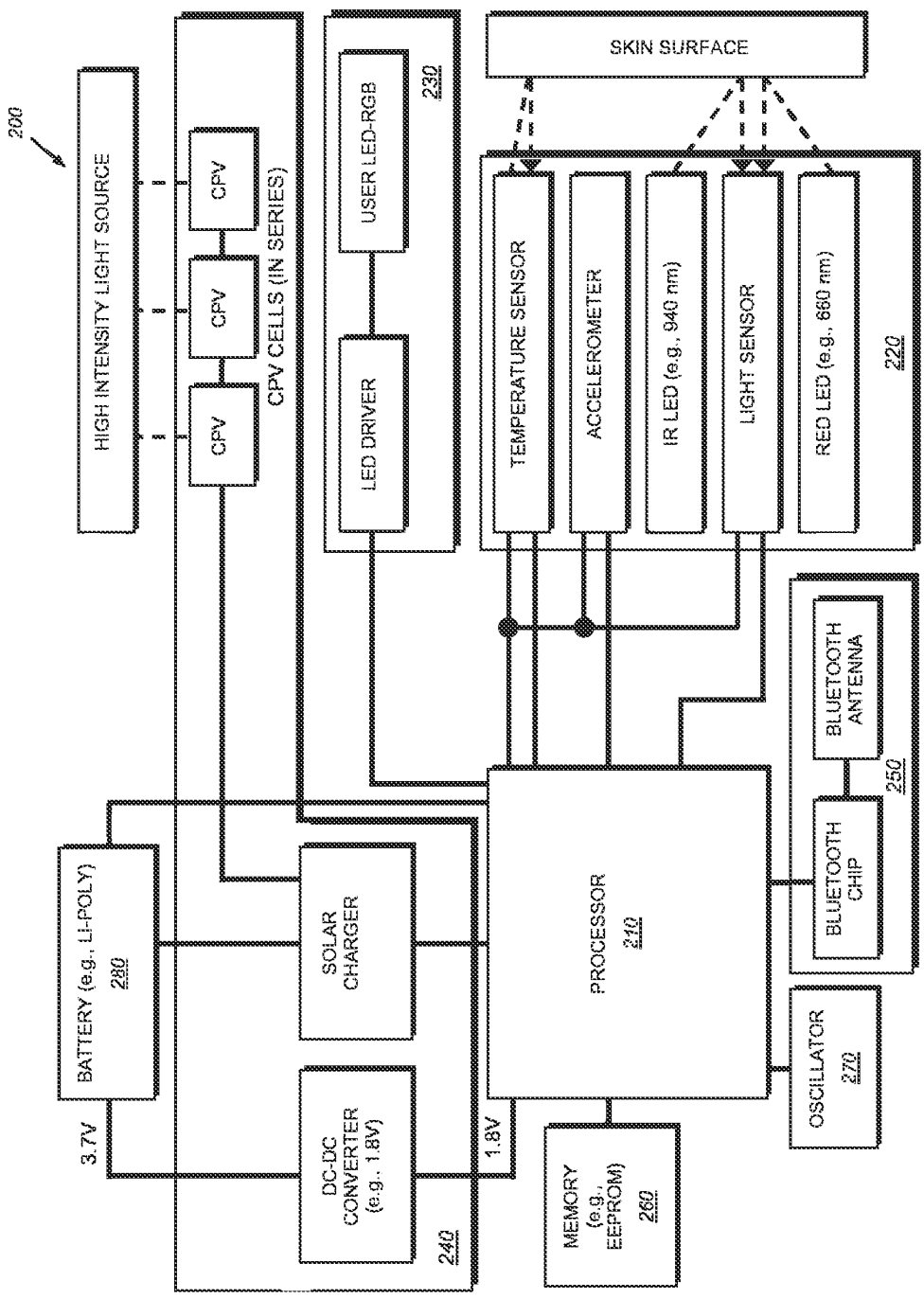


FIG. 2

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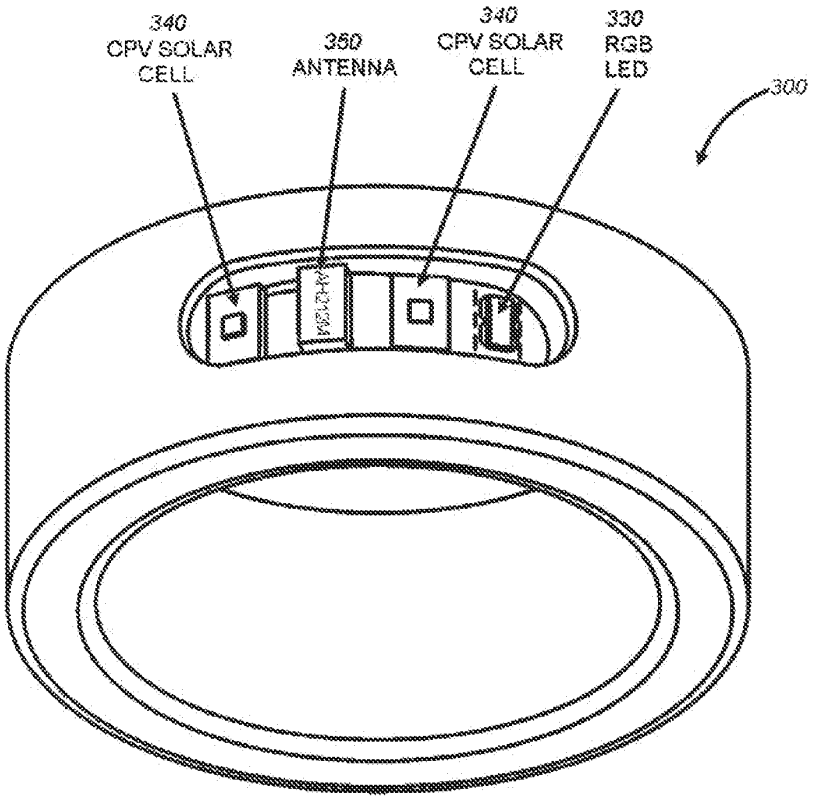

340
CPV SOLAR CELL
350
ANTENNA
340
CPV SOLAR CELL
330
RGB LED
300

FIG. 3A

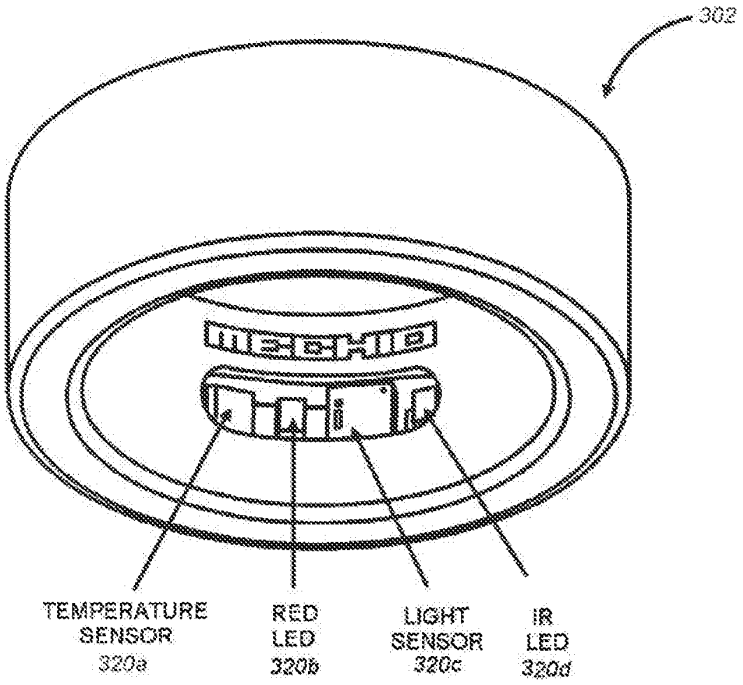

302
TEMPERATURE SENSOR 320a
RED LED 320b
LIGHT SENSOR 320c
IR LED 320d

FIG. 3B

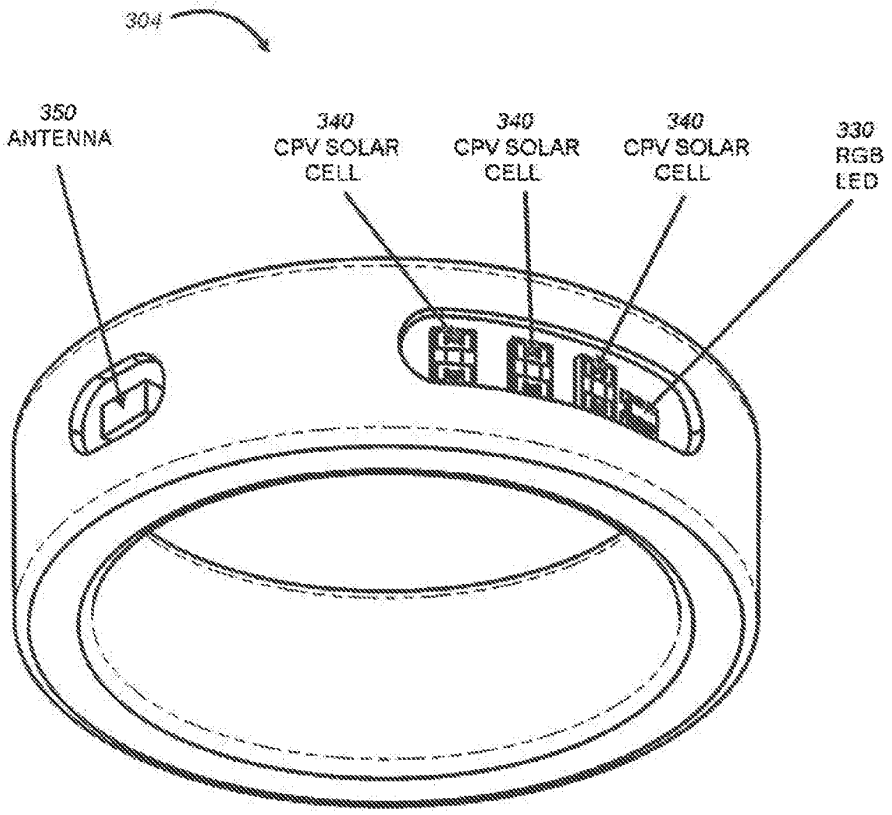

304
350
ANTENNA
340
CPV SOLAR
CELL
340
CPV SOLAR
CELL
340
CPV SOLAR
CELL
330
RGB
LED

FIG. 3C

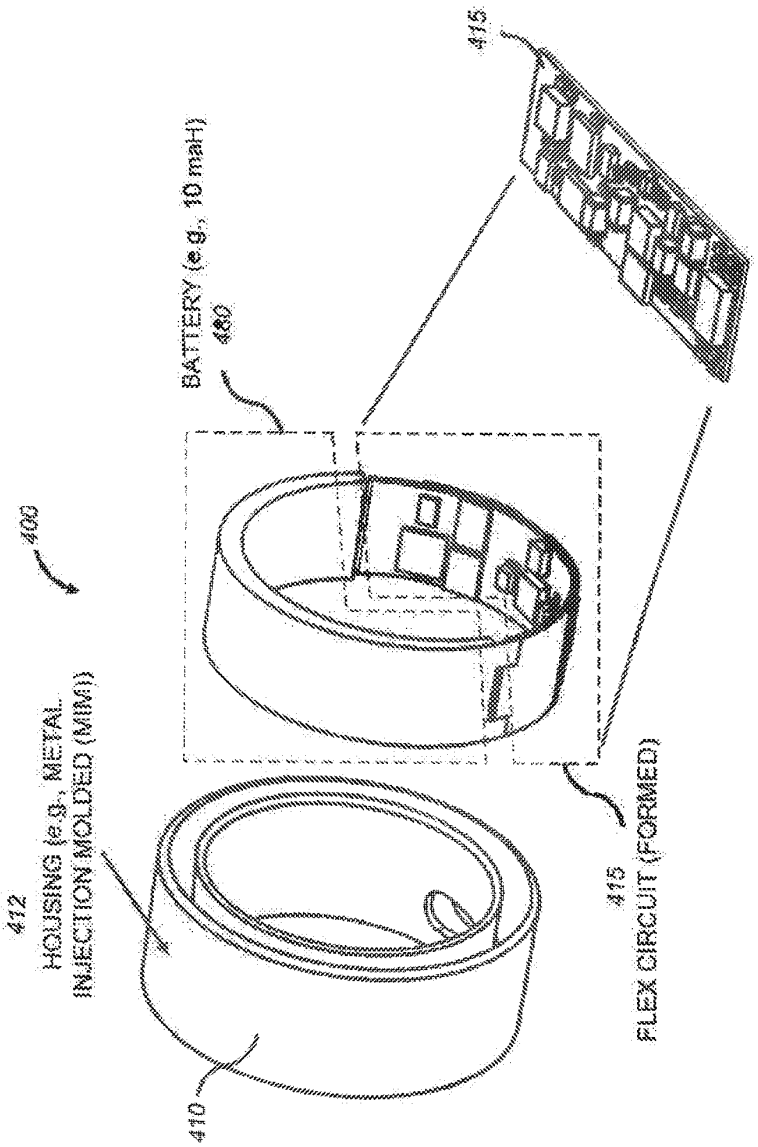

400
412
HOUSING (e.g., METAL INJECTION MOLDED (MIM))
410
BATTERY (e.g., 10 mAH)
480
415
FLEX CIRCUIT (FORMED)
415

FIG. 4

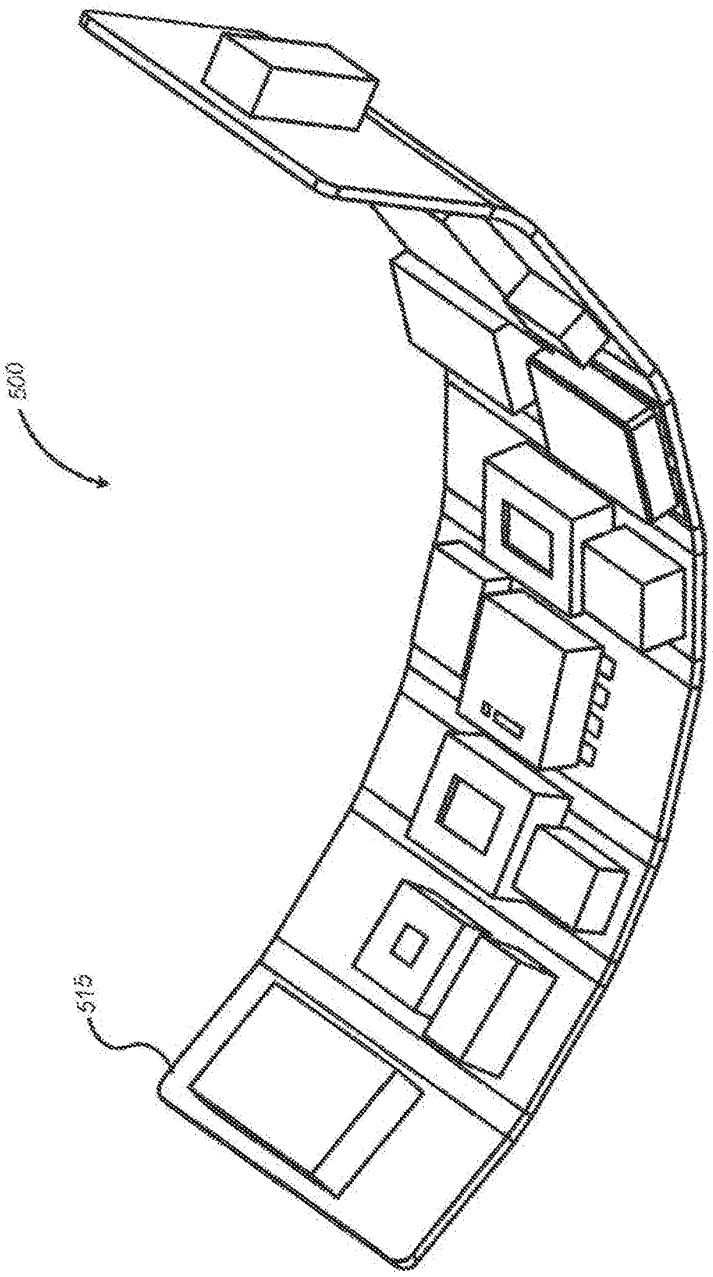


FIG. 5

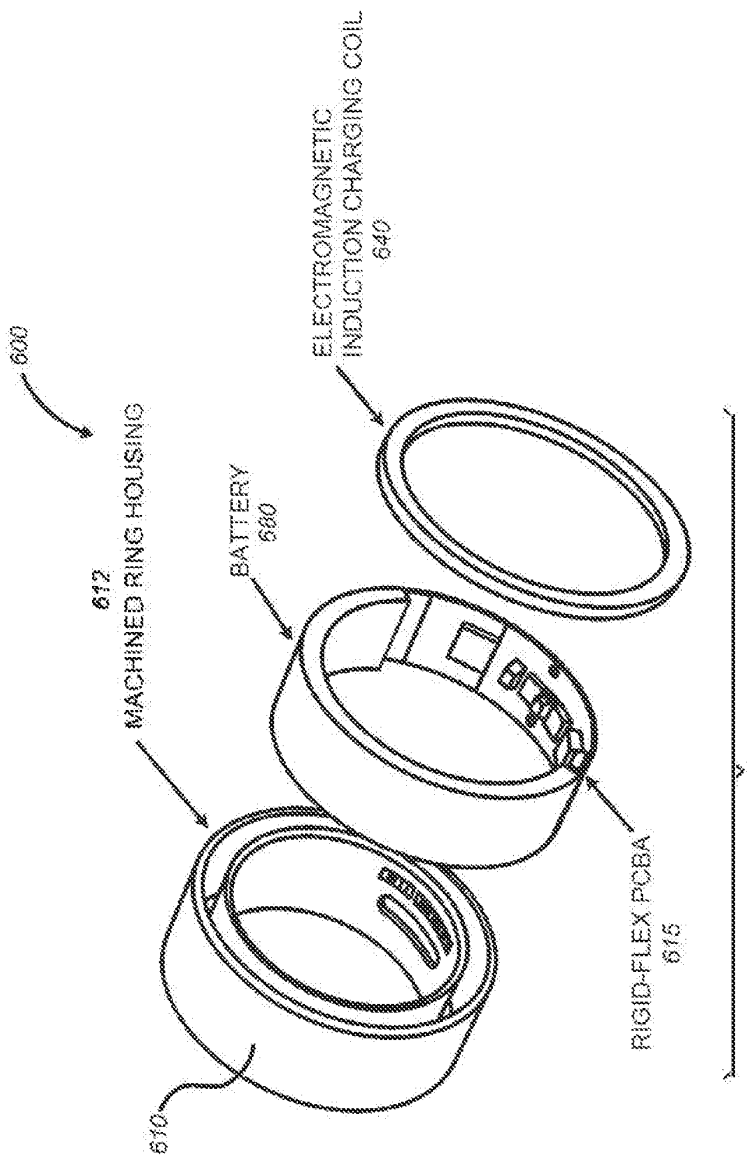

600
612
MACHINED RING HOUSING
610
BATTERY
660
ELECTROMAGNETIC
INDUCTION CHARGING COIL
640
RIGID-FLEX PCBA
615

FIG. 6

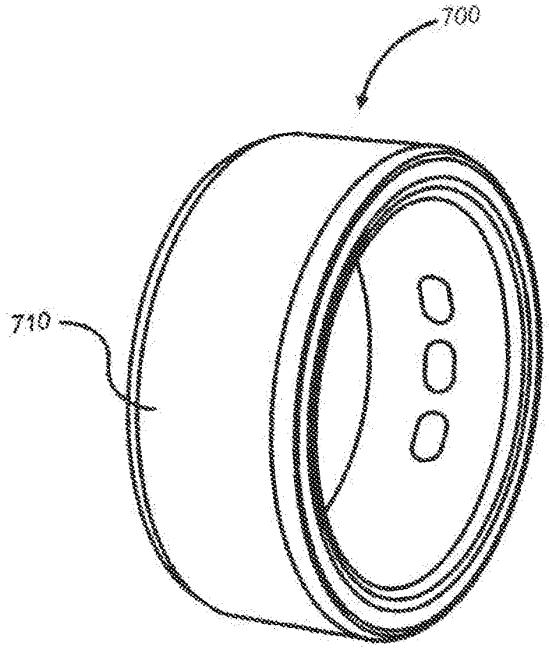


FIG. 7

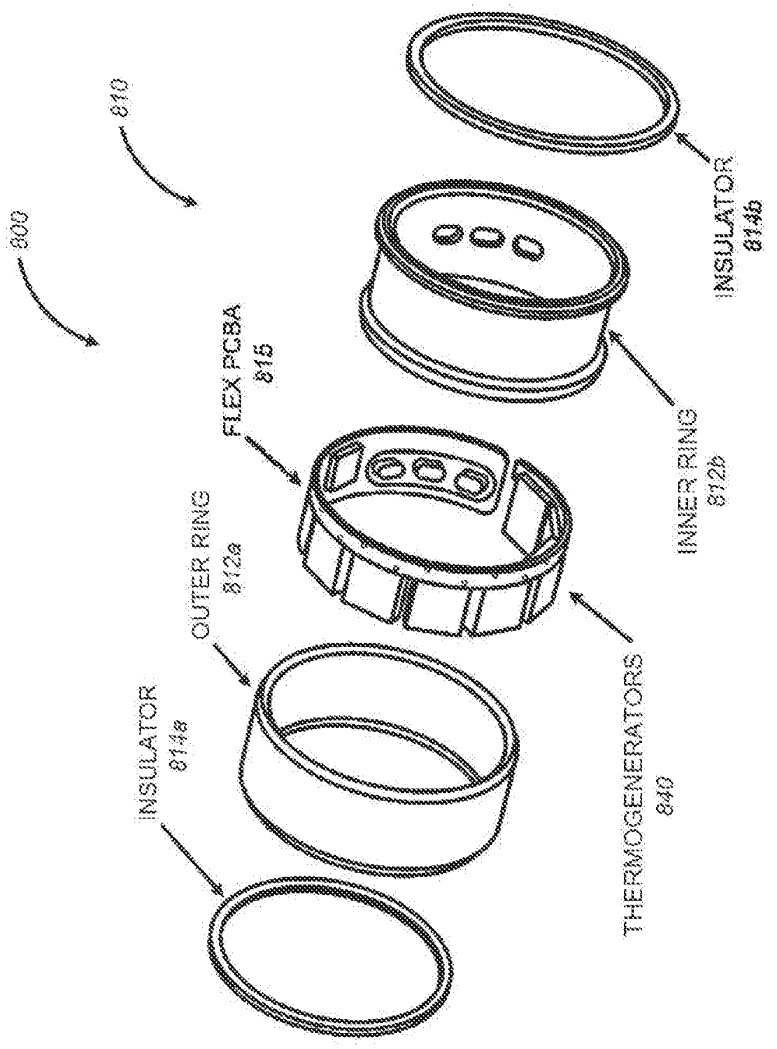

800
810
INSULATOR
814a
OUTER RING
812a
FLEX PCBA
815
THERMOGENERATORS
840
INNER RING
812b
INSULATOR
814b

FIG. 8

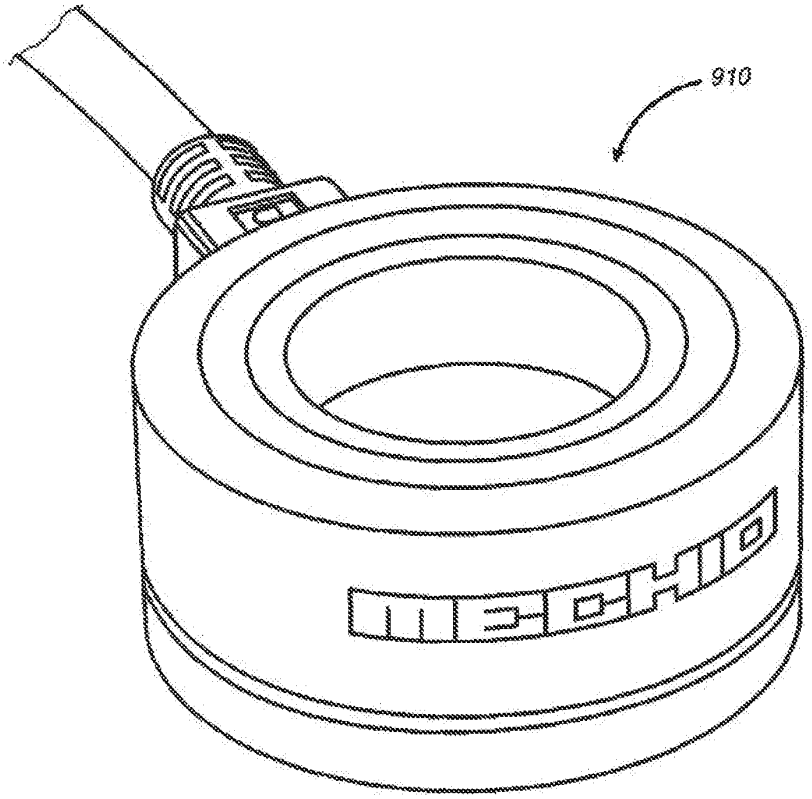


FIG. 9A

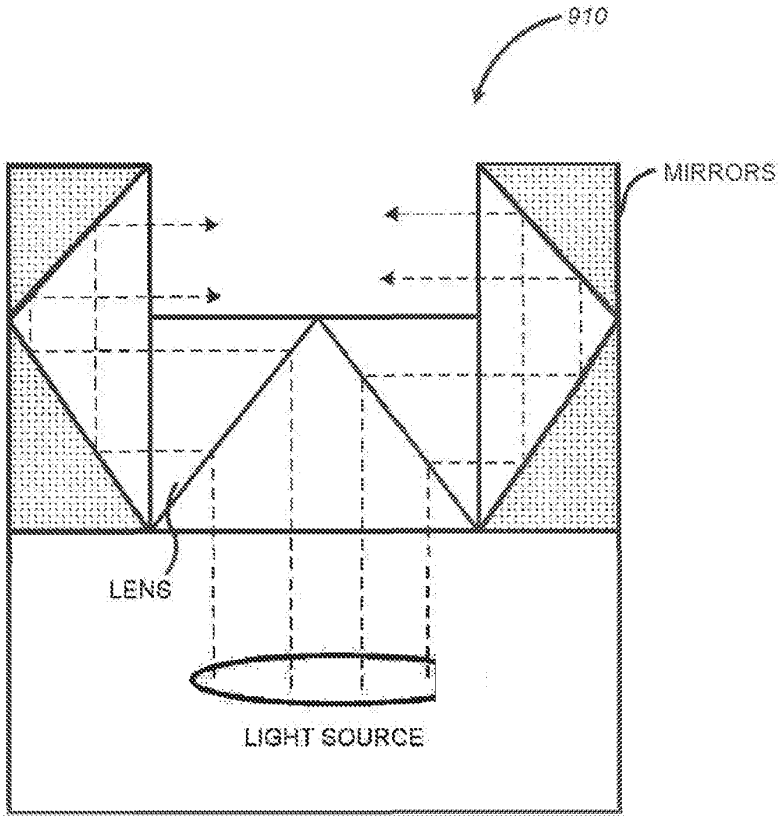


FIG. 9B

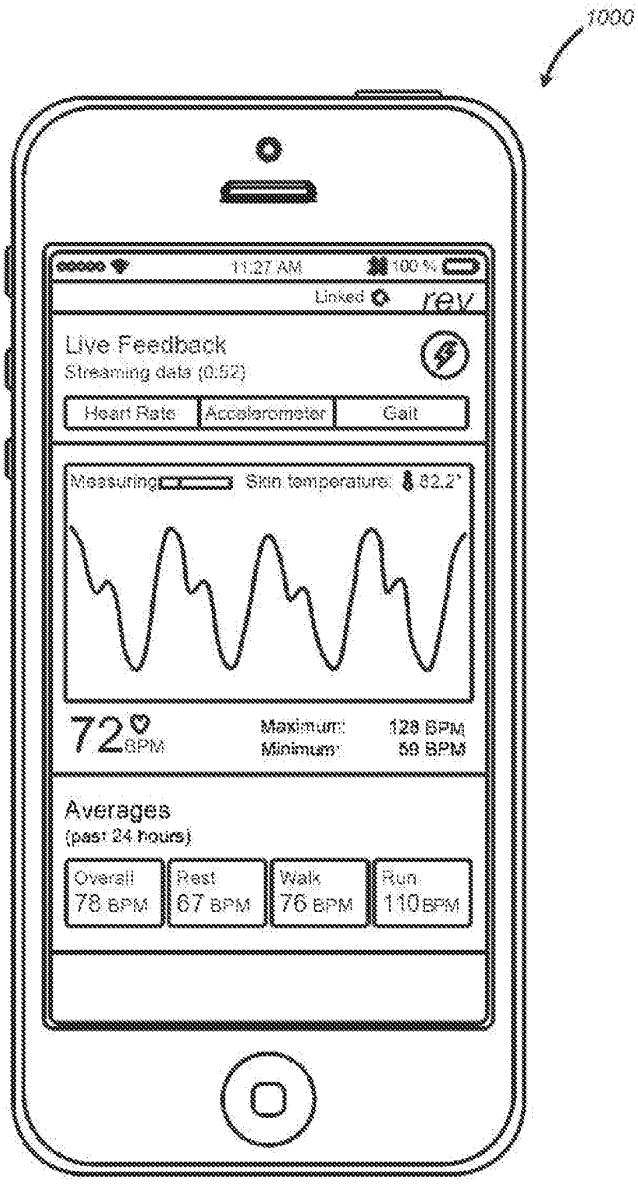

1000
11:27 AM
100 %
Linked
rev
Live Feedback
Streaming data (0:52)
Heart Rate
Accelerometer
Gait
Measuring
Skin temperature: 82.2°
72°
BPM
Maximum: 128 BPM
Minimum: 59 BPM
Averages
(past 24 hours)
Overall
78 BPM
Rest
67 BPM
Walk
76 BPM
Run
110 BPM

FIG. 10

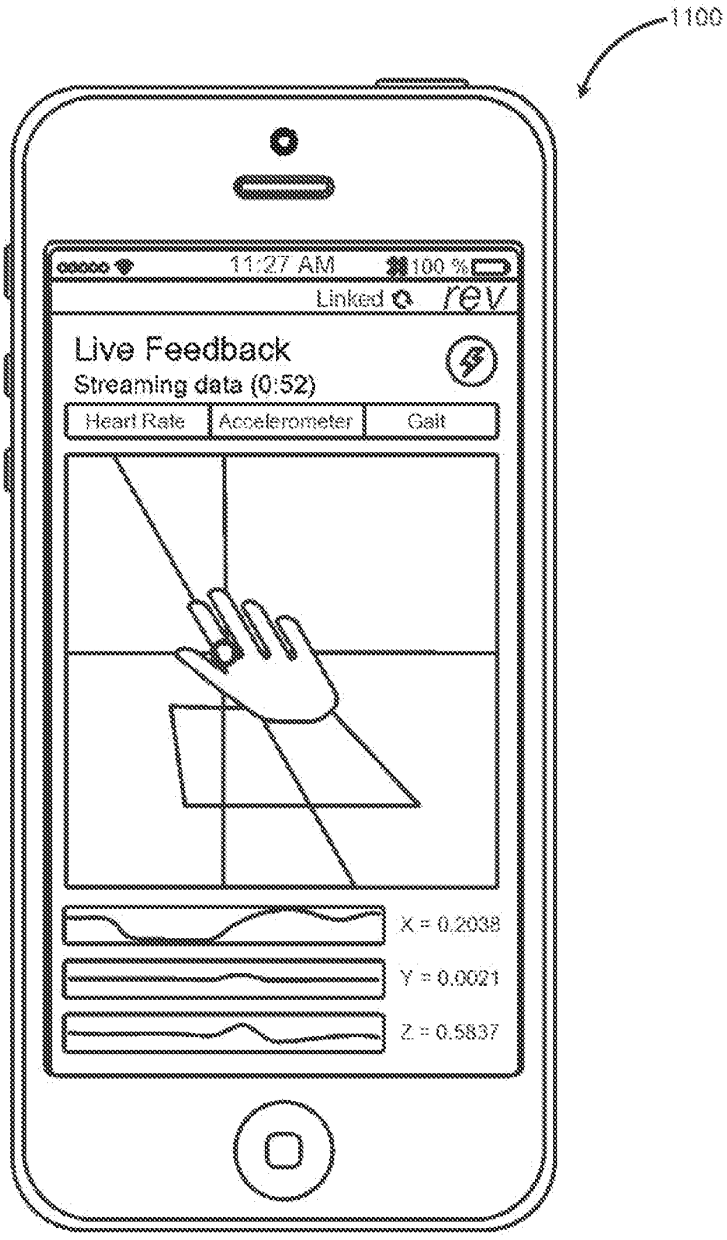

1100
11:27 AM
100 %
Linked
rev
Live Feedback
Streaming data (0:52)
Heart Rate
Accelerometer
Gait
X = 0.2038
Y = 0.0021
Z = 0.5837

FIG. 11

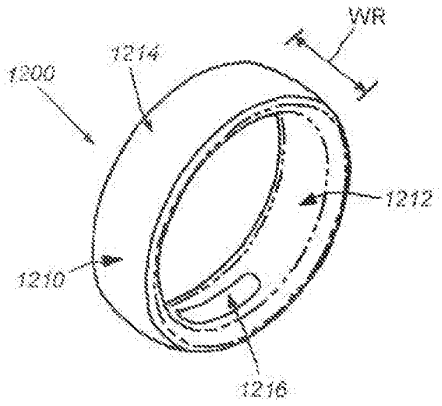


FIG. 12A

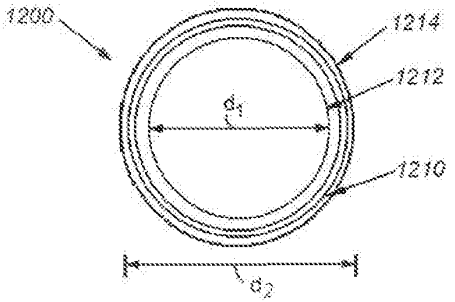


FIG. 12B

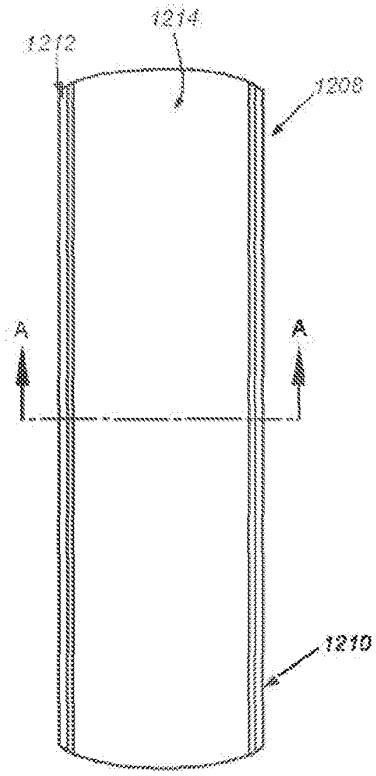


FIG. 12C

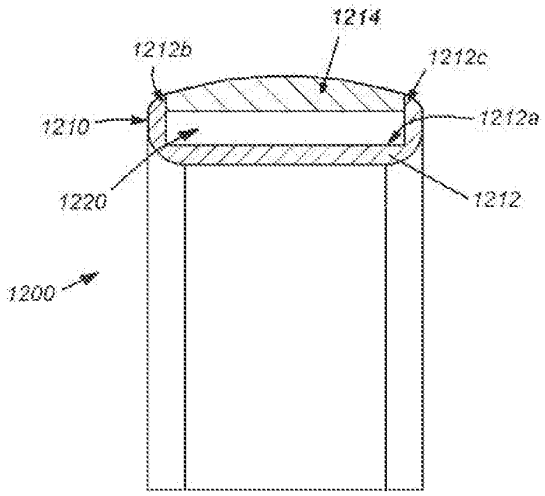


FIG. 12D

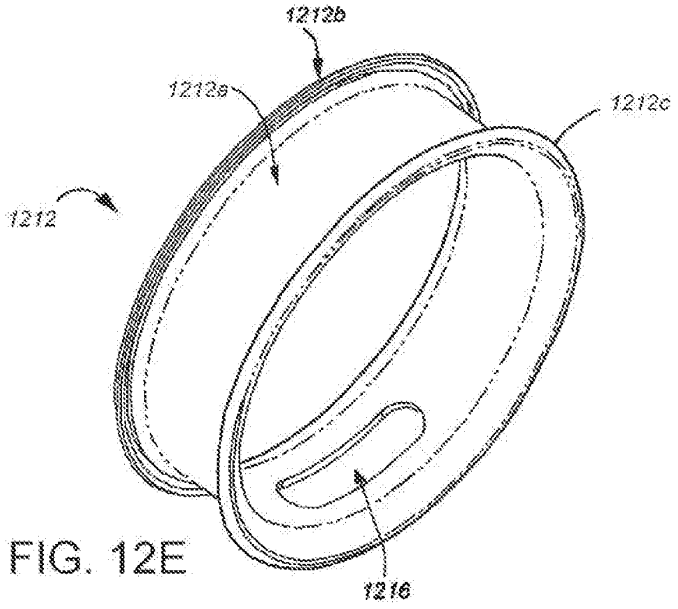


FIG. 12E

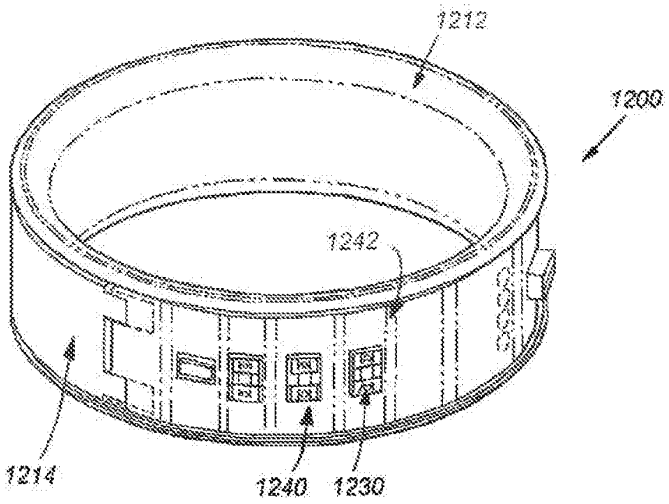


FIG. 12F

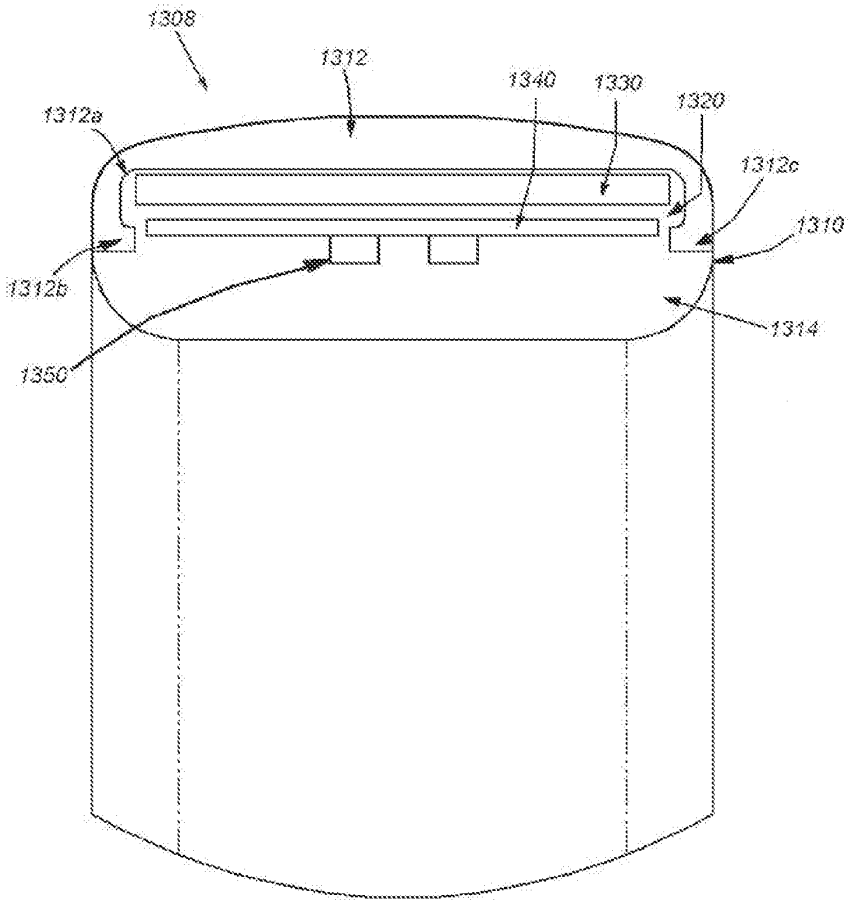


FIG. 13

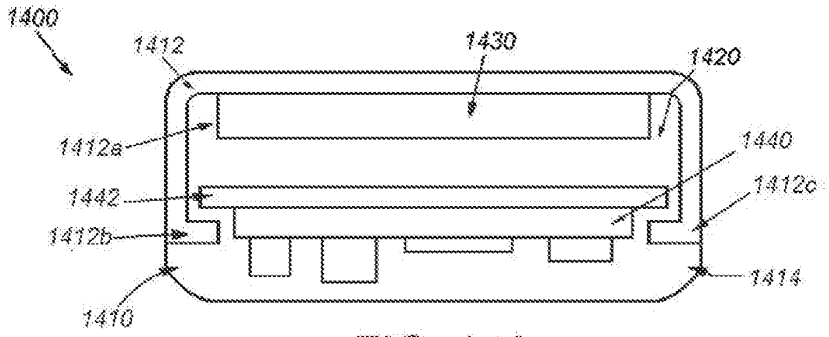


FIG. 14A

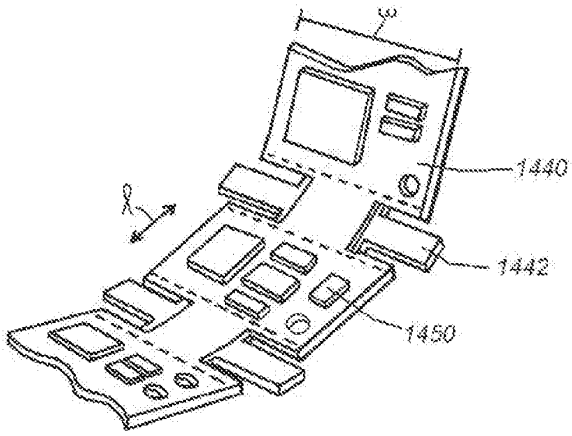


FIG. 14B

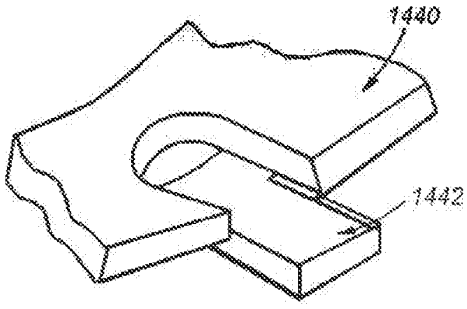


FIG. 14C

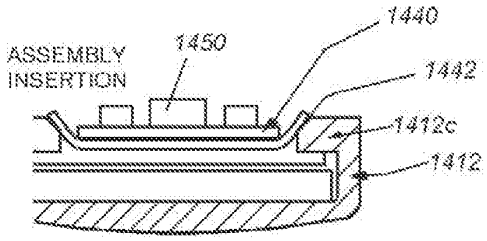


FIG. 14D

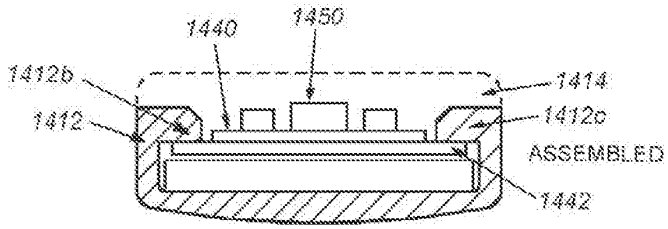


FIG. 14E

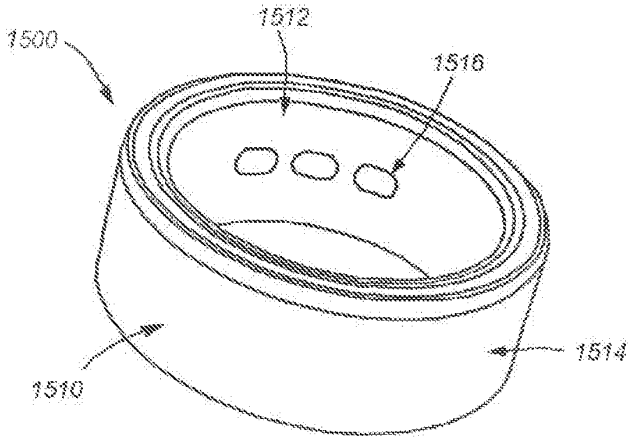


FIG. 15A

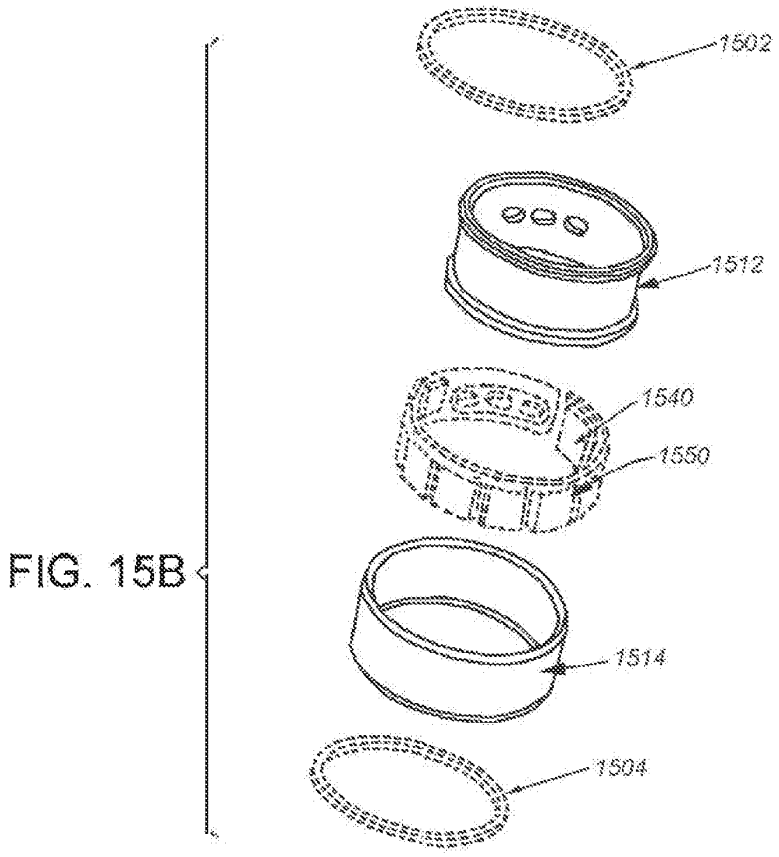
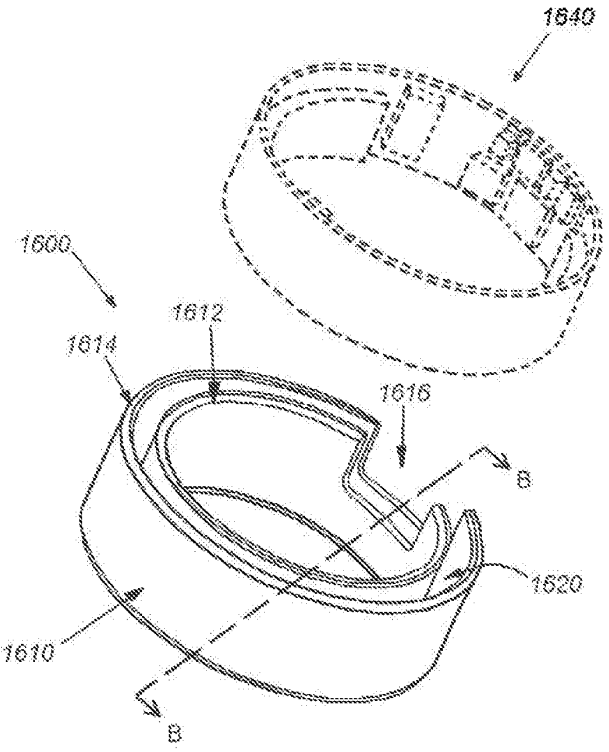


FIG. 15B

FIG. 16A



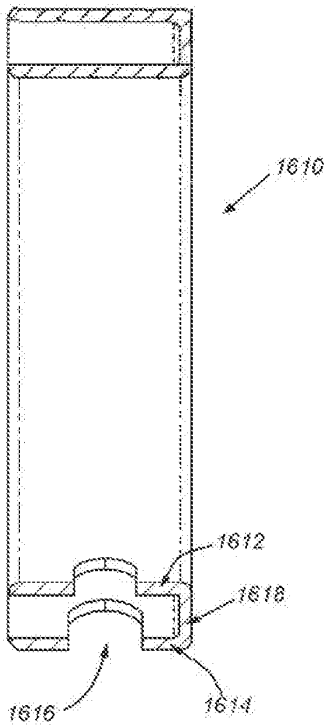


FIG. 16B

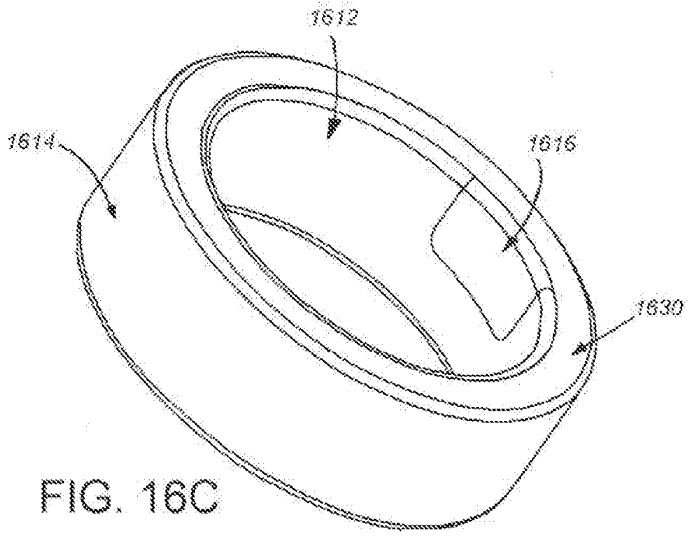


FIG. 16C

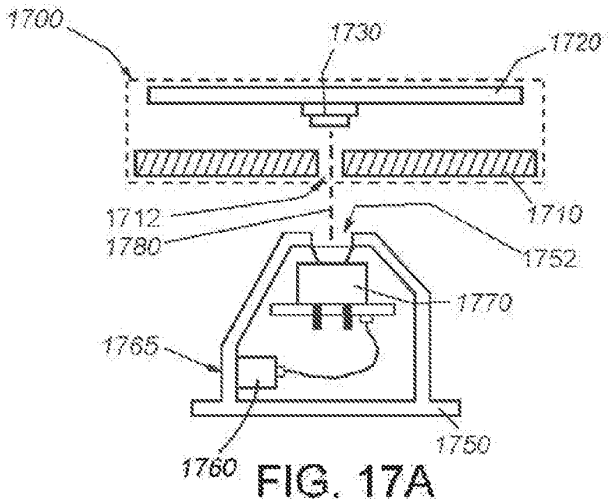


FIG. 17A

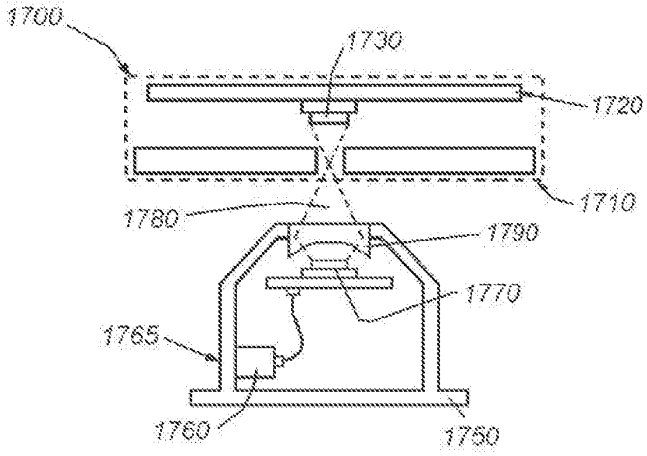


FIG. 17B

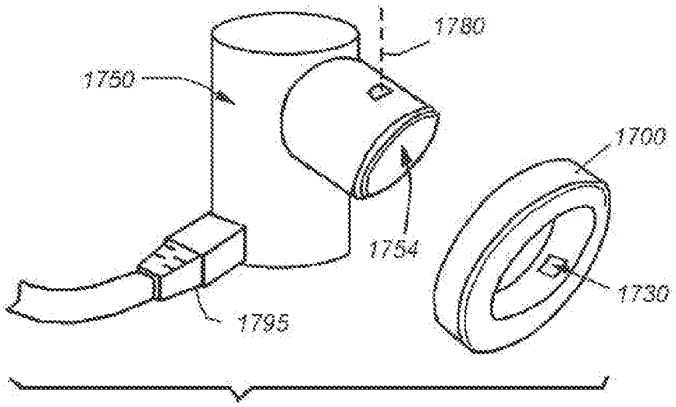


FIG. 17C

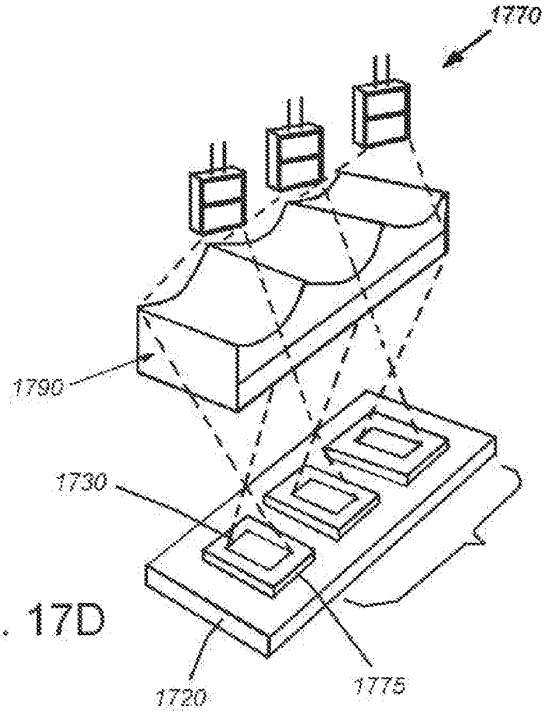


FIG. 17D

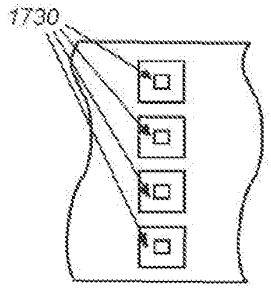


FIG. 17E

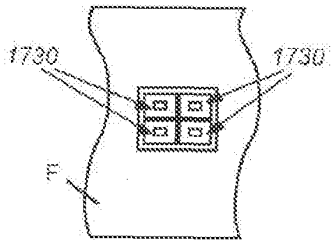


FIG. 17F

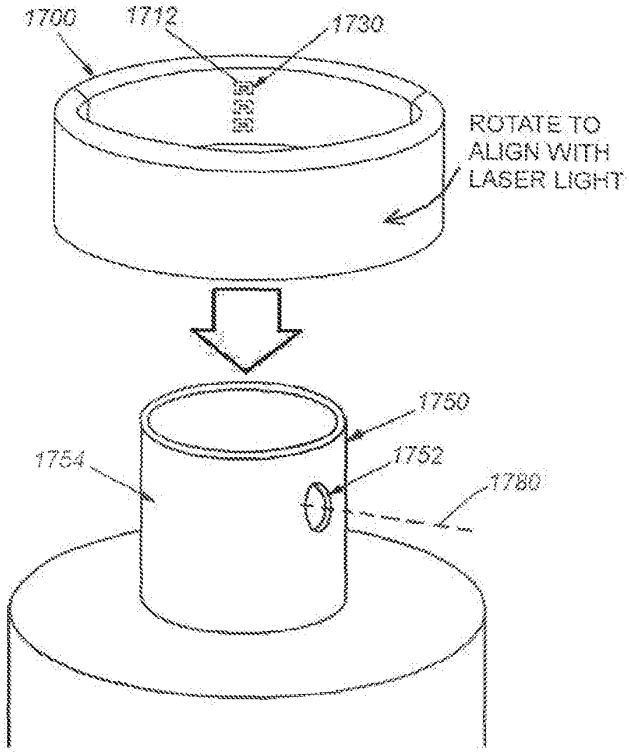


FIG. 17G

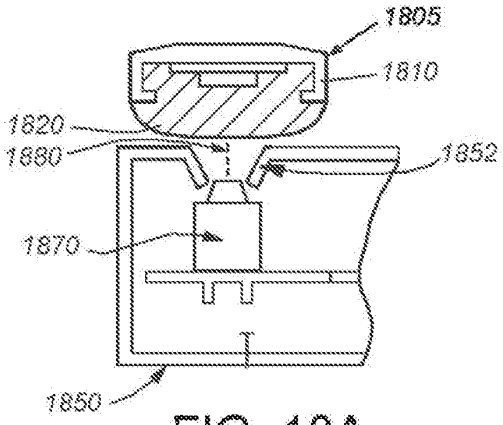


FIG. 18A

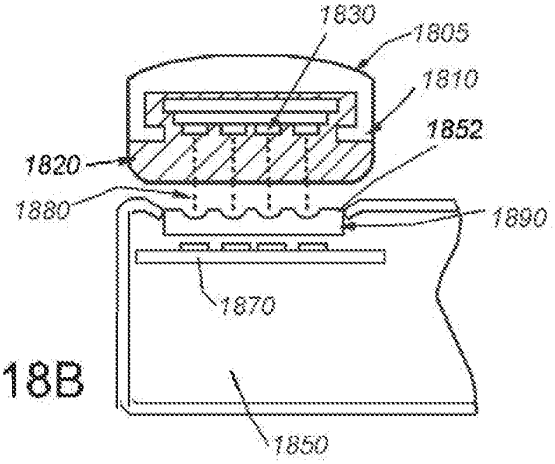


FIG. 18B

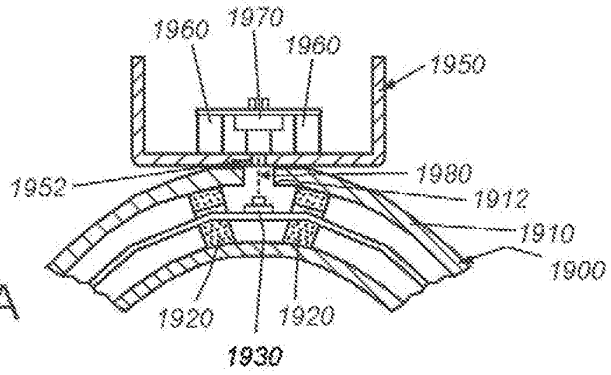


FIG. 19A

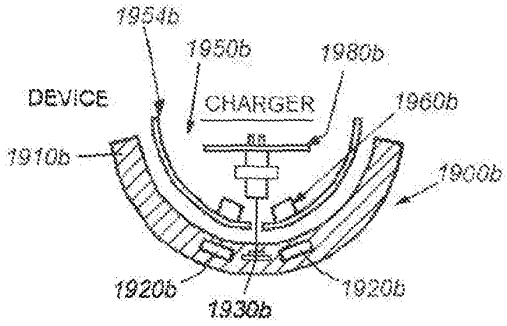


FIG. 19B

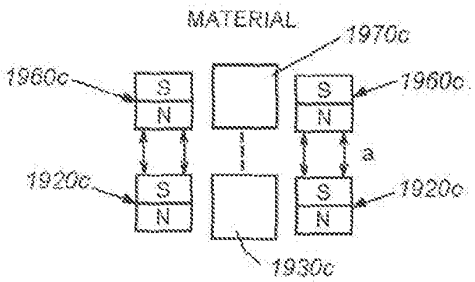


FIG. 19C

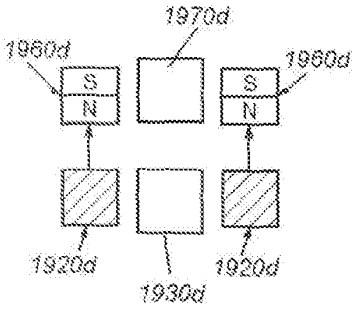


FIG. 19D

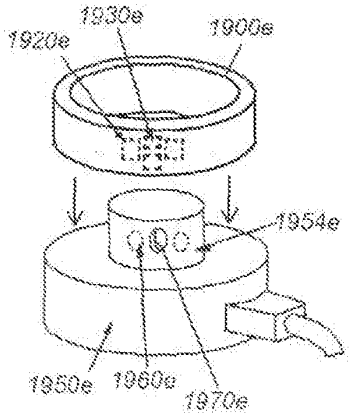


FIG. 19E

Petitioner Samsung Ex-1004, 0102

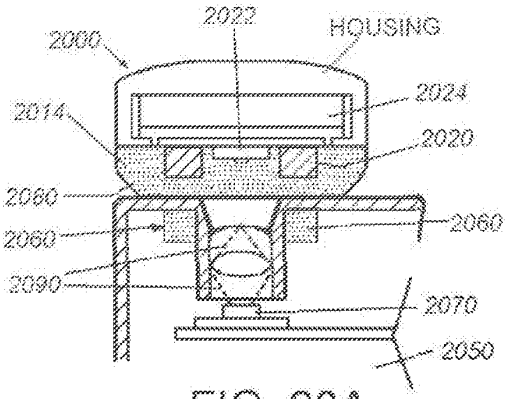


FIG. 20A

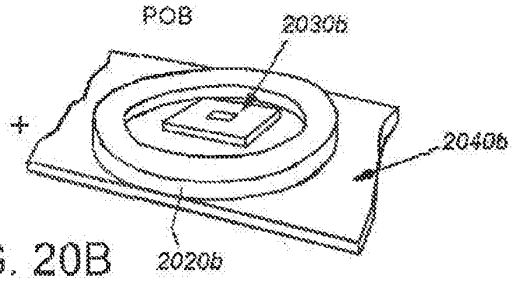


FIG. 20B

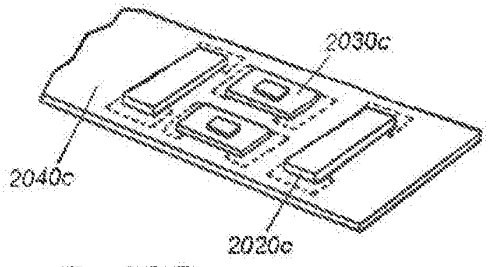


FIG. 20C

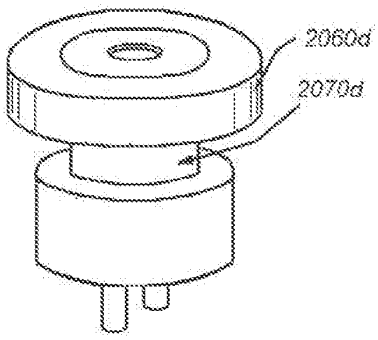


FIG. 20D

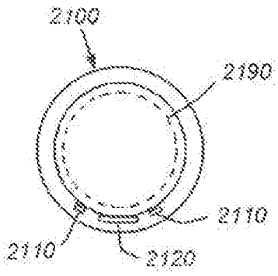


FIG. 21A

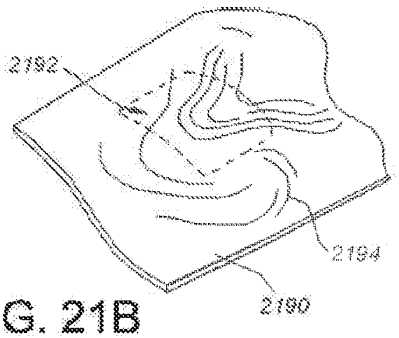
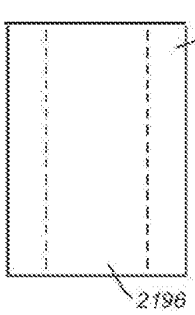


FIG. 21B



* SYSTEM WILL ONLY MATCH TO A SUBSET OF THE TOTAL SCANNED AREA

FIG. 21C

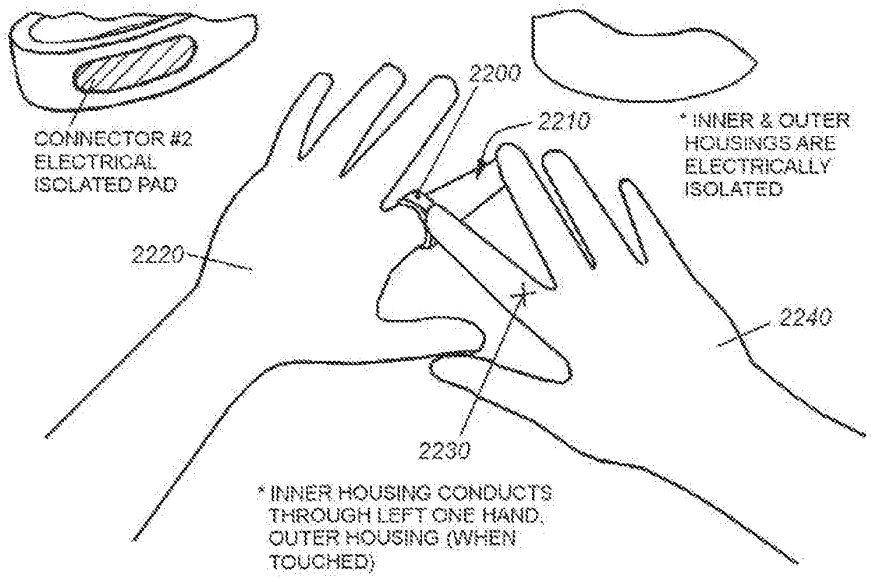


FIG. 22A

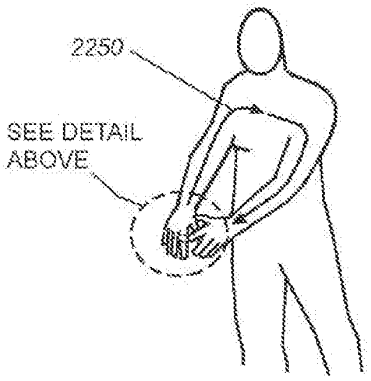


FIG. 22B

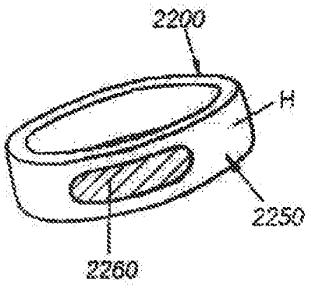


FIG. 22C

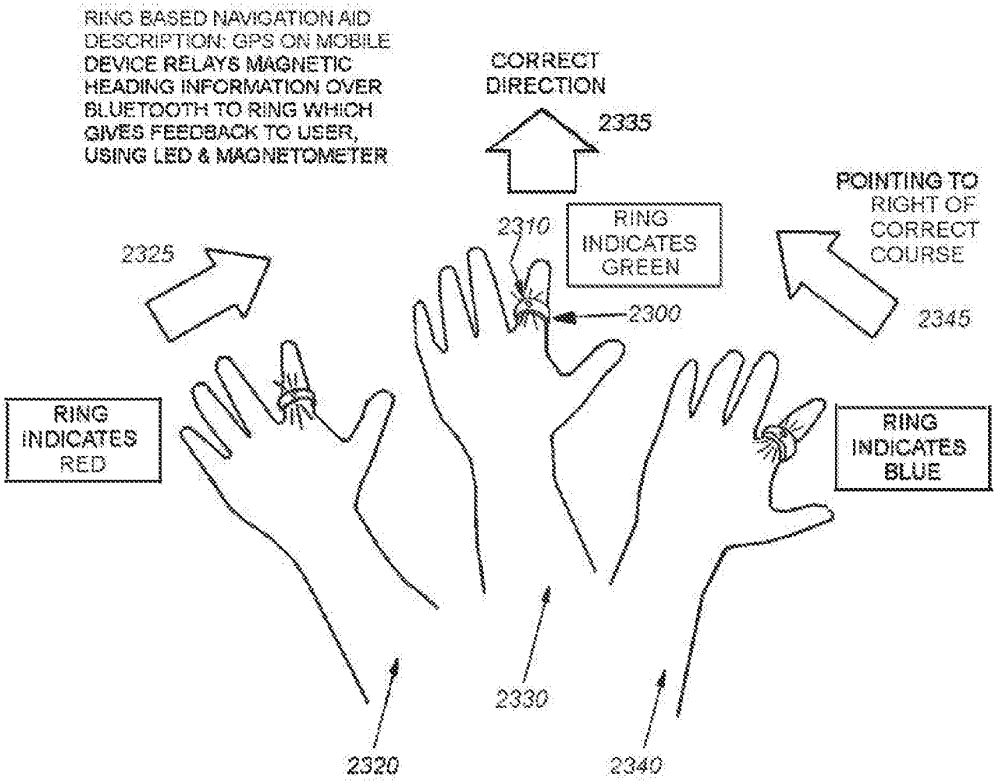

RING BASED NAVIGATION AID DESCRIPTION: GPS ON MOBILE DEVICE RELAYS MAGNETIC HEADING INFORMATION OVER BLUETOOTH TO RING WHICH GIVES FEEDBACK TO USER, USING LED & MAGNETOMETER
CORRECT DIRECTION
2335
POINTING TO RIGHT OF CORRECT COURSE
2345
2310
RING INDICATES GREEN
2300
2325
RING INDICATES RED
RING INDICATES BLUE
2330
2320
2340

FIG. 23A

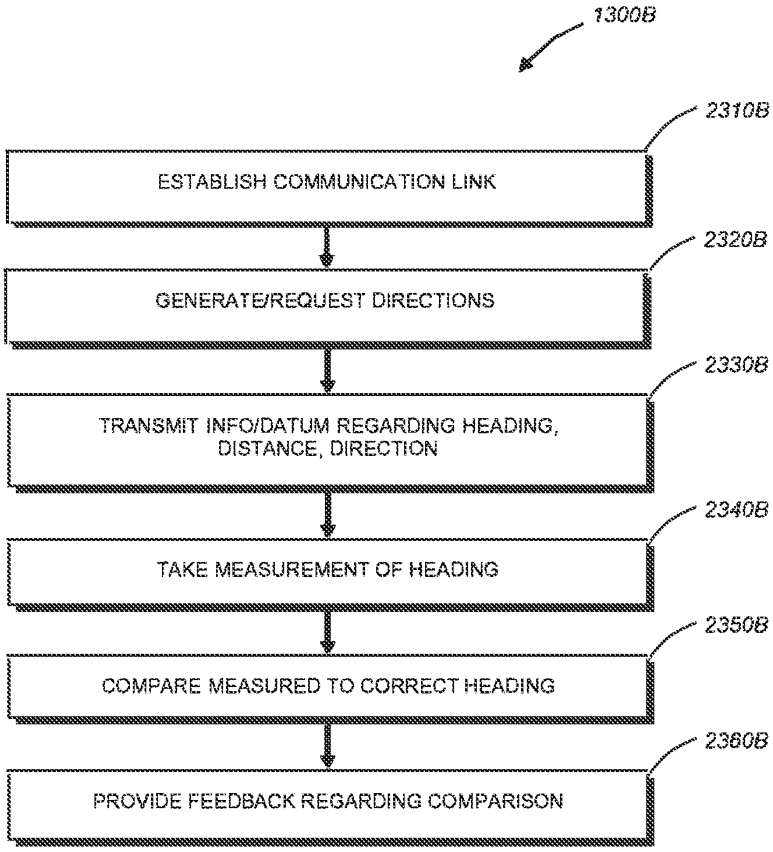

1300B
2310B
ESTABLISH COMMUNICATION LINK
2320B
GENERATE/REQUEST DIRECTIONS
2330B
TRANSMIT INFO/DATUM REGARDING HEADING, DISTANCE, DIRECTION
2340B
TAKE MEASUREMENT OF HEADING
2350B
COMPARE MEASURED TO CORRECT HEADING
2360B
PROVIDE FEEDBACK REGARDING COMPARISON

FIG. 23B

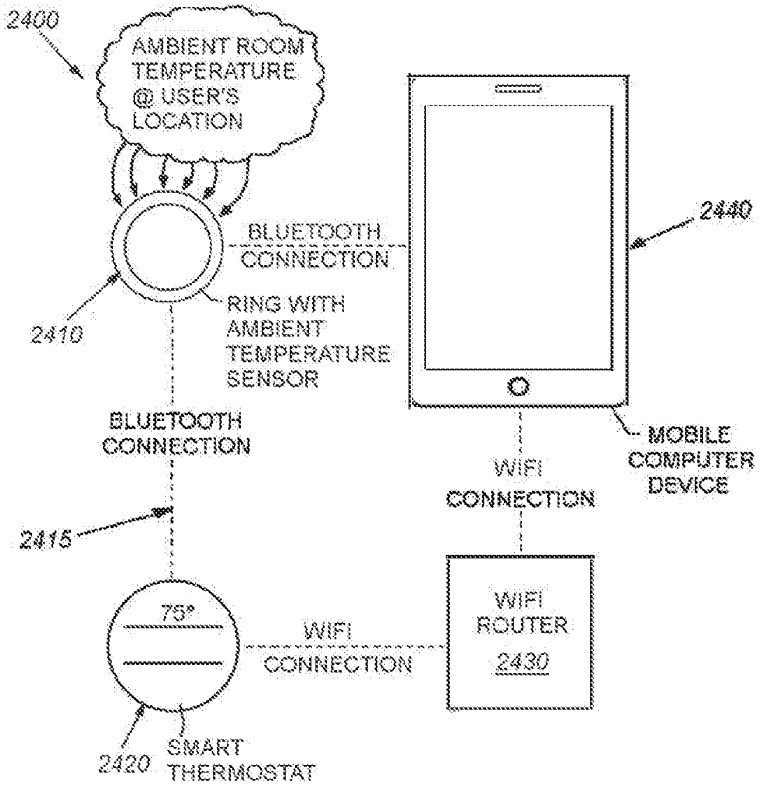


FIG. 24A

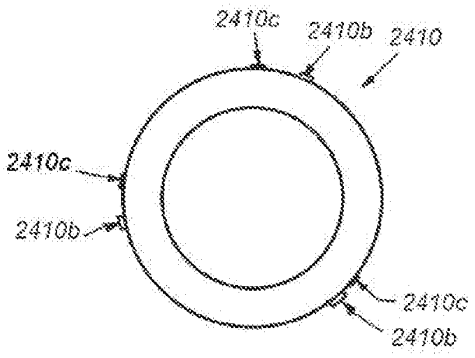


FIG. 24B

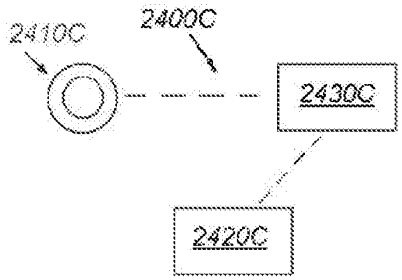


FIG. 24C

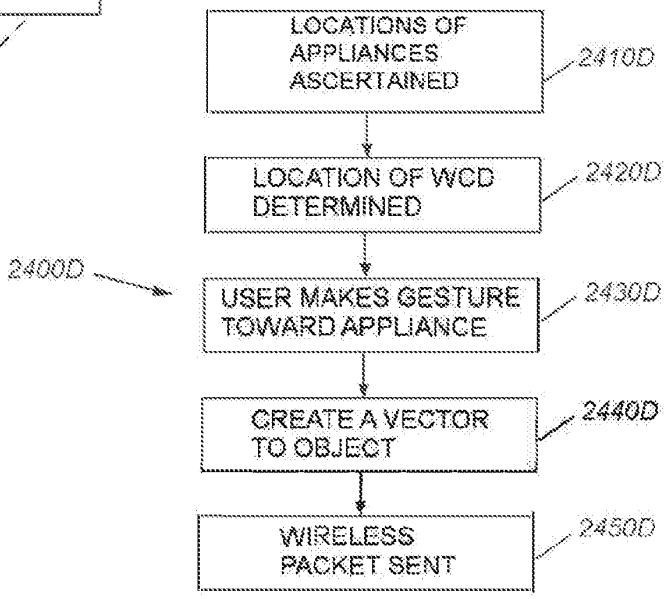


FIG. 24D

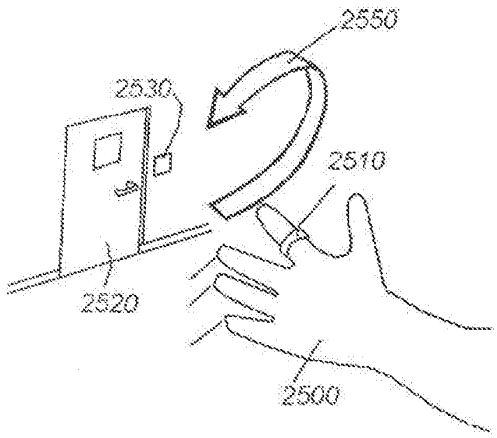


FIG. 25

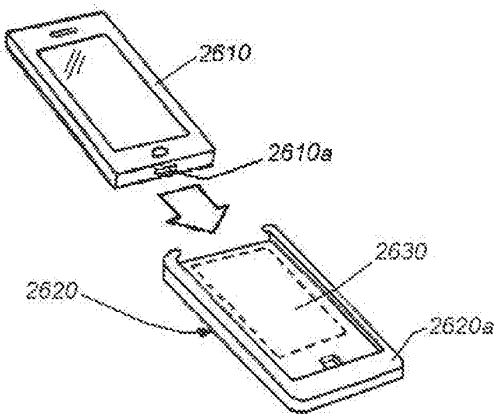


FIG. 26A

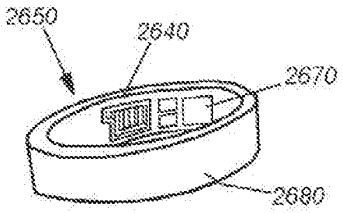


FIG. 26B

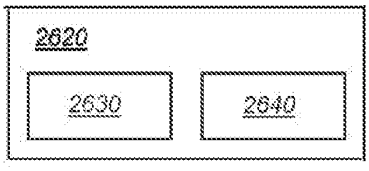


FIG. 26C

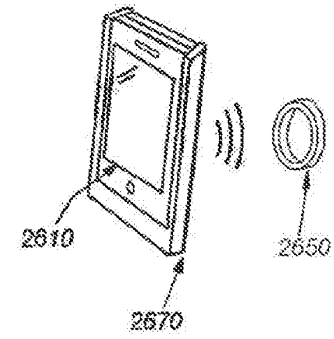


FIG. 26D

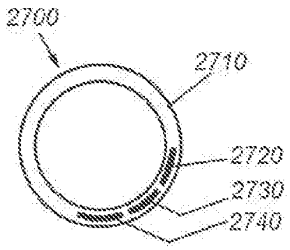


FIG. 27A

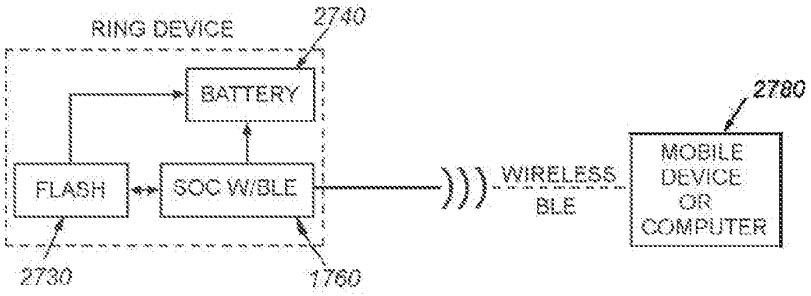


FIG. 27B

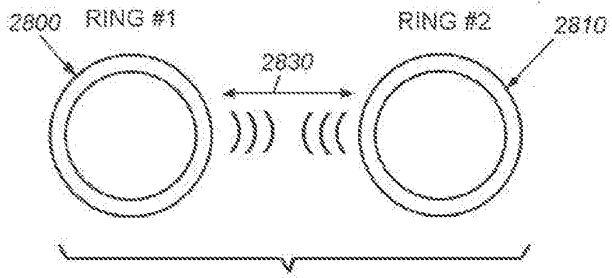


FIG. 28A

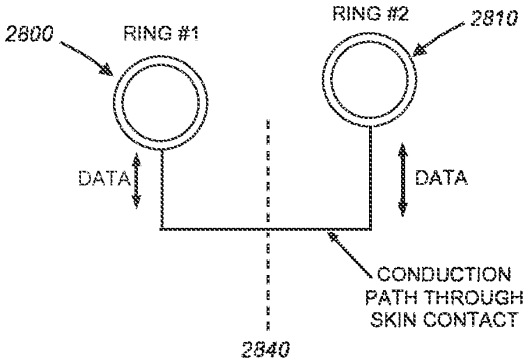


FIG. 28B

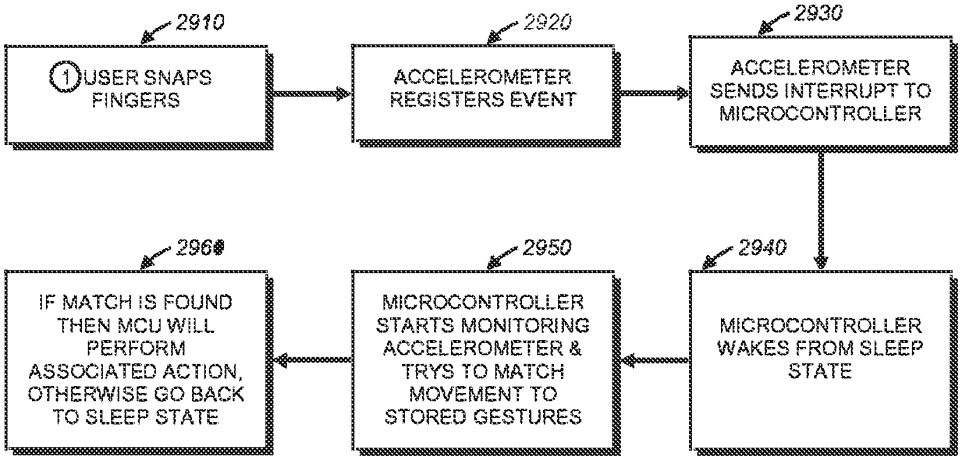


FIG. 29A

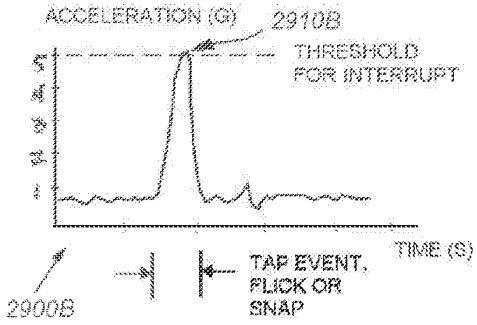


FIG. 29B

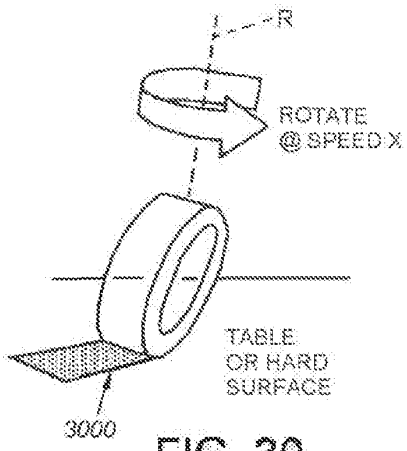


FIG. 30

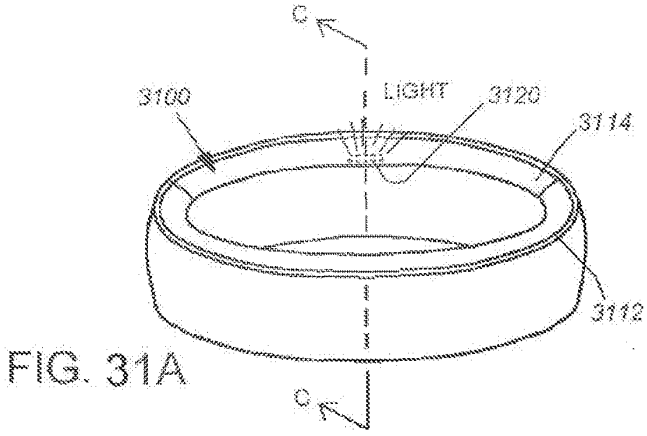


FIG. 31A

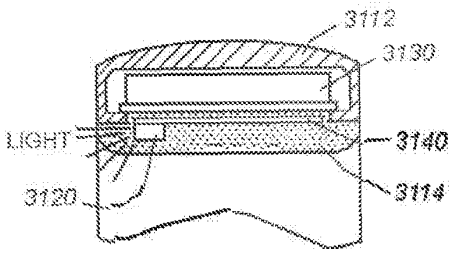


FIG. 31C

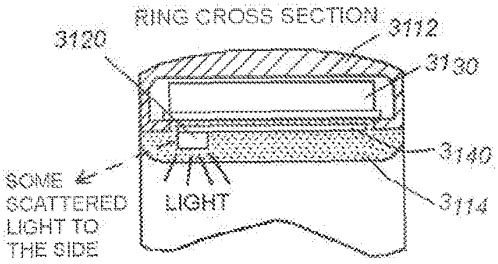


FIG. 31B

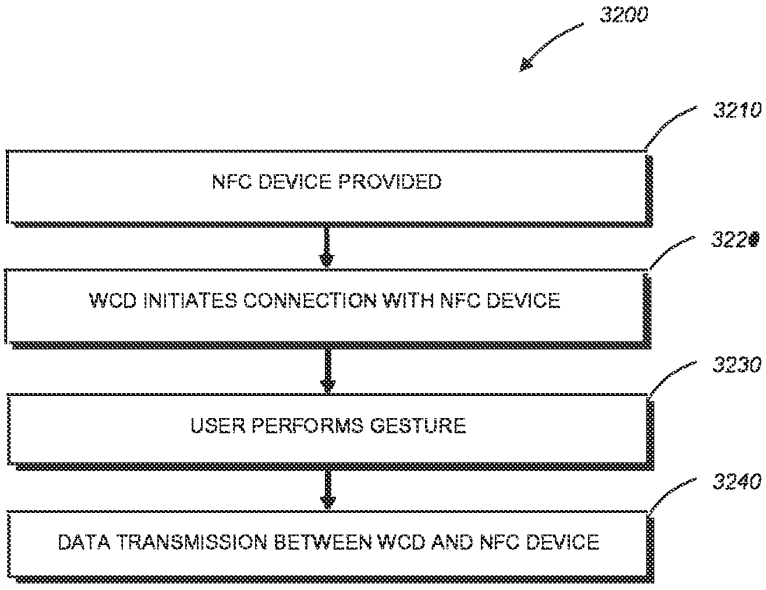

3200
3210
NFC DEVICE PROVIDED
3220
WCD INITIATES CONNECTION WITH NFC DEVICE
3230
USER PERFORMS GESTURE
3240
DATA TRANSMISSION BETWEEN WCD AND NFC DEVICE

FIG. 32

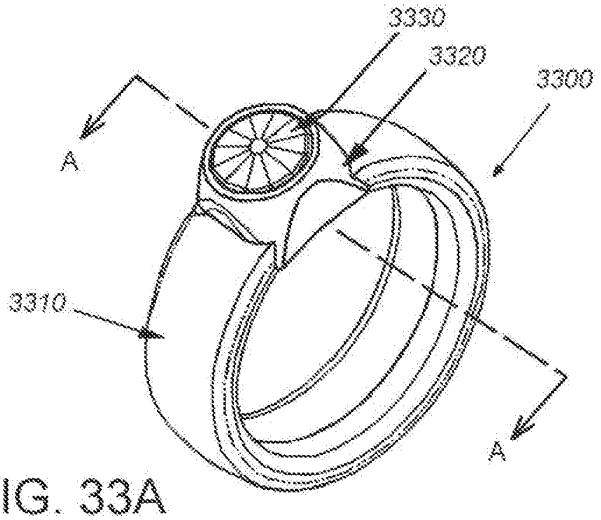


FIG. 33A

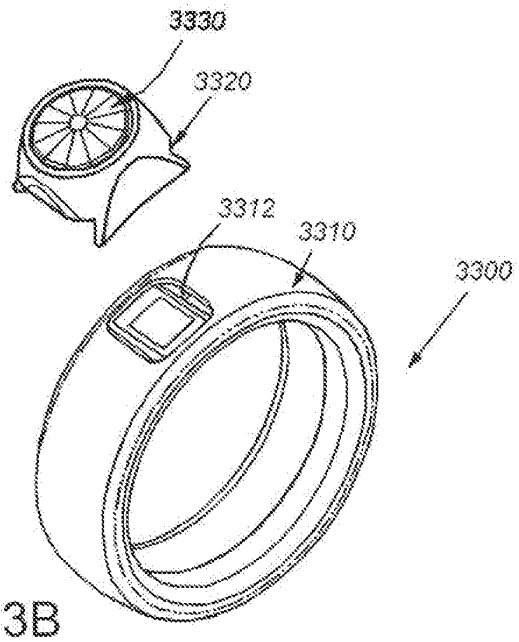


FIG. 33B

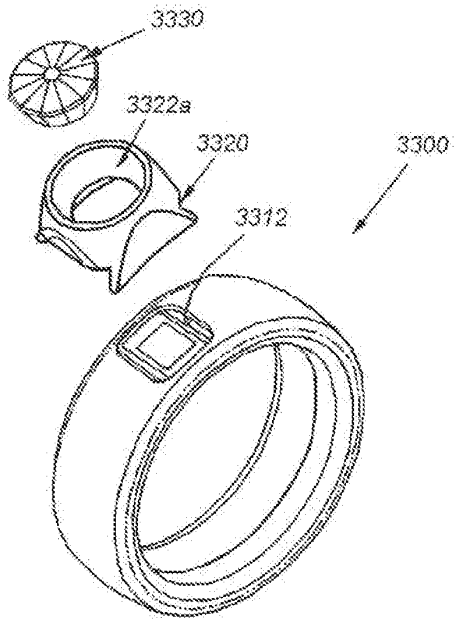


FIG. 33C

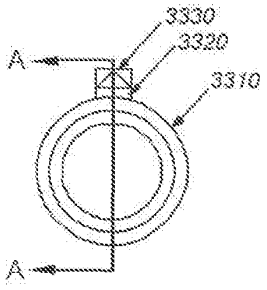


FIG. 33D

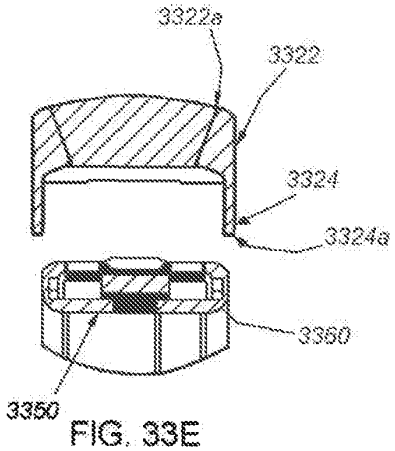


FIG. 33E

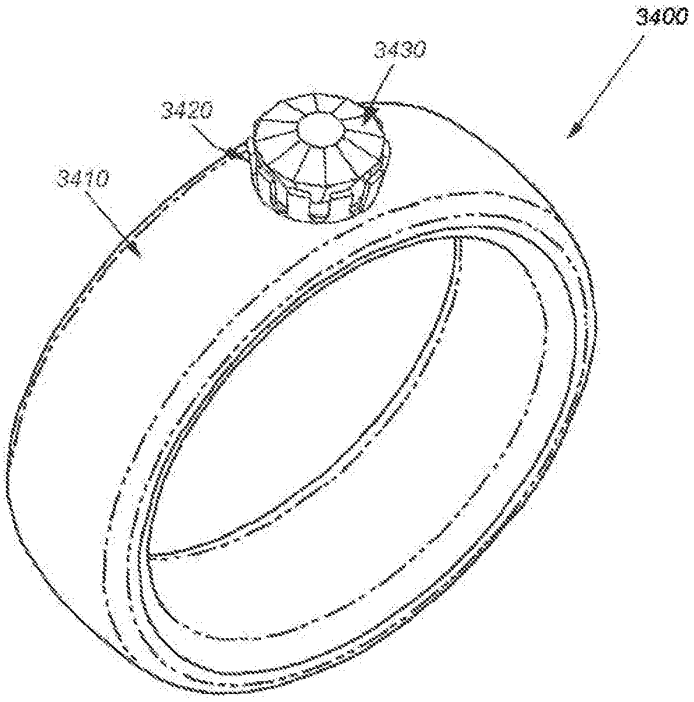


FIG. 34A

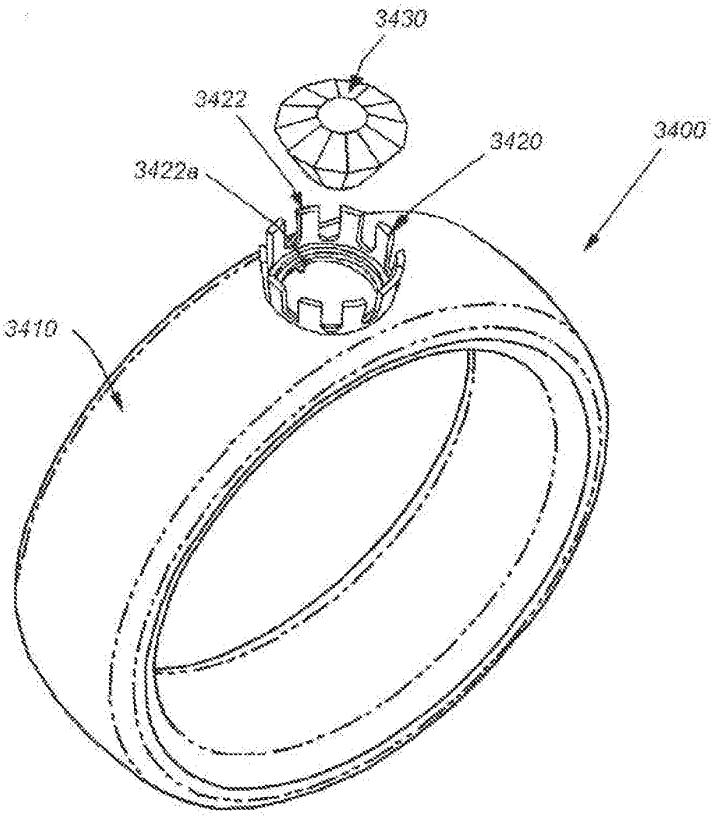


FIG. 34B

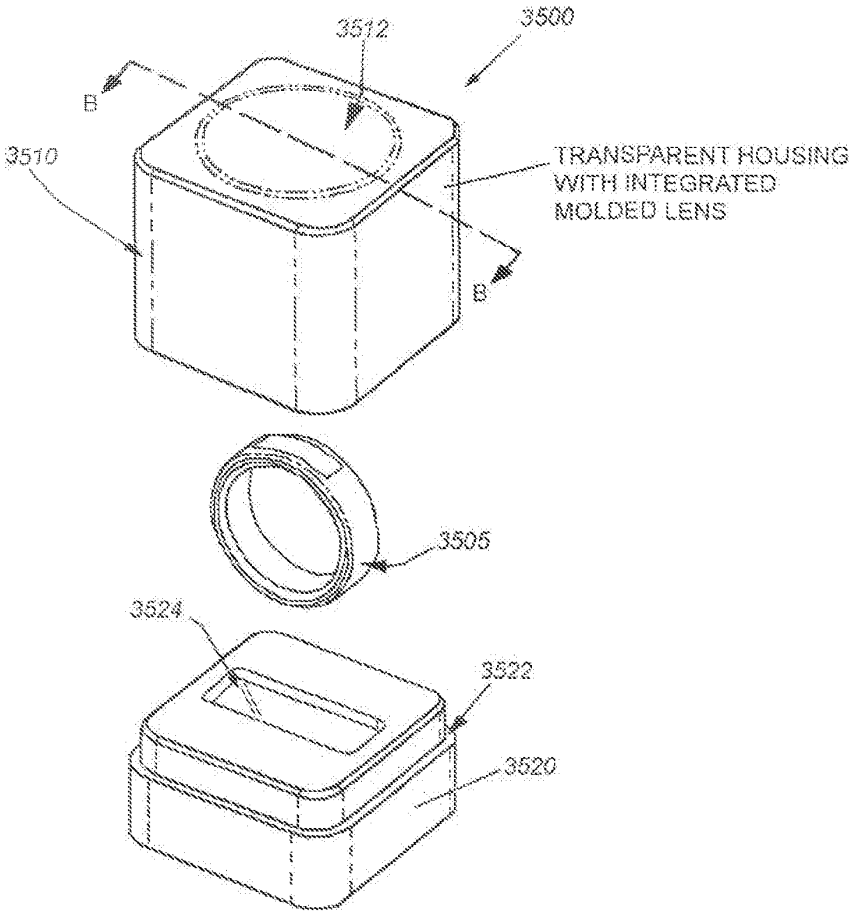

3512
3500
B
3510
TRANSPARENT HOUSING
WITH INTEGRATED
MOLDED LENS
B
3505
3524
3522
3520

FIG. 35A

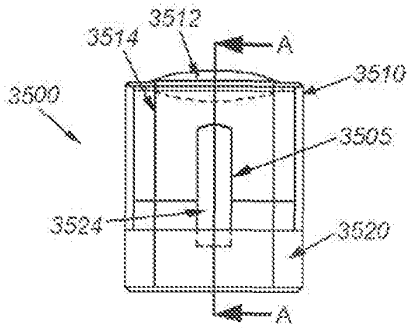


FIG. 35B

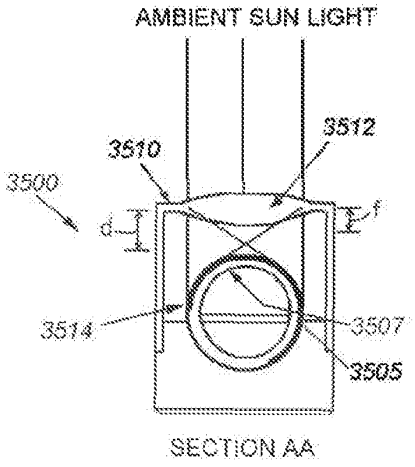


FIG. 35C

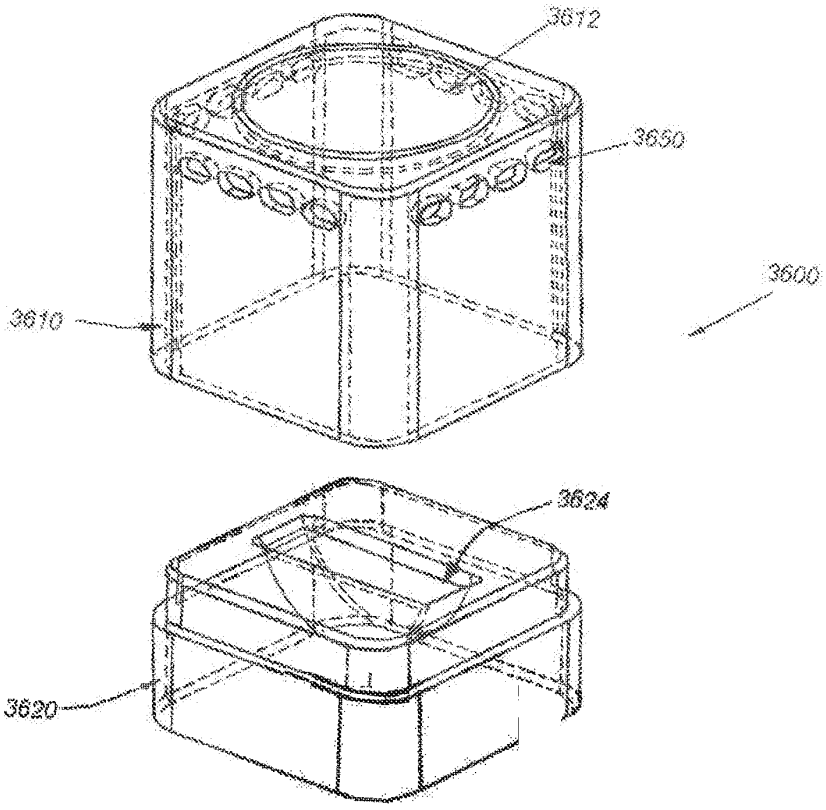


FIG. 36

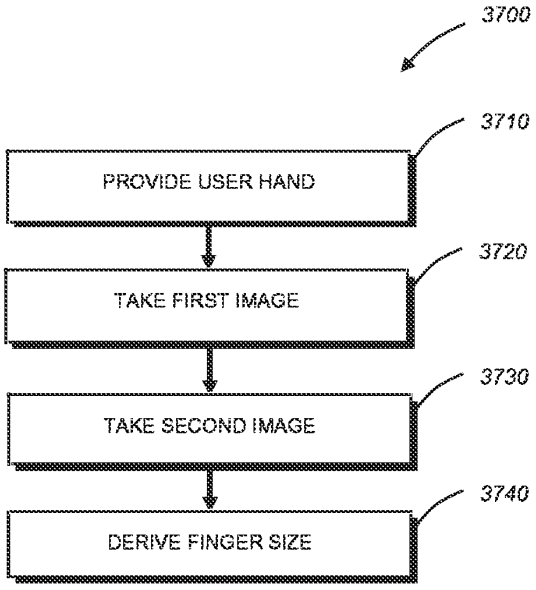

3700
3710
PROVIDE USER HAND
3720
TAKE FIRST IMAGE
3730
TAKE SECOND IMAGE
3740
DERIVE FINGER SIZE

FIG. 37

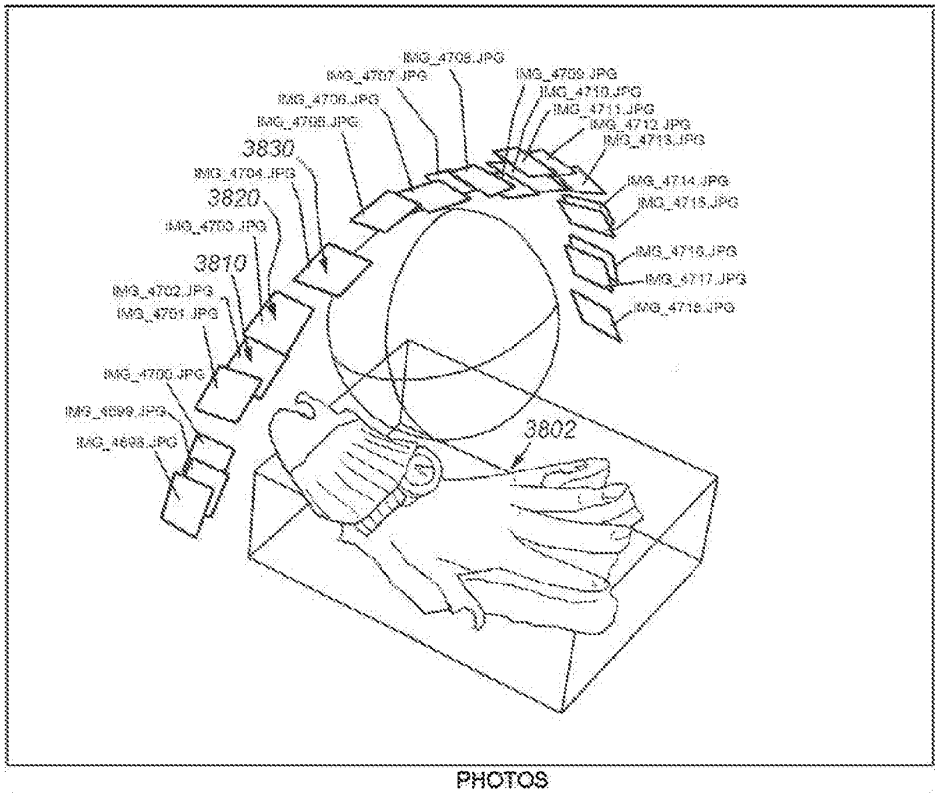

IMG_4708.JPG
IMG_4707.JPG
IMG_4709.JPG
IMG_4706.JPG
IMG_4710.JPG
IMG_4705.JPG
IMG_4711.JPG
IMG_4712.JPG
3830
IMG_4713.JPG
IMG_4704.JPG
IMG_4714.JPG
3820
IMG_4715.JPG
IMG_4703.JPG
IMG_4716.JPG
3810
IMG_4717.JPG
IMG_4702.JPG
IMG_4718.JPG
IMG_4701.JPG
IMG_4700.JPG
IMG_4699.JPG
IMG_4698.JPG
3802
PHOTOS
IMG_4702.JPG
IMG_4703.JPG
IMG_4704.JPG
IMG_4705.JPG
IMG_4706.JPG
IMG_4707.JPG
IMG_4708.JPG
3812
3822
3832

FIG. 38

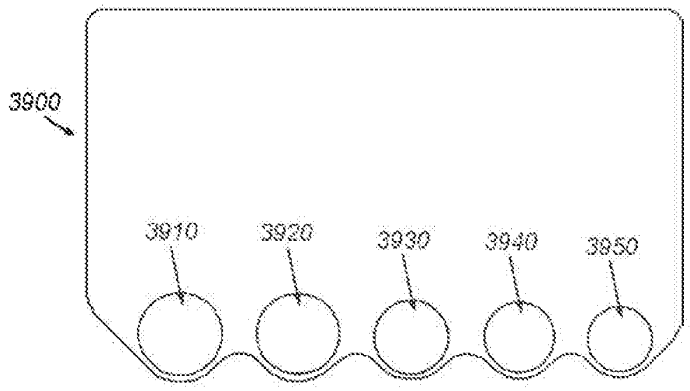


FIG. 39

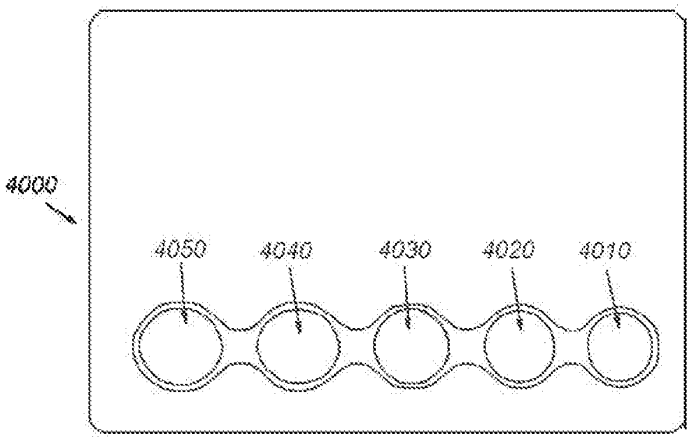


FIG. 40

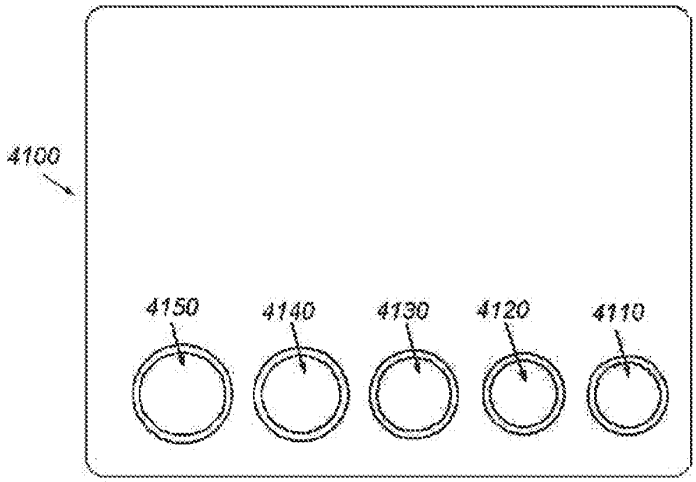


FIG. 41

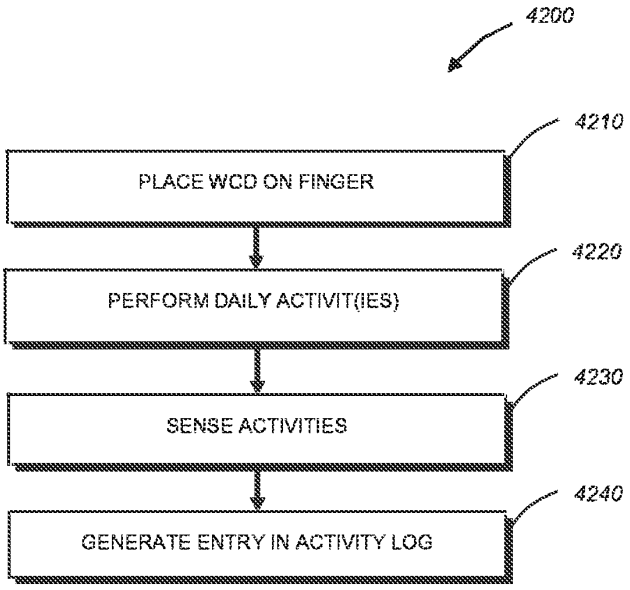

4200
4210
PLACE WCD ON FINGER
4220
PERFORM DAILY ACTIVIT(IES)
4230
SENSE ACTIVITIES
4240
GENERATE ENTRY IN ACTIVITY LOG

FIG. 42

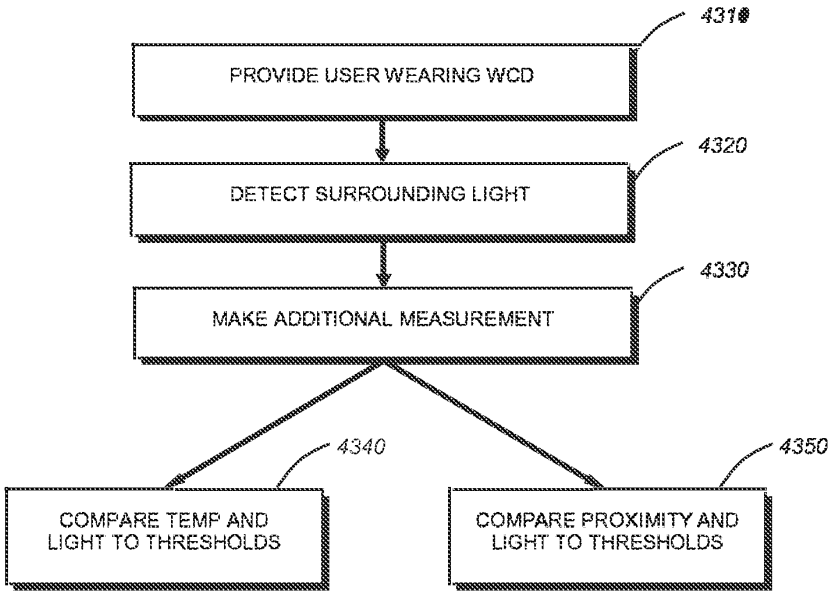

4310
PROVIDE USER WEARING WCD
4320
DETECT SURROUNDING LIGHT
4330
MAKE ADDITIONAL MEASUREMENT
4340
COMPARE TEMP AND LIGHT TO THRESHOLDS
4350
COMPARE PROXIMITY AND LIGHT TO THRESHOLDS

FIG. 43

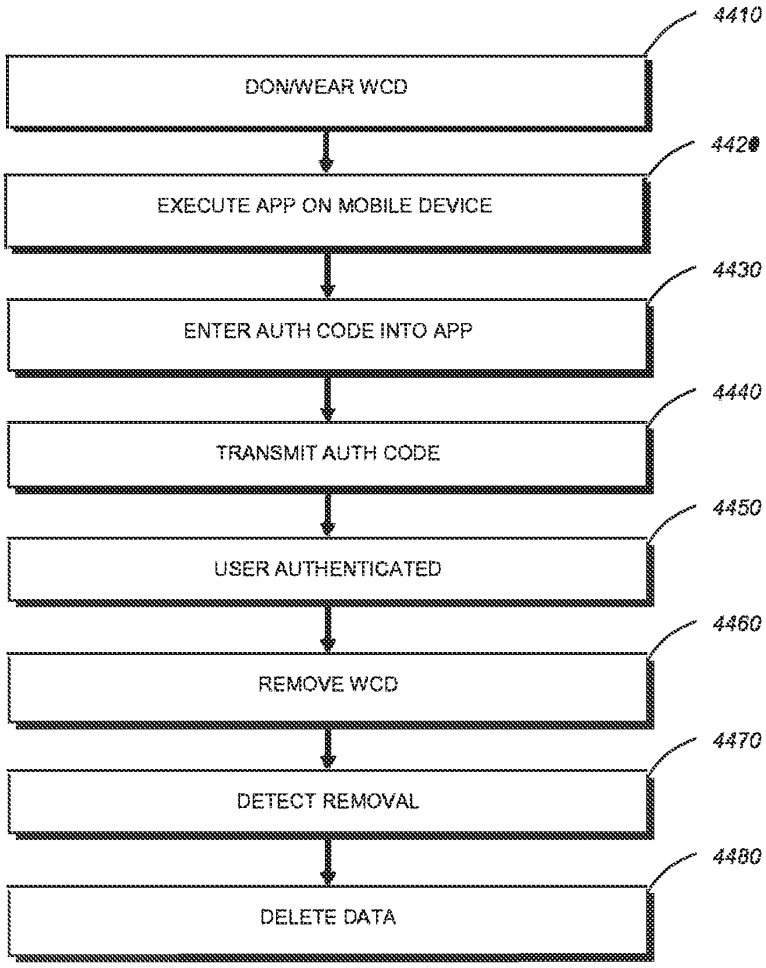

4410
DON/WEAR WCD
4420
EXECUTE APP ON MOBILE DEVICE
4430
ENTER AUTH CODE INTO APP
4440
TRANSMIT AUTH CODE
4450
USER AUTHENTICATED
4460
REMOVE WCD
4470
DETECT REMOVAL
4480
DELETE DATA

FIG. 44

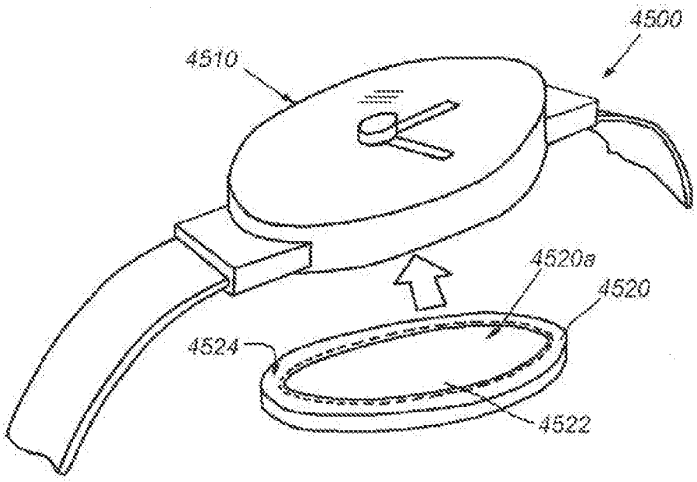


FIG. 45A

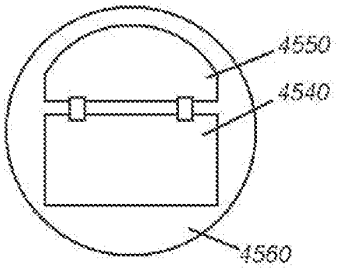


FIG. 45B

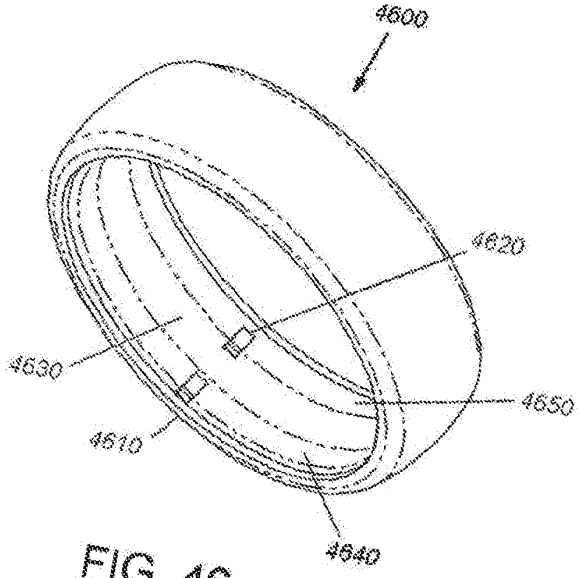


FIG. 46

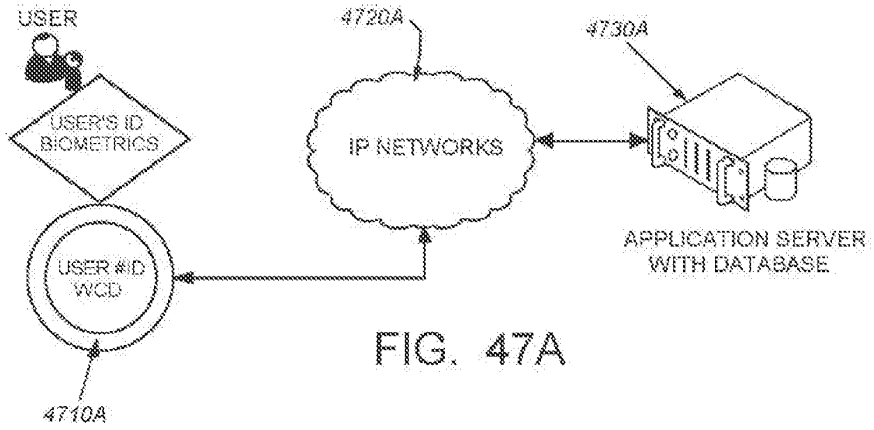


FIG. 47A

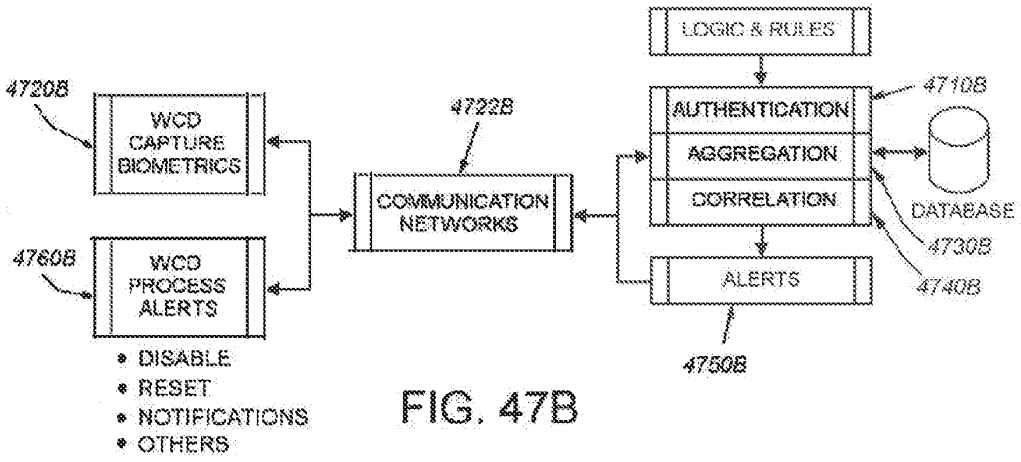


FIG. 47B

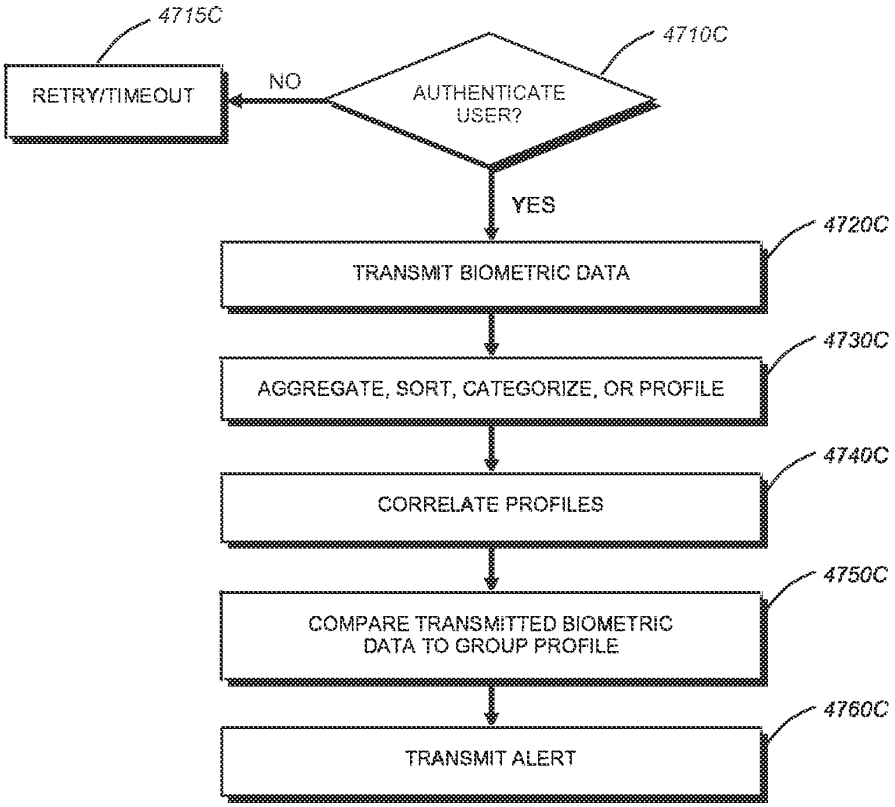

4715C
RETRY/TIMEOUT
NO
4710C
AUTHENTICATE USER?
YES
4720C
TRANSMIT BIOMETRIC DATA
4730C
AGGREGATE, SORT, CATEGORIZE, OR PROFILE
4740C
CORRELATE PROFILES
4750C
COMPARE TRANSMITTED BIOMETRIC DATA TO GROUP PROFILE
4760C
TRANSMIT ALERT

FIG. 47C

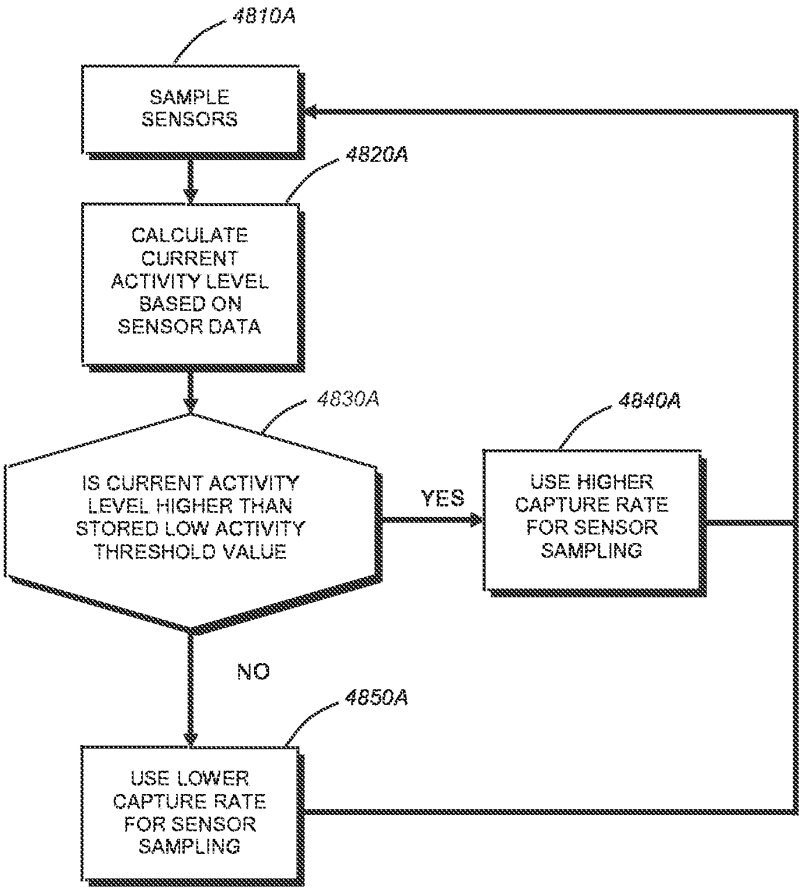

4810A
SAMPLE SENSORS
4820A
CALCULATE CURRENT ACTIVITY LEVEL BASED ON SENSOR DATA
4830A
IS CURRENT ACTIVITY LEVEL HIGHER THAN STORED LOW ACTIVITY THRESHOLD VALUE
YES
4840A
USE HIGHER CAPTURE RATE FOR SENSOR SAMPLING
NO
4850A
USE LOWER CAPTURE RATE FOR SENSOR SAMPLING

FIG. 48A

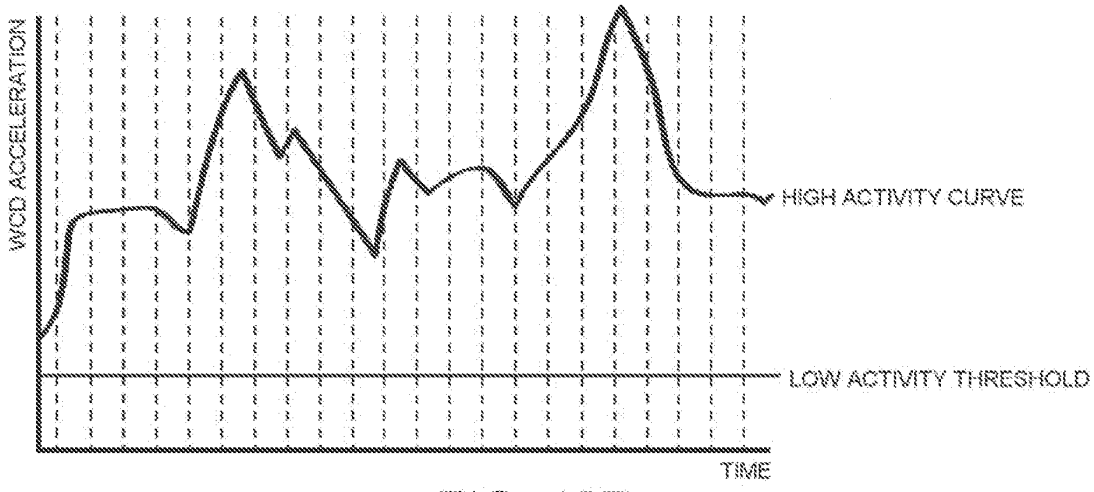


FIG. 48B

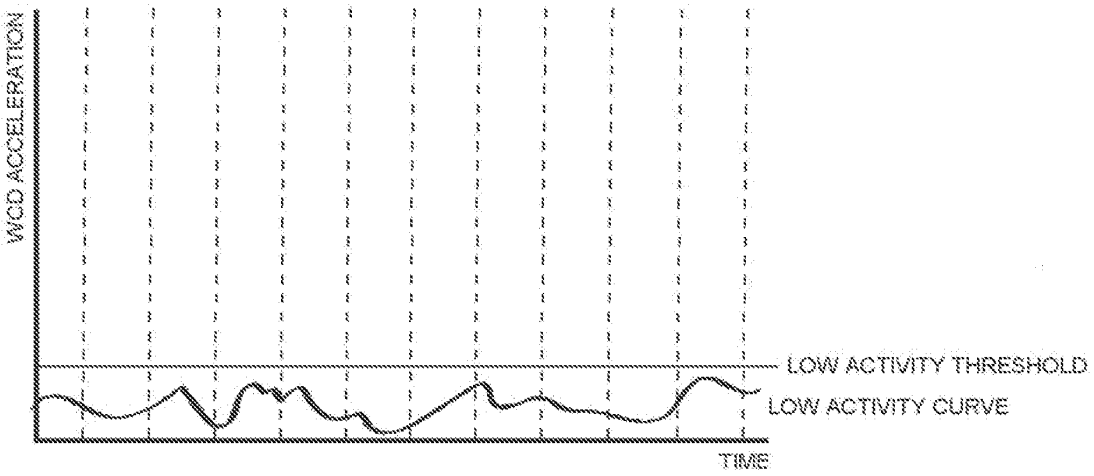


FIG. 48C

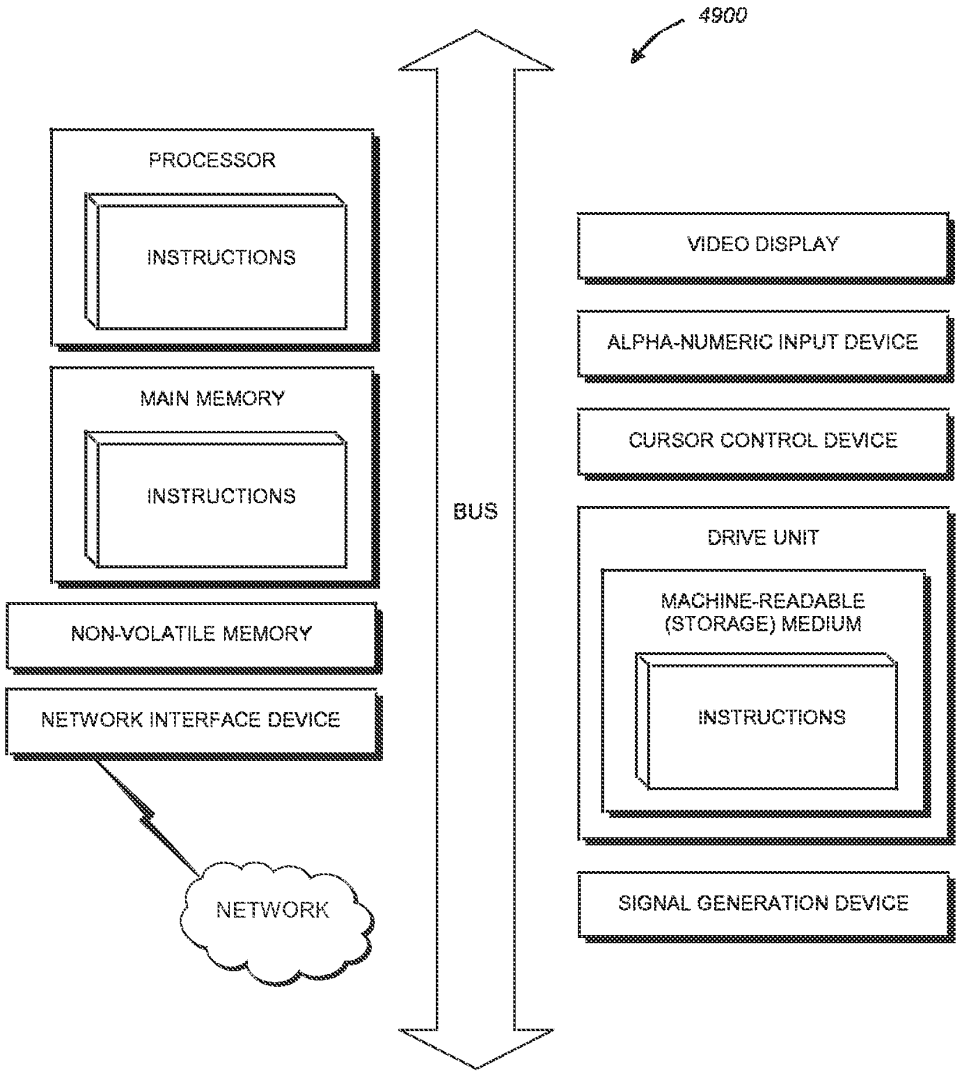

4900
PROCESSOR
INSTRUCTIONS
MAIN MEMORY
INSTRUCTIONS
NON-VOLATILE MEMORY
NETWORK INTERFACE DEVICE
NETWORK
BUS
VIDEO DISPLAY
ALPHA-NUMERIC INPUT DEVICE
CURSOR CONTROL DEVICE
DRIVE UNIT
MACHINE-READABLE (STORAGE) MEDIUM
INSTRUCTIONS
SIGNAL GENERATION DEVICE

FIG. 49

PTO/AIA/01 (06-12)
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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATIONS USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	WEARABLE COMPUTING DEVICE

As the below named inventor, I hereby declare that:

This declaration is directed to:

[ ] The attached application, or

[X] United States application or PCT international application number 14/556,062 filed on November 28, 2014.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published applications or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Curt C. von Badinski Date (Optional): 4/1/2015

Signature: Curt von Badinski

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comment on the amount of time you required to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATIONS USING AN APPLICATION DATA SHEET (37 CFR 1.76)

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LEGAL NAME OF INVENTOR

Inventor: Michael J. Strasser Date (Optional): 3/19/15

Signature:

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LEGAL NAME OF INVENTOR

Inventor: Peter Twiss Date (Optional): 3/23/2015

Signature:

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/AIA/01 form for each additional inventor.

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UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/323,385	**05/24/2023 10:06:08 PM ET**	**PM0002**

Title of Invention

WEARABLE COMPUTING DEVICE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7585	FILED BY	Jamie LaFleur
PATENT CENTER #	62149978	FILING DATE	-
CUSTOMER #	179918	FIRST NAMED INVENTOR	Mr. Curt C. von Badinski
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Nathan Mutter

Documents

TOTAL DOCUMENTS: 7

DOCUMENT		PAGES	DESCRIPTION	SIZE (KB)
PM0002_ADS.pdf		10	Application Data Sheet	2175 KB
PM0002_App.pdf		141	-	6900 KB
PM0002_App-TRACK1.REQ.pdf	(1-2)	2	Track One Request	135 KB
PM0002_App-TRNA.pdf	(3-3)	1	Transmittal of New Application	123 KB
PM0002_App-SPEC.pdf	(4-70)	67	Specification	298 KB
PM0002_App-CLM.pdf	(71-74)	4	Claims	75 KB
PM0002_App-DRW.pdf	(75-138)	64	Drawings-only black and white	5863 KB

			line drawings	
PM0002_App-OATH.pdf	(139-141)	3	Oath or Declaration filed	500 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
PM0002_ADS.pdf	B4C680A7DEF12D34431B39FAE163552685094E00051AF67DDBE241A8FC99FD1917FE3F19A2BF319AD3398AAD9C9D641ADE24F454829908EED0827117BCF66949
PM0002_App.pdf	0FFF61409C6A513F0F2913A073D91AA2C8B895357A0AC0783334D1E600503077E9C0453BF594BDCF50C6FD88F781FCE95C888523668559857 7E8BCA26835FAF7
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PM0002_App-DRW.pdf	4D871DD7C4076A659A83FF28BB200156F19F021634120E8328FD5F8CE31203E46492EB897FD2F8D7A1470861A514FEFD9DA1E50E578FA8EA720F811B6458CF13
PM0002_App-OATH.pdf	19BD5AED3FFEF0A67C50918D48AFCCA7778F48CDAA6E2D1

D47DB5AEA8A7ADD7BAAF97A44964F4D9AA82CFC147132D0C
CB1E5903BD8DFD67AFF9C371DB4F8F533

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	PM0002
	Application Number	
Title of Invention	WEARABLE COMPUTING DEVICE	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
Mr.	Curt	C.	von Badinski	

Residence Information (Select One) ● US Residency Non US Residency Active US Military Service

City	Valencia	State/Province	CA	Country of Residence	US

Mailing Address of Inventor:

Address 1	500 3rd Street #245		
Address 2			
City	San Francisco	State/Province	CA
Postal Code	94107	Country	US

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
Mr.	Michael	J.	Strasser	

Residence Information (Select One) ◉ US Residency Non US Residency Active US Military Service

City	San Francisco	State/Province	CA	Country of Residence	US

Mailing Address of Inventor:

Address 1	500 3rd Street #245		
Address 2			
City	San Francisco	State/Province	CA
Postal Code	94107	Country	US

Inventor 3 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
Mr.	Peter		Twiss	

Residence Information (Select One) ◉ US Residency Non US Residency Active US Military Service

Petitioner Samsung Ex-1004, 0143

PTO/AIA/14 (01-22)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	PM0002
	Application Number	
Title of Invention	WEARABLE COMPUTING DEVICE	

City	Lakewood	**State/Province**	CA	**Country of Residence**	US

Mailing Address of Inventor:

Address 1	500 3rd Street #245		
Address 2			
City	San Francisco	**State/Province**	CA
Postal Code	94107	**Country**	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	179918		
Email Address	patentdocket@hollandhart.com	Add Email	Remove Email
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	WEARABLE COMPUTING DEVICE		
Attorney Docket Number	PM0002	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	64	**Suggested Figure for Publication (if any)**	3B

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Petitioner Samsung Ex-1004, 0144

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	PM0002
	Application Number	
Title of Invention	WEARABLE COMPUTING DEVICE	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	● Customer Number	US Patent Practitioner	◯ Limited Recognition (37 CFR 11.9)
Customer Number	179918		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending	Remove

Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	18179272	2023-03-06

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
18179272	Continuation of	17519201	2021-11-04	11599147	2023-02-15

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
17519201	Continuation of	17013348	2020-09-04	11188124	2021-11-10

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
17013348	Continuation of	16224686	2018-12-18	10768666	2020-08-19

Petitioner Samsung Ex-1004, 0145

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	PM0002
	Application Number	
Title of Invention	WEARABLE COMPUTING DEVICE	

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16224686	Division of	15444217	2017-02-27	10156867	2018-11-28
Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15444217	Division of	14556062	2014-11-28	9582034	2017-02-08
Prior Application Status	Expired				Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
14556062	Claims benefit of provisional	62006835	2014-06-02		
Prior Application Status	Expired				Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
14556062	Claims benefit of provisional	61910201	2013-11-29		
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.					Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

			Remove
Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.			Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

Petitioner Samsung Ex-1004, 0146

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	PM0002
	Application Number	
Title of Invention	WEARABLE COMPUTING DEVICE	

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Petitioner Samsung Ex-1004, 0147

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	PM0002
	Application Number	
Title of Invention	WEARABLE COMPUTING DEVICE	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Petitioner Samsung Ex-1004, 0148

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	PM0002
	Application Number	
Title of Invention	WEARABLE COMPUTING DEVICE	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

● Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	Ouraring Inc.		
Mailing Address Information For Applicant:			
Address 1	c/o WeWork		
Address 2	415 Mission St. 37th Floor		
City	San Francisco	**State/Province**	CA
Country	US	Postal Code	94105
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Petitioner Samsung Ex-1004, 0149

PTO/AIA/14 (01-22)
Approved for use through 05/31/2024. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	PM0002
	Application Number	
Title of Invention	WEARABLE COMPUTING DEVICE	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Nathan J. Mutter/			Date (YYYY-MM-DD)	2023-05-24
First Name	Nathan	Last Name	Mutter	Registration Number	70,107

Additional Signature may be generated within this form by selecting the Add button. Add

Petitioner Samsung Ex-1004, 0150

PTO/AIA/14 (01-22)
Approved for use through 05/31/2024. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	PM0002
	Application Number	
Title of Invention	WEARABLE COMPUTING DEVICE	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Petitioner Samsung Ex-1004, 0151

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3 A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Petitioner Samsung Ex-1004, 0152

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
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ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/323,385	05/24/2023 10:06:08 PM ET	PM0002

Title of Invention

WEARABLE COMPUTING DEVICE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7585	FILED BY	Jamie LaFleur
PATENT CENTER #	62149978	AUTHORIZED BY	Nathan Mutter
CUSTOMER #	179918	FILING DATE	-
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Mr. Curt C. von Badinski

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
DA / 082623	E20235NM07099346	Jamie LaFleur

PRE-AUTHORIZED ACCOUNT	PRE-AUTHORIZED CATEGORY
082623	37 CFR 1.16 (National application filing, search, and examination fees); 37 CFR 1.17 (Patent application and reexamination processing fees); 37 CFR 1.19 (Document supply fees); 37 CFR 1.20 (Post Issuance fees); 37 CFR 1.21 (Miscellaneous fees and charges)

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
2081	UTILITY APPL. SIZE FEE > THAN 100 PAGES (FEE X PAGES >= 101 IN 50 PAGE INCREMENTS)	168.00	1	168.00
2817	REQUEST FOR PRIORITIZED EXAMINATION	1680.00	1	1680.00
2111	UTILITY PATENT APPL. SEARCH FEE	280.00	1	280.00
4011	BASIC FILING FEE- UTILITY	64.00	1	64.00

2311	EXAMINATION OF ORIGINAL PATENT APPLICATION	320.00	1	320.00

TOTAL AMOUNT: **$2,512.00**

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc Code: TRACK1.REQ
Document Description: TrackOne Request

PTO/AIA/424 (04-14)

CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e) (Page 1 of 1)

First Named Inventor:	von Badinski et al.	Nonprovisional Application Number (if known):	
Title of Invention:	WEARABLE COMPUTING DEVICE		

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently $0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.

2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.

3. The applicable box is checked below:

I. ☑ Original Application (Track One) - Prioritized Examination under § 1.102(e)(1)

i. (a) The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a). This certification and request is being filed with the utility application via EFS-Web.

---OR---

(b) The application is an original nonprovisional plant application filed under 35 U.S.C. 111(a). This certification and request is being filed with the plant application in paper.

ii. An executed inventor's oath or declaration under 37 CFR 1.63 or 37 CFR 1.64 for each inventor, **or** the application data sheet meeting the conditions specified in 37 CFR 1.53(f)(3)(i) is filed with the application.

II. ☐ Request for Continued Examination - Prioritized Examination under § 1.102(e)(2)

i. A request for continued examination has been filed with, or prior to, this form.
ii. If the application is a utility application, this certification and request is being filed via EFS-Web.
iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C. 371.
iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

Signature /Nathan J. Mutter/	Date 2023-05-24
Name (Print/Typed) Nathan J. Mutter	Practitioner Registration Number 70,107

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required.**

☐ *Total of _____ forms are submitted.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
18/323,385	05/24/2023		832	PM0002	18	1

CONFIRMATION NO. 7585

179918
Holland & Hart LLP/Oura Health Oy
P.O. Box 11583
Salt Lake City, UT 84147

FILING RECEIPT

OC000000058244764

Date Mailed: 06/15/2023

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Curt C. von Badinski, Valencia, CA;
Michael J. Strasser, San Francisco, CA;
Peter Twiss, Lakewood, CA;

Applicant(s)

Ouraring Inc., San Francisco, CA;

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 18/179,272 03/06/2023
which is a CON of 17/519,201 11/04/2021 PAT 11,599,147
which is a CON of 17/013,348 09/04/2020 PAT 11,188,124
which is a CON of 16/224,686 12/18/2018 PAT 10,768,666
which is a DIV of 15/444,217 02/27/2017 PAT 10,156,867
which is a DIV of 14/556,062 11/28/2014 PAT 9,582,034
which claims benefit of 62/006,835 06/02/2014
and claims benefit of 61/910,201 11/29/2013

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Petitioner Samsung Ex-1004, 0157

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 06/13/2023

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 18/323,385**

Projected Publication Date: To Be Determined - pending completion of Corrected Papers.

Non-Publication Request: No

Early Publication Request: No
**** SMALL ENTITY ****
Title

WEARABLE COMPUTING DEVICE

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

Petitioner Samsung Ex-1004, 0158

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor

Petitioner Samsung Ex-1004, 0159

community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

Petitioner Samsung Ex-1004, 0160

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 18/323,385

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	64		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	280		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	320		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	18 minus 20 =	* 0	x =	0	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*	x =	0			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			168			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	832		TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
18/323,385	05/24/2023	Curt C. von Badinski	PM0002

CONFIRMATION NO. 7585

179918
Holland & Hart LLP/Oura Health Oy
P.O. Box 11583
Salt Lake City, UT 84147

FORMALITIES LETTER

OC000000058244766

Date Mailed: 06/15/2023

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

An application number and filing date have been accorded to the above-identified nonprovisional application. The application is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- **Drawing Items**

  The drawings submitted on 05/24/2023 are not acceptable because:

  - More than one figure is present and at least one figure appears to be unnumbered or misnumbered in comparison to the brief description of the figures contained in the specification. See Figure(s) 15C. The figures must be labeled "Fig." with a consecutive Arabic numeral (1, 2, etc.) or an Arabic numeral and capital letter in the English alphabet (1A, 1B, etc.) and correspond with a brief description having the same figure number. See 37 CFR 1.84(u)(1).
    - To correct the figure numbering, replacement drawing sheets with proper figure labeling in compliance with 37 CFR 1.84 and 1.121(d) are required.
    - To add a brief description of a figure that was not previously numbered, or correct the reference in the specification to the figures, a proper substitute specification in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125, providing a brief description of each drawing figure presented, added or amended to correspond to the corrected numbering of the figures, is required. See also 37 CFR 1.77(b)(9).
  - The application contains a section in the specification containing the brief description of the figures, but is missing the description of Figure(s) **26D** as required by 37 CFR 1.74 and 37 CFR 1.77(b)(9). A proper substitute specification in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125, providing a brief description of each drawing figure presented, is required to satisfy this requirement.
  - Note: 37 CFR 1.84(u)(1) requires that each figure must be labeled with "Fig." with a consecutive Arabic numeral (1, 2, etc.) or an Arabic numeral and capital letter in the English alphabet (1A, 1B, etc.). Therefore, the substitute specification must refer to each of the properly labeled figure(s) in the brief description. Also, if applicant wishes to delete the undescribed figure, replacement drawing sheets with proper figure labeling in compliance with 37 CFR 1.84 and 1.121(d) are required.

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

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REPLY VIA ELECTRONIC FILING

A reply may be submitted via electronic filing only by registered users of the appropriate USPTO patent electronic filing system and must include:

- A separate document having the document description, "**Applicant response to Pre-Exam Formalities Notice**"; and
- the item(s) for which a reply period is set forth above.

For more information about electronic filing, contact the Patent Electronic Business Center (EBC) 1-866-217-9197 or visit https://www.uspto.gov/ebc

NOTE: If the reply is not being submitted electronically, a copy of this notice must be included.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/mgabre/

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:	Confirmation No.: 7585
von Badinski	Examiner: TBD
For: WEARABLE COMPUTING DEVICE	Art Unit: TBD
Application No.: 18/323,385	**RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS**
Filed: May 24, 2023	**CERTIFICATE OF TRANSMISSION** I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on: July 19, 2023.
Docket No.: PM001.01.03.01.01.01.01.02	By: / Jamie LaFleur / Jamie LaFleur
Customer No.: 179918	

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Commissioner:

In the Notice to File Corrected Application Papers ("Notice") dated June 15, 2023, it was noted that there were inconsistencies between the as-filed drawings and the drawings listed in the Brief Description of the Drawings section of the as-filed application. Attached herewith is a replacement specification that includes a revised Brief Description of the Drawings section to address these inconsistencies.

The Commissioner is authorized to charge any fees or underpayments that may be due with this response, or credit any overpayments, to Deposit Account No. 08-2623.

If the Examiner believes a telephone conference would expedite prosecution of this

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Application, please call the undersigned at 303-473-2700.

Respectfully submitted,

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WEARABLE COMPUTING DEVICE

CROSS REFERENCE

[0001] The present Application for Patent is a Continuation of U.S. Patent Application No. 18/179,272, by von Badinski et al., entitled "WEARABLE COMPUTING DEVICE," filed March 6, 2023, which is a Continuation of U.S. Patent Application No. 17/519,201, by von Badinski et al., entitled "WEARABLE COMPUTING DEVICE," filed November 4, 2021, which is a Continuation of U.S. Patent Application No. 17/013,348, by von Badinski et al., entitled "WEARABLE COMPUTING DEVICE," filed September 4, 2020, which is a Continuation of U.S. Patent Application No. 16/224,686, by von Badinski et al, entitled "WEARABLE COMPUTING DEVICE," filed December 18, 2018, which is a Division of U.S. Patent Application No. 15/444,217, by von Badinski et al., entitled "WEARABLE COMPUTING DEVICE," filed February 27, 2017, which is a Division of U.S. Patent Application No. 14/556,062, by von Badinski et al, entitled "WEARABLE COMPUTING DEVICE," filed November 28, 2014, which claims the benefit of United States Provisional Application Serial No. 62/006,835, by von Badinski et al., entitled "WEARABLE COMPUTING DEVICE," filed June 2, 2014, and United States Provisional Application Serial No. 61/910,201, by von Badinski et al., entitled "FINGER RING DEVICE FOR ACTIVITY MONITORING OR GESTURAL INPUT," filed November 29, 2013, each of which is expressly incorporated by reference herein.

FIELD OF TECHNOLOGY

[0002] This invention is in the field of wearable electronic devices.

BACKGROUND

[0003] Wearable electronics are an emerging technology with many applications for the wearer. They can improve lifestyles, ease access to technology and help monitor activity within the wearer's body. However, many current wearable electronics are bulky and can be intrusive or interfere with a person's daily life. In this regard, the wearer may not be comfortable wearing the device for extended periods of time.

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SUMMARY OF THE INVENTION

[0004] This invention overcomes the disadvantages of the prior art by providing a wearable computing device (WCD) in the shape of a ring. The wearable computing device can be worn for extended periods of time and can take many measurements and perform various functions because of its form factor and position on the finger of a user.

[0005] One aspect of the disclosure provides a wearable computing device, comprising: an interior wall; an exterior wall; a flexible printed circuit board disposed between the interior wall and the exterior wall; at least one component disposed on the flexible printed circuit board; and wherein at least one of the interior wall and the exterior wall defines a window that facilitates at least one of data transmission, battery recharge, and status indication.

[0006] In one example, the window comprises an internal window defined by the interior wall.

[0007] In one example, the window comprises an exterior window defined by the exterior wall.

[0008] In one example, the window comprises a plurality of exterior windows defined by the exterior wall.

[0009] In one example, the plurality of exterior windows comprises a first exterior window and a second exterior window, wherein the first exterior window facilities battery charging and the second exterior window facilities data transmission.

[0010] In one example, at least one concentrated photovoltaic cell, an antenna, and at least one LED are accessible via the window.

[0011] Another aspect of the disclosure provides a wearable computing device, comprising: an internal housing portion configured to be disposed near a finger of a user; a flexible printed circuit board arranged around a portion of a circumference of an interior surface of the internal housing; at least one component disposed on the flexible printed circuit board; and an external housing portion configured to seal the at least one component and the printed circuit board in an internal space defined by the interior surface of the internal housing.

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[0012] In one example, the external housing portion comprises a substantially transparent external potting.

[0013] In one example, the at least one component comprises at least one LED configured to emit at least one of visible light, infrared radiation, and ultraviolet radiation through the external potting.

[0014] In one example, the at least one component comprises a concentrated photovoltaic cell configured to receive concentrated light through the transparent external potting.

[0015] In one example, the flexible printed circuit board includes a plurality of stiffener elements configured to engage with a corresponding plurality of flanges disposed on the internal housing portion.

[0016] Another aspect of the disclosure provides a wearable computing device, comprising: an external housing portion; a flexible printed circuit board arranged around a portion of a circumference of an interior surface of the external housing; at least one component disposed on the flexible printed circuit board; and an internal housing portion configured to seal the at least one component and the printed circuit board in an internal space defined by the interior surface of the external housing.

[0017] In one example, the internal housing portion comprises a substantially transparent internal potting.

[0018] In one example, the at least one component comprises at least one LED configured to emit at least one of visible light, infrared radiation, and ultraviolet radiation through the internal potting.

[0019] In one example, the at least one component comprises a concentrated photovoltaic cell configured to receive concentrated light through the transparent internal potting.

[0020] In one example, the flexible printed circuit board includes a plurality of stiffener elements configured to engage with a corresponding plurality of flanges disposed on the external housing portion.

[0021] Another aspect of the disclosure provides a system, comprising: a wearable computing device, including a housing and a photovoltaic element disposed at least

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partially within the housing; and a base assembly, the base assembly including a concentrated light source directed at the photovoltaic element.

[0022] In one example, the wearable computing device includes at least one ferrous element disposed within the housing, and wherein the base assembly includes at least one magnetic element disposed therein.

[0023] In one example, the concentrated light source is arranged circumferentially around the wearable computing device when the wearable computing device is engaged with the base assembly.

[0024] In one example, the concentrated light source comprises at least one of a laser diode and a light emitting diode (LED).

[0025] In one example, a housing of the WCD defines an opening through which the WCD is configured to receive concentrated light.

[0026] In one example, the base assembly comprises an optical element for focusing concentrated light emitted from the concentrated light source.

[0027] In one example, the optical element comprises a lens and is selected from the group consisting of concave, convex, piano-concave, piano-convex.

[0028] In one example, the WCD comprises at least one transparent potting configured to allow concentrated light to pass therethrough.

[0029] In one example, the WCD is ring-shaped and the base assembly comprises at least one post configured to engaged with a finger space of the WCD.

[0030] In one example, the photovoltaic cell comprises a plurality of photovoltaic cells.

[0031] Another aspect of the disclosure provides an enclosure for a wearable computing device, the enclosure comprising: a base defining a receptacle for receiving the wearable computing; a lid configured to engage with the base to substantially enclose the wearable computing device, the lid having an optical element configured to direct incident electromagnetic radiation to photovoltaic cell disposed on the wearable computing device to allow charging thereof.

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[0032] In one example, the lid includes a plurality of vent holes that prevent overheating within the enclosure.

[0033] In one example, the optical element comprises a lens.

[0034] In one example, the lens has a focal length and wherein a distance between a central portion of the lens and the photovoltaic cell is greater than or less than the focal length.

[0035] Another aspect of the disclosure provides a timepiece system, comprising: a timepiece having a substantially planar under surface; and a timepiece computing device adhered to the planar under surface, the timepiece computing device being substantially cylindrical and comprising: a processor; a memory; and at least one sensor.

[0036] Another aspect of the disclosure provides a wearable computing device system, comprising: a wearable computing device; an attachment frame coupled to the wearable computing device; and an optical element removably coupled to the attachment frame, wherein the optical element is configured to direct electromagnetic radiation to a photovoltaic cell disposed on a surface of the wearable computing device to allow for charging of the wearable computing device.

[0037] In one example, the attachment frame is removably coupled to the wearable computing device.

[0038] In one example, the attachment frame engages with an inward-facing surface of the wearable computing device.

[0039] Another aspect of the disclosure provides a method of identifying an authorized user of a wearable computing device, comprising: illuminating a portion of a skin surface of the user; imaging the portion of the skin surface of the user to generate at least one first image; generating a reference capillary map corresponding to the user based at least in part on the at least one image.

[0040] In one example, the method further includes rotating the wearable computing device during the illuminating and imaging steps.

[0041] In one example, the method further includes imaging the portion of the skin surface of the user to generate at least one second image; and comparing the at least one second image to the reference capillary map in order to authenticate the user.

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[0042] Another aspect of the disclosure provides a method of navigating, comprising: gesturing in a first direction while wearing a wearable computing device; comparing the first direction to a predetermined direction in a predetermined set of directions; providing feedback based on the comparison of the first direction of the predetermined direction.

[0043] In one example, the gesture comprises pointing a finger and the first direction comprises a first heading.

[0044] Another aspect of the disclosure provides a method of regulating temperature, comprising: measuring a skin temperature of a user via a first temperature sensor; measuring an ambient temperature via a second temperature sensor; comparing the skin temperature to a predetermined threshold temperature; and adjusting the ambient temperature based in part on the comparison.

[0045] In one example, measuring the skin temperature comprises measuring the skin temperature via a first temperature sensor disposed at an inward facing surface of a wearable computing device.

[0046] In one example, measuring the ambient temperature comprises measuring the ambient temperature via a second temperature sensor disposed at an outward facing surface of the wearable computing device.

[0047] Another aspect of the disclosure provides a method for controlling appliances, comprising: identifying a position of a first appliance in a room; gesturing a first gesture in a direction of the first appliance; identifying the direction of the first direction via a wearable computing device; issuing a controlling command to the first appliance based in part on the identified direction of the gesture.

[0048] Another aspect of the disclosure provides a method of generating an alert, comprising: authenticating a first wearer of a first wearable computing device as a first authenticated user; transmitting first biometric data associated with the first wearer; associating the first biometric data with a first profile associated with the first wearer of the first wearable computing device; comparing the first biometric data with a group profile comprising aggregated biometric data from a plurality of distinct wearers of a plurality of distinct wearable computing devices; and generating an alert if the first

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biometric data falls outside of a predetermined threshold set by the aggregated biometric data.

[0049] In one example, the biometric data comprises at least one of heart rate; ECG profile; blood sugar, and blood pressure.

[0050] In one example, the plurality of distinct wearers share a common trait, resulting in their aggregation into the group profile.

[0051] In one example, the common trait comprises at least one of: age, gender, profession, and location.

[0052] Another aspect of the disclosure provides a method of determine a sampling rate of a wearable computing device, comprising: determining an activity level of a wearer of a wearable computing device based at least in part on data from at least one sensor disposed onboard the wearable computing device; comparing the activity level to a predetermined activity threshold; and increasing a first sensor sampling rate if the activity level is above a predetermined activity threshold.

[0053] In one example, the method further includes decreasing the first sensor sampling rate if the activity level is below a predetermined activity threshold.

[0054] In one example, the predetermined activity threshold comprises an acceleration measurement.

BRIEF DESCRIPTION OF THE DRAWINGS

[0055] The invention description below refers to the accompanying drawings, of which:

[0056] FIG. 1A is a perspective view of a WCD illustrating an exterior window in accordance with some embodiments;

[0057] FIG. 1B is a perspective view of the WCD of FIG. IA illustrating an interior window in accordance with some embodiments;

[0058] FIG. 1C is a perspective view of an alternative WCD design of the ring of FIG. IA in accordance with some embodiments;

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[0059] FIG. 2 is an abstract functional diagram illustrating example components within the WCD in accordance with some embodiments;

[0060] FIG. 3A is a view of an exterior window of a WCD with example components exposed in accordance with some embodiments;

[0061] FIG. 3B is a view of an interior window of a WCD with example components exposed in accordance with some embodiments;

[0062] FIG. 3C is a view of the exterior windows of an alternative WCD with example components exposed in accordance with some embodiments;

[0063] FIG. 4 is an exploded view of a WCD illustrating a battery and a flexible circuit which are configured to fit inside the housing of the WCD in accordance with some embodiments;

[0064] FIG. 5 is a perspective view of the flexible circuit of FIG. 4 in accordance with some embodiments;

[0065] FIG. 6 is an exploded view of a WCD with an alternative charging mechanism in accordance with some embodiments;

[0066] FIG. 7 is a perspective view of an alternative design of a WCD in accordance with some embodiments;

[0067] FIG. 8 is an exploded view of the WCD of FIG. 7 illustrating another alternative charging mechanism in accordance with some embodiments;

[0068] FIG. 9A is a perspective view of a charging device for the ring station in accordance with some embodiments;

[0069] FIG. 9B is an abstract diagram illustrating a partial structure of the charging station of FIG. 9A in accordance with some embodiments;

[0070] FIG. 10 is an example screenshot illustrating a user interface of a mobile application coupled to the WCD and displaying fitness monitoring readings in accordance with some embodiments;

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[0071] FIG. 11 is an example screenshot illustrating a user interface of a mobile application coupled to the WCD and displaying sensor readings (e.g., for calibration purposes) in accordance with some embodiments;

[0072] FIG. 12A is a perspective view of a wearable computing device (WCD) according to one or more aspects of the disclosure;

[0073] FIG. 12B is a side view of a WCD according to one or more aspects of the disclosure;

[0074] FIG. 12C is a front view of the WCD according to one or more aspects of the disclosure;

[0075] FIG. 12D is a cross section of the WCD along the line A-A of FIG. 12C;

[0076] FIG. 12E is a perspective view of the internal housing without external potting;

[0077] FIG. 12F is a perspective view of the internal housing with a portion of the external potting removed and showing one or more components and printed circuit board (PCB);

[0078] FIG. 13 is a cross section of a WCD according to another aspect of the disclosure;

[0079] FIG. 14A is a cross section of a WCD according to another aspect of the disclosure;

[0080] FIG. 14B is a perspective view of the PCB and stiffener element of FIG. 14A;

[0081] FIG. 14C is a perspective view of the PCB and stiffener element of FIG. 14A;

[0082] FIG. 14D shows a cross section of the WCD at a point in time when the PCB is being inserted into the internal space and prior to the application of potting;

[0083] FIG. 14E is a cross section of the WCD of after a potting material has been applied subsequent to the WCD of FIG. 14D;

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[0084] FIG. 15A depicts a perspective view of a WCD according to another aspect of the disclosure;

[0085] FIG. 15B is a side view of the WCD of FIG. 15A;

~~**[0086] FIG. 15C is an exploded view of the WCD;**~~

~~**[0087]**~~ **[0086]** FIG. 16A is an exploded view of a housing and a PCB of a WCD according to one or more aspects of the disclosure;

~~**[0088]**~~ **[0087]** FIG. 16B is a cross section of FIG. 16A along line B-B;

~~**[0089]**~~ **[0088]** FIG. 16C is a perspective view of the WCD with potting material;

~~**[0090]**~~ **[0089]** FIG. 17A depicts a cross section of a WCD employing charging by concentrated light source according to one or more aspects of the disclosure;

~~**[0091]**~~ **[0090]** FIG. 17B depicts a cross section of a WCD employing charging by concentrated light source according to another aspect of the disclosure;

~~**[0092]**~~ **[0091]** FIG. 17C is a perspective view of a base assembly and WCD 700 according to one or more aspects of the disclosure;

~~**[0093]**~~ **[0092]** FIG. 17D depicts a perspective view of internal components of the base assembly 750 and WCD 700 according to another aspect of the disclosure;

~~**[0094]**~~ **[0093]** FIGs. 17E-F depict other CPV configurations according to one or more aspects of the disclosure;

~~**[0095]**~~ **[0094]** FIG. 17G is perspective view of a WCD and base assembly with a lx3 CPV arrangement;

~~**[0096]**~~ **[0095]** FIG. 18A depicts a cross section of a WCD 800 employing charging by concentrated light source according to another of the disclosure;

~~**[0097]**~~ **[0096]** FIG. 18B depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure;

~~**[0098]**~~ **[0097]** FIG. 19A depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure;

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~~[0099]~~ **[0098]** FIG. 19B depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure;

~~[0100]~~ **[0099]** FIG. 19C depicts a schematic diagram of magnets that can be used in a WCD and/or base assembly according to one or more aspects of the disclosure;

~~[0101]~~ **[0100]** FIG. 19D depicts a schematic diagram of magnets that can be used in a WCD and/or base assembly according to one or more aspects of the disclosure;

~~[0102]~~ **[0101]** FIG. 19E is a perspective view of a WCD and a base assembly according to one or more aspects of the disclosure;

~~[0103]~~ **[0102]** FIG. 20A is a cross section of a WCD engaged with a base assembly 1050 according to one or more aspects of the disclosure;

~~[0104]~~ **[0103]** FIG. 20B is a perspective view of a PCB 1040b with a CPV 1030b and ferrous element 1020b configuration according to one or more aspects of the disclosure;

~~[0105]~~ **[0104]** FIG. 20C is a perspective view of a PCB with a CPV 1030c and ferrous element 1020c configuration according to one or more aspects of the disclosure;

~~[0106]~~ **[0105]** FIG. 20D is a perspective view of a magnet and a concentrated light source 1070d according to one or more aspects of the disclosure;

~~[0107]~~ **[0106]** FIG. 21A is a schematic view of a WCD showing components used for identifying the wearer of the WCD;

~~[0108]~~ **[0107]** FIGs. 21B-C are perspective views of a skin surface according to one or more aspects of the disclosure;

~~[0109]~~ **[0108]** FIG. 22A is a perspective view of a user employing ECG monitoring according to one or more aspects of the disclosure;

~~[0110]~~ **[0109]** FIG. 22B is a view of a human with an electric pathway though his body according to one or more aspects of the disclosure;

~~[0111]~~ **[0110]** FIG. 22C is a perspective view of a WCD that can employ ECG monitoring according to one aspect of the disclosure;

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~~[0112]~~ **[0111]** FIG. 23A is a perspective view of the hand of a user in various positions employing the navigational features of the WCD;

~~[0113]~~ **[0112]** FIG. 23B is a flow chart depicting a method of providing feedback to a user according to one or more aspects of the disclosure;

~~[0114]~~ **[0113]** FIG. 24A is a schematic diagram of a system 1400 for controlling an environment of a user according to one or more aspects of the disclosure;

~~[0115]~~ **[0114]** FIG. 24B is a side view of a WCD showing one or more temperatures sensors according to one or more aspects of the disclosure;

~~[0116]~~ **[0115]** FIG. 24C is a system diagram of a system for controlling home appliances according to one or more aspects of the disclosure;

~~[0117]~~ **[0116]** FIG. 24D is a flow chart depicting a method of controlling home appliances according to one or more aspects of the disclosure;

~~[0118]~~ **[0117]** FIG. 25 is a perspective view of the hand of a user employing a two-factor authentication technique according to one or more aspects of the disclosure;

~~[0119]~~ **[0118]** FIG. 26A is a schematic view of a charging apparatus for charging the WCD according to one or more aspects of the disclosure;

~~[0120]~~ **[0119]** FIG. 26B shows a WCD including an RF antenna and charging circuitry;

~~[0121]~~ **[0120]** FIG. 26C is a block diagram of the charging apparatus according to one aspect of the disclosure;

[0121] **FIG. 26D is a pictorial diagram showing the WCD according to one or more aspects of the disclosure;**

[0122] FIG. 27A is a pictorial diagram and FIG. 27B is a block diagram of a WCD employing flash storage according to one or more aspects of the disclosure;

[0123] FIG. 28A is a schematic diagram of one or more WCDs performing proximity functions according to one or more aspects of the disclosure;

[0124] FIG. 28B is a schematic diagram of one or more WCDs performing proximity functions according to one or more aspects of the disclosure;

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[0125] FIG. 29A is a flow chart depicting a method of initiating gesture input according to one or more aspects of the disclosure;

[0126] FIG. 29B is a chart showing acceleration vs. time as measured by the accelerometer of the WCD;

[0127] FIG. 30 is a perspective view of a WCD 2000 employing a reset function;

[0128] FIG. 31A is a perspective view of a WCD including an LED indicator according to one or more aspects of the disclosure;

[0129] FIGs. 31B and 31C are cross sections along line C-C of a WCD employing an LED indicator according to one or more aspects of the disclosure;

[0130] FIG. 32 is flow chart depicting a method of communicating with a near field communication (NFC) device according to one or more aspects of the disclosure;

[0131] FIG. 33A depicts a perspective view of a WCD assembly according to one or more aspects of the disclosure;

[0132] FIGs. 33B-D depict exploded views of the WCD assembly of FIG. 33A;

[0133] FIG. 33E depicts a cross sectional view of the WCD assembly along A-A;

[0134] FIGs. 34A-B depict a WCD assembly according to one or more aspects of the disclosure;

[0135] FIG. 35A depicts an enclosure or case for storing a WCD according to one or more aspects of the disclosure;

[0136] FIG. 35B is a cross sectional view of the assembled enclosure of FIG. 35A along the line B-B;

[0137] FIG. 35C depicts a cross sectional view of the assembled enclosure of FIG. 35B along line A-A;

[0138] FIG. 36 depicts an enclosure including air vents according to one or more aspects of the disclosure;

[0139] FIG. 37 depicts a method of sizing a finger according to one or more aspects of the disclosure;

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[0140] FIG. 38 is a pictorial diagram showing a plurality of image perspectives of a user's hand;

[0141] FIG. 39 depicts a sizing tool for sizing the finger of a user;

[0142] FIG. 40 depicts a sizing tool for sizing the finger of a user according to an alternate example;

[0143] FIG. 41 depicts yet another alternate example of a sizing tool for sizing the finger of a user;

[0144] FIG. 42 depicts a method of monitoring activity according to one or more aspects of the disclosure;

[0145] FIG. 43 depicts a method of determining whether a user is wearing gloves according to one or more aspects of the disclosure;

[0146] FIG. 44 depicts a method of securing data onboard the WCD according to one or more aspects of the disclosure;

[0147] FIG. 45A is a timepiece system according to one or more aspects of the disclosure;

[0148] FIG 45B is a bottom view of the TCD;

[0149] FIG. 46 depicts a WCD with a pair of LED indicators disposed at an inward-facing portion of the WCD;

[0150] FIG. 47A is a system for generating and managing alerts according to one or more aspects of the disclosure;

[0151] FIG. 47B depicts a block process diagram for generating and managing alerts according to one or more aspects of the disclosure;

[0152] FIG. 47C is a flow chart depicting a method for generating and managing alerts according to one or more aspects of the disclosure;

[0153] FIG. 48A is a method for variable sampling according to one or more aspects of the disclosure; FIG. 48B and 48c are graphs depicting one or more aspects of the sample method of FIG. 48A; and

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[0154] FIG. 49 is a diagrammatic representation of a machine in the example form of a computer system within which a set of instructions, for causing the machine to perform any one or more of the methodologies discussed herein, may be executed.

DETAILED DESCRIPTION

[0155] The present disclosure describes a wearable computing device (WCD) that enables a wearable fitness monitor(s)/computer(s) which is suitable for prolonged usage with accurate results. The WCD can be in the form of a ring that can be worn on the finger of a human (or animal) user. Although the WCD of the present disclosure is depicted as a ring that can be worn on the finger of a user, other shapes, designs, and form factors can be utilized for the WCD. For example, the WCD can be in the form of a wrist band, bracelet, necklace, earring, or any other type of wearable accessory. In this regard, references to the finger of a user in the present application can be considered to apply to other portions of a human body depending on the form of the WCD, such as wrist, neck, ear, etc.

[0156] The term "coupled" as used herein means connected directly to or connected through one or more intervening components or circuits. Any of the signals provided over various buses described herein may be time-multiplexed with other signals and provided over one or more common buses. Additionally, the interconnection between circuit elements or software blocks may be shown as buses or as single signal lines. Each of the buses may alternatively be a single signal line, and each of the single signal lines may alternatively be buses, and a single line or bus might represent any one or more of a myriad of physical or logical mechanisms for communication (e.g., a network) between components. The present embodiments are not to be construed as limited to specific examples described herein but rather to include within their scope all embodiments defined by the appended claims.

[0157] FIG. 1A is a perspective view of 100 of a WCD 110 illustrating an exterior window 120 in accordance with some embodiments, and FIG. 1B is a perspective view 102 of the WCD 110 of FIG. 1A illustrating an interior window 130.

[0158] As previously mentioned, it is recognized in the present disclosure that conventional wearable fitness monitors such as clip-on devices, wristbands, or watch-type monitors still often suffer from inaccuracy mainly because they lack constant and

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consistent ways to read from the body areas they aim to monitor. It can also be an extra burden for the person to remember and wear such conventional fitness monitors each time the person perform exercises in order to create an accurate history tracking the exercise activities.

[0159] Accordingly, the present embodiments of the WCD 110 can function as fitness monitors/computer which is suitable for prolonged usage so as to create accurate results. In addition or as an alternative to fitness monitoring, as will be discussed in more detail below, the WCD 110 can function as a remote input device through, for example, gesture recognition. In some embodiments, the WCD 110 can further function as a sleep monitor, a heart rate sensor, a cardiac monitor a body temperature detector, or the like. It is noted that, for those embodiments which can function as a cardiac monitor (e.g., that measures electrocardiogram (EKG)), it may be necessary to establish a closed loop (e.g., for the electrical measurement of EKG) across the heart. As such, in some of those embodiments, a separate conductive pad can be coupled to the WCD 110 so that a user can pinch the pad with fingers on an opposite hand,

[0160] Specifically, in some embodiments of the present disclosure, the WCD 110 can be worn by the user (e.g., on a finger) for fitness, physical activity, biological data monitoring as well as for gestural input or other suitable purposes. As shown in FIGS. 1A and 1B, the WCD 110 can include the exterior window 120 on its exterior wall for input/output data transmission and reception, battery recharge, or status indication. The WCD 110 can also include the interior window 130 on its interior wall for various monitoring or sensing activities. The form factor of the WCD 110 allows it to be worn for prolonged hours with constant and consistent contact with the skin area, thereby creating a more reliable and extended recording (e.g., as compared to aforementioned conventional fitness monitors) of the user's fitness activity, physical exercise, as well as health information such as heart rates and body temperature. More implementation details regarding the WCD 110 are discussed below.

[0161] FIG. 1C is a perspective view of an alternative design of the WCD 110 of FIG. IA in accordance with some embodiments. As shown in FIG. IC, the WCD 112 includes a second exterior window 124 in addition to a first exterior window 122. The two exterior windows 122 and 124 can include spacing between the two windows 122 and 124 so that the mechanical strength of the housing structure of the WCD 112 may

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be stronger than that of the WCD 110, which is shown to include one single exterior window 120. Further, in some embodiments, radio antennas (e.g., Bluetooth) or other sensitive circuitry can be positioned in the second exterior window 124 away from the first exterior window 122 so that quality of reception may be improved.

[0162] FIG. 2 is an abstract functional diagram 200 illustrating example components within the WCD (e.g., WCD 110) in accordance with some embodiments. As shown in diagram 200, the WCD 110 can include a processor module 210, a plurality of sensor modules 220, a status indicator module 230, a power generation and management module 240, a communication module 250, a memory 260, and miscellaneous modules 270 (e.g., a real-time clock (RTC) crystal oscillator as illustrated in FIG. 2). The WCD 110 can also include a battery 280 module that provides electrical power for the WCD 110. In some embodiments, the battery 280 can be of a lithium-polymer type or a zinc-polymer type. It is noted that modules illustrated in diagram 200 are for purposes of facilitating a better understanding of the present embodiments; other suitable modules may be included in the WCD 110 and are not shown for simplicity. As used herein, the term "components" is considered to generally include any of the modules depicted and/or described in FIG. 2, as well as any other modules described herein.

[0163] It is noted that the aforementioned modules are intended for purposes of enabling the present embodiments, rather than limiting. As such, a person of ordinary skill in the art will understand that the present disclosure covers apparent alternatives, modifications, and equivalents (e.g., combining or separating the modules) made to the techniques described herein. For example, in some embodiments, a portion of the communication module 250 (e.g., the Bluetooth Chip as shown in FIG. 2) can be combined into the processor module 210. For another example, one or more modules herein can be combined into one to form a system-on-the-chip (SOC).

[0164] The processor module 210 can have generic characteristics similar to general purpose processors or may be application specific integrated circuitry that provides arithmetic and control functions to the WCD 110. The processor can be any type of processor, such as a processor manufactured by AMtel, Freescale, Nordic Semiconductor, Intel®, AMD®, or an ARM® type processor. The processor module 210 can include a dedicated cache memory (not shown for simplicity). The processor

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module 210 is coupled to all modules 220-270 in the WCD 110, either directly or indirectly, for data and control signal transmission.

[0165] The memory 260 may include any suitable type of storage device including, for example, ROM, such as Mask ROM, PROM, EPROM, EEPROM; NVRAM, such as Flash memory; Early stage NVRAM, such as nvSRAM, FeRAM, MRAM, or PRAM, or any other type, such as, CBRAM, SONOS, RRAM, Racetrack memory, NRAM, Millipede memory, or FJG. Other types of data memory can be employed as such are available in the form factor desired.

[0166] In addition to storing instructions which can be executed by the processor module 210, the memory 260 can also store data generated from the processor module 210. It is noted that the memory 260 can be an abstract representation of a generic storage environment. According to some embodiments, the memory 260 may be comprised of one or more actual memory chips or modules. In some embodiments, the memory 260 can function as a temporary storage (e.g., for firmware updates, and/or for avoiding accidental malfunctions (such as so-called "bricking")).

[0167] In accordance with one or more embodiments, the sensor modules 220 can include various sub-modules for the WCD 110 to perform different monitoring or sensing activities. A view 302 of the interior window (e.g., window 130) of a WCD (e.g., WCD 110) with example components exposed is shown in FIG. 3B. As shown in the example of FIG. 3B, the sensor modules 220 can include a temperature sensor 320a, a red light emitting diode (LED) 320b, a light sensor 320c, and an infra-red LED 320d. Among the sensors in the sensor modules 220, those sensors (e.g., sensors 320a-320d) which are directly related to biological sign monitoring can be configured and positioned in a way that is close to the skin (e.g., facing the interior window 130 of the WCD 110). Although not shown in FIG. 3B for simplicity, the sensor modules 220 can further include sensors that are not directly related to biological sign monitoring; some examples of these sensors include accelerometers, gyroscopes, vibration, sensors (e.g., a magnetometer or a digital compass), or other suitable sensors (e.g., for gesture recognition). The magnetometer can measure the strength and/or direction of a prevailing magnetic field. In this regard, the magnetometer can be used during global positioning and/or navigation. In particular, the magnetometer can be used to measure a directional heading when the WCD is in motion and can supplement position data

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where the WCD is out of communication range. In one or more embodiments, the accelerometers in the sensor modules 220 can detect movements in multiple (e.g., 3) dimensions or axes. The accelerometer can measure force of acceleration of the WCD and can measure gestures performed by a user while wearing the WCD. In other examples, the accelerometer can detect acceleration of the user while wearing the WCD. This can permit tracking of activity level, such as steps taken or number of laps swum in a pool.

[0168] The temperature sensor can be any type of sensor that detects temperature, such as a thermistor, PTC, NTC, etc. In another example, the temperature sensor can use IR light emitted from an object to calculate a surface temperature of the object in a manner clear to those of ordinary skill in the art.

[0169] Together, the processor module 210 and the sensor modules 220 can enable the WCD 110 to perform multiple functions including, for example, pedometer, sleep monitor (e.g., which monitors sleep quality), heart rate sensor, pulse oximetry, skin (and in select embodiments, ambient) temperature. In addition, some embodiments of the WCD 110 can further function as a gesture input device. In particular, the present embodiments recognize that the WCD 110 can detect finger motions or gestures which may be difficult for conventional fitness sensors to detect, such as a tap, a snap, a knock on the table, and the like. In some embodiments, the WCD 110 can utilize the accelerometer to measure the activity level (e.g., arm movement) in conjunction with the measured heart rate to determine if the user is walking horizontally, running, swimming, or climbing stairs. Other activities can be identified by the WCD 110 may include biking or sleeping.

[0170] In some embodiments, the WCD 110 can also be programmed to learn particular gestures or physical exercise from the user using, for example, a training mode. For example, the user can instruct (e.g., using a computer or a mobile device of the user) the WCD 110 to enter the training mode and perform the gesture or physical exercise; the WCD 110 can record the readings from the sensor modules 220, recognize patterns therefrom, and store the result in, for example the memory 260, so that such gesture or exercise can be recognized by the WCD 110 after the training. The WCD 110 can be configured (e.g., via a mobile application running on a mobile device of the user) so that the recognized gestures can perform functions designated by the user, such as

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clicks, swipes, unlocks, or media player controls. In one embodiment, the WCD 110 can include near field communication (NFC) chips so that certain functions (e.g., unlocking a smart phone) can be performed when the WCD 110 touches upon or otherwise be detected by another NFC device. In some embodiments, the unlocking function of the WCD 110 can also unlock a user device (e.g., a phone) via the communication module 250 (e.g., Bluetooth) by the WCD 110 transmitting a proper unlock code.

[0171] Moreover, the WCD 110 can function as a key or a control device for keyless access to home, automobile, or other suitable user authentication processes. The WCD 110 can also be integrated with games and game consoles so that it can function as an input device to those games and consoles. In some embodiments, the WCD 110 can be adapted for use in medical and home health monitoring, or as a transportation safety device (e.g., that broadcasts emergency messages to relevant authorities). Additional examples of sensors/functionalities of the WCD 110 can include an inertial measurement unit (IMU) (e.g., for more complex gesture recognition, a near-infrared (NIR) spectrometer (e.g., for measuring light absorption and deriving blood glucose/ blood alcohol/ CO2 content), a Galvanic skin response sensor (e.g., for measuring sweat/ nervousness), an electrocardiogram (ECG or EKG), and so forth.

[0172] In some embodiments, the processor module 210 can determine (e.g., based on identified physical activities, routine pattern, and/or time) a frequency at which one or more sensors in the sensor modules 220 should operate. Because it is recognized in the present disclosure that the heart rate of a human being typically does not vary too widely (e.g., beyond a certain percentage of what has been previously measured), in some embodiments, the WCD 110 can automatically adjust the sensor modules 220 (e.g., to slow down) so as to save power. More specifically, some embodiments of the WCD 110 can include a phase-locked loop or logic to predict the pulse width by determining lower and upper ranges in which the heart rate is predicted to be, thus only powering up the sensor modules 220 at the time of the predicted heartbeats. For one example, if the WCD 110 determines that the user is at sleep (e.g., based on the heart rate, the body temperature, together with the movements detected by the accelerometer and/or the vibration detector), the WCD 110 can slow down its heart rate detection frequency (e.g., from 1 measurement per second to 1 measurement per 10 seconds) and skip the measurement of several heartbeats because it is unlikely that the heart rate will

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change drastically during that period. Conversely, if the WCD 110 determines that the user is performing a high intensity physical exercise, the WCD 110 can increase the frequency of monitoring and recording of the sensor modules 220.

[0173] In accordance with one or more embodiments, the WCD 110 also includes various modules coupled to the processor module 210 for, by way of example but not limitation, input/output data transmission, battery recharge, or status indication. A view 300 of the exterior window (e.g., window 120) of a WCD (e.g., WCD 110) with example components exposed is shown in FIG. 3A. As shown in the example of FIG. 3A, the modules configured to face the exterior window 120 of the WCD 110 can include parts from the status indicator module 230, the power generation and management module 240, and the communication module 250.

[0174] Specifically, one embodiment of the WCD 110 includes the status indicator module 230 coupled to the processor module 210 to indicate various statuses. In some embodiments, the status indicator module 230 includes a light emitting diode (LED) 330, such as shown in FIG. 3A. The LED 330 can be a single red/green/blue (RGB) LED. In other embodiments, the status indicator module 230 can include other suitable types of indicator devices including, for example, a single color LED, an electrophoretic ink (or "e-ink") display, a persistent display, or the like. In accordance with some embodiments, the WCD 110 can utilize the indicator module 230 (e.g., via the RGB LED 330 through the exterior window 120) to visually communicate with the user. For example, a red color can be displayed (e.g., for a predetermined period of time) by the LED 330 that the WCD 110 needs to be recharged, and a green color can be displayed to indicate that the WCD 110 is fully charged. For another example, a blue color can be displayed when the communication module 250 is in use. In one or more embodiments, the user can program a fitness goal (e.g., a target heart rate) to the WCD 110 so that, for example, a green color can be displayed when the heart rate is below the target, a yellow color can be displayed when the target is reached, and a red color can be displayed when the heart rate is above a certain percentage of the set target. Some embodiments of the WCD 110 include the communication module 250 for wireless data transmission. Particularly, in some embodiments, the communication module 250 includes one Bluetooth chip and a Bluetooth antenna 350, such as shown in FIG. 3A. One or more embodiments of the WCD 110 also provides the capability of storing activity logs (e.g.,

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in the memory 260). More specifically, fitness activities, exercise histories, as well as recorded biological signs such as heart rate and body temperature, can be stored onboard in the memory 260 of the WCD 110. Each data entry in the activity logs can be time- stamped using, for example, an onboard real-time clock (e.g., which may be included in miscellaneous modules 270). For power saving and other purposes, the activity log can be downloaded (e.g., via the communication module 250) when requested by the user. In other embodiments, the activity log can be pushed (e.g., via email or other suitable means) by the WCD 110 to a user device at a time designated by the user. In some embodiments, the memory 260 can store up to a full week worth of activity logs.

[0175] The WCD 110 can include the power generation and management module 240 for recharging the battery 280 and for providing electrical power to various modules 210-270 in the WCD 110. Particularly, in some embodiments, the power generation and management module 240 includes one or more concentrated photovoltaic (CPV) cells 340, such as shown in FIG. 3A. The CPV cells 340 can be high-efficiency tandem solar cells and can be attached on the flexible printed circuit (e.g., circuit 415,515). Because the small form factor of the embodiments of the WCD 110, CPV cells 340, which can absorb more light energy from a wider spectrum of light than the traditional solar cells, are used. In some embodiments, multiple (e.g., 3) CPV cells 340 can be configured in series to provide sufficient voltage and/or current for charging the battery 280.

[0176] According to some embodiments, the WCD can include one or more sensing or imaging devices that can be any type of device capable of detecting electromagnetic radiation, such as visible light, IR, NIR, UV, etc. In one example, the device is an imaging device, such as a CMOS or CCD camera.

[0177] According to some embodiments, the WCD 110 can be placed or docked into a charging station for recharging. A perspective view 900 of an example charging station 910 for the WCD 110 is shown in FIG. 9A. The charging station 910 can have concentrated light source circumferentially around the WCD 110 so that the user does not have to be concerned with whether the WCD 110 is facing the right direction for charging. Some embodiments of the charging station 910 can include a light distribution means that takes a single light source and distributes the light all around. An abstract

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diagram illustrating a partial structure of the light distribution means inside the charging device of FIG. 9A is shown in FIG. 9B. It is noted that, even with the charging station 910, for some embodiments, regular outdoor sunlight or other ambient light source can still function as a secondary source of energy so that the CPV cells 340 on the WCD 110 can extend the operational time provided by the battery 280.

[0178] Additionally or alternatively, energy source attached to the power generation and management module 240 can be passive; for example, some embodiments provides that a clip with a concentrator lens can be attached to the WCD 110 in a way such that the power generation and management module 240 can charge the battery 280 using natural sunlight. In an alternative embodiment, gemstone(s) (e.g., sapphire, diamond, or other suitable materials) in the shape of a dome or with faceted protrusion can be configured to concentrate/magnify light energy while also serving as a decorative feature.

[0179] In some alternative embodiments, the power generation and management module 240 can include electromagnetic induction charging coil so that a WCD (e.g., ring 610) can be charged using an inductive charger. FIG. 6 shows an exploded view 600 of such alternative embodiment of WCD with the inductive charging mechanism including the charging coil 640, as well as battery 680, housing 612, and rigid-flex PCBA 615. However, it is noted that there may be a need to manufacture the inductive charging coil 640 in different sizes that correspond to different ring sizes. Further, it is noted that the efficiency of the electromagnetic induction charging mechanism may be adversely affected by the adoption of a metallic housing. Additionally or alternatively, to avoid multiple sized coils mounted to the edge of the ring, the coil can be placed on the inner or outer sides of the ring by positioning the coil beneath a window in the metal housing of the ring.

[0180] In order to achieve optimal power management of the WCD, one or more of the components can be selected to minimize power usage. For example, a processor, memory, or any other component can be selected based on rated power usage. In one example, it may be desirable to select components that draw current on the order of microamps in order to extend the battery life of the WCD and to allow the WCD to perform health/activity monitoring functions between charging sessions.

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[0181] In still some other alternative embodiments, the power generation and management module 240 can include thermoelectric generator (TEG) modules so that a WCD (e.g., WCD 710,810) can be charged by the difference between the body temperature and the ambient temperature. FIG. 7 is a perspective view 700 of such alternative design, and FIG. 8 is an exploded view 800 of the WCD 710 of FIG. 7. Also shown in FIGS. 7 and 8 is an alternative design of the housing for the WCD where the ring includes an outer ring 812a, an inner ring 812b, and insulators 814a and 814b. However, it is noted that utilizing TEGs for charging the battery may be less than ideal since the difference between body temperature and ambient temperature might not be great enough to fully charge the battery, and that in many occasions (e.g., during sleep), the temperature difference needed for TEG to generate electricity may quickly disappear (e.g., since the WCD 710, 810 may be covered inside the comforter).

[0182] The battery can be any type of battery, such as a rechargeable battery. The battery can be a thin, flexible lithium ceramic chemistry battery. In another example, the battery can be a circular formed lithium polymer or lithium ion battery. The battery can provide power to any of the components described above. In one example, the battery can be a lithium cell integrated directly with the flexible PCB described above. Other implementations can integrated the battery directly onto the housing to reduce the volume of space taken up by battery packaging.

[0183] The WCD can also include one or more polymer or piezo actuators for providing appropriate haptic or physical feedback and alerts to a user while the user is wearing the ring. The piezo actuator can also provide audible feedback to a user.

[0184] As previously mentioned, the WCD 110 can be used with a software application (e.g., a mobile phone application for the Apple iOS or the Google Android OS) which can run on the user's computing device (e.g., a mobile device such as a smart phone). Specifically, the software application can facilitate the mobile device of the user to couple to the WCD 110 (e.g., via the communication module 250) for data communication, such as downloading activity logs, changing configuration and preferences, training the WCD. The software application can also generate a user interface showing the results or readings from the health and fitness tracking performed by the WCD 110. FIG. 10 is an example screenshot illustrating such user interface 1000 displaying fitness monitoring readings in accordance with some embodiments.

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[0185] Further, the WCD 110 can be used for gesture input, and the software application can facilitate the user to customize gesture input and control. FIG. 11 is an example screenshot illustrating such user interface 1100 displaying sensor readings (e.g., for calibration purposes) in accordance with some embodiments. In one or more embodiments, the WCD 110 can also be used directly with other Bluetooth enabled devices such as electronic locks or keyless car entry. In other examples, the WCD 110 can also control other devices via a smartphone and other Wireless LAN enabled devices such as home automation systems.

[0186] FIG. 3C is a view 304 of two exterior windows of an alternative WCD (e.g., WCD 112 of FIG. 3C) with example components exposed in accordance with some embodiments. The components 330, 340, and 350 shown in FIG. 3C function similarly to those components described in FIG. 3A. However, some components (e.g., antenna 350) can be positioned to face a different exterior window than the exterior window the rest of the components face. This may increase the mechanical strength of the housing structure of the ring, and/or may reduce signal interference among the components.

[0187] FIG. 4 is an exploded view 400 showing an exemplary WCD 410 (e.g., WCD 110) illustrating a battery 480 and a flexible circuit 415 which are configured to fit inside a housing 412 of the WCD 410. It is recognized by the present disclosure that a human being's finger can come in various different sizes and so should the WCD 410. In order to reduce the cost of manufacturing different sizes of printed circuits, in some embodiments, the modules 210-270 (of FIG. 2) are formed on a flexible or rigid-flex printed circuit (FPC) board, an example 500 of which is shown as FPC 515 in FIG. 5. In particular, one or more embodiments provide that the FPC 515 and the battery 480 are not specific to a ring size, and that the same circuitry and/or battery can fit a multitude of sizes.

[0188] According to some embodiments, the WCD 410 provides a desirable form factor for a user to wear it for a prolonged period of time. The edges and the shape of the WCD 410 can be configured in a way that is comfortable and ergonomic; for example, the finished parts of the embodiments are to be free from burrs and sharp edges. The material which forms the housing portion of the WCD 410 can include medical grade metallic alloys that reduce the likelihood of allergic reactions. Examples

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of the housing material include stainless steel, tungsten carbide, titanium alloy, silver, platinum or gold.

[0189] In the examples shown in FIG. 4, the U-shape of the ring housing 412 allows for the flexible PCB 415 to be inserted into the edge of the WCD 410. The windows (e.g., windows 120, 130) on the walls of the WCD 410 can align with the operating circuitry to allow, for example, battery charging, Bluetooth connection, and user feedback LED/micro display on the outer wall, and biological feedback sensors (e.g., pulse oximetry, temperature sensor) on the inner wall. In one or more embodiments, the WCD 410 can be completely sealed using potting epoxy. The sealing epoxy can be transparent to allow light to pass through for the CPVs and sensors. In some embodiments, the WCD 410 can be potted with two different compounds. In these embodiments, the body of the WCD 410 can be filled with clear material, and the edge of the WCD 410 can be filled with an opaque material so that different colors can be incorporated (e.g., as a decorative element). It is noted that sealing the assembly using potting epoxy can also bring the additional benefit of making the WCD 410 completely or almost completely waterproof as well as increasing the structural rigidity of the WCD 410.

[0190] **I. Internal Housing/External Potting**

[0191] FIG. 12A is a perspective view and FIG. 12B is a side view of a WCD 1200 according to one or more aspects of the disclosure. The WCD 1200 can be in the shape of a ring and can be worn on any of the five fingers (including the thumb) of (typically) a human user. In this regard, the WCD 1200 can define an interior diameter d1 and exterior diameter d2. The interior diameter d1 can be defined as the distance between opposing points on the interior surface of the ring, with the interior surface being the portion of the WCD facing the finger of a user while the device is worn by the user. The interior surface of the WCD can generally define a finger space for receiving the finger of the user. The exterior diameter d2 can be defined as the diameter between opposing points on the exterior surface of the ring, with the exterior surface being the portion of the WCD opposed to the interior surface and facing away from the finger of the user.

[0192] The interior diameter d1 and exterior diameter d2 can be any size to accommodate any finger size. In one example, d2 is determined by d1 plus a thickness

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of any components and/or flexible circuit boards disposed within the WCD. Additionally, although depicted as being circular, the finger space of the WCD 1200 can be any shape, such as ovular, elliptical, or the like, to accommodate users with atypical finger profiles. In these examples, the dimensions of the interior and/or exterior diameter may be measured according to other variables, such as length, width, major diameter, minor diameter, etc. By way of non-limiting example, the WCD interior diameter d1 (the diameter generally defining the ring size) can be in an approximate range of 12mm to 24mm so as to accommodate finger sizes ranging from a small child to a larger adult, and on any acceptable finger, including the thumb. The exterior diameter d2 can also be any reasonable size or shape, and can define an approximate range of between 18mm and 30mm. Likewise, the thickness between diameters d1 and d2 can vary widely, but can typically reside in an approximate range of 1.5mm to 3 mm. The width WR of the WCD along the direction of finger extension (finger longitudinal direction) is widely variable, and can be selected, in part to accommodate internal and external components. In a non-limiting example, the width WR is in a range of approximately 3mm to 8mm.

[0193] The WCD 1200 can include an overall housing 1210 that includes an internal housing 1212 and an external potting or encapsulant 1214. Together, the internal housing 1212 and external potting 1214 combine to form the overall form factor of the WCD 1200, in addition to providing a housing for one or more electronic components stored within the housing 1210 of the WCD 1200, as will be described in greater detail below.

[0194] The internal housing 1212 can be formed of any material, such as a nonconductive material, a conductive material, a ferrous material and/or a nonferrous metal, composite material (e.g. carbon-fiber and/or glass fiber composite) a dielectric material, or a combination of any of the above. In one example, the material of the inner housing 1212 is conductive and nonferrous, such as aluminum, titanium, or stainless steel. In other examples, the internal housing can be formed of a polymer, such as plastic. The external potting 1214 can be formed of any material, solid or gelatinous, that can provide resistance to shock and/or vibration and can prevent moisture and/or debris from entering the housing 1210 of the WCD 1200, such as silicone, epoxy, polyester resin or any other polymer.

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[0195] In one example, the external potting 1214 can be transparent. In this regard, the transparent external potting can allow electromagnetic radiation, such as visible, IR, or UV light sources from inside the housing 1210 to pass through the external potting 1214 without the need of a window or discontinuity in the external potting 1214 and without changing the optical properties of the radiation. In the same vein, electromagnetic radiation sources, such as visible, IR, or UV light, external to the housing can pass through the external potting 1214 and can be detected by, sensed by, or fall incident upon internal components of the WCD 1200 without the need for a window or discontinuity in the housing and without changing the optical properties of the radiation. In another example, the external potting 1214 can be tinted. The tint can be cosmetic and can prevent the internal components of the WCD to be visible by the user. In this regard, depending on the tint, optical properties of light passing therethough may be slightly changed. For example, certain colors of the light can be filtered and can result in decreased power transmission. The above description regarding external potting 1214 can be applied to any of the pottings described below.

[0196] The internal housing 1212 can define a window 1216. In one example, the internal housing is formed of a material that completely or partially prevents light (or other electromagnetic radiation) from passing through the internal housing 1212. In this regard, the internal housing 1212 can define the window 1216 to allow for such radiation to pass through the housing 1212. As shown, the window 1216 can be generally elliptical-shaped, but can be any other suitable shape according to other examples, such as rectangular, circular, ovular, etc. Since the window 116 is defined by the internal housing 1212, the window 1216 can face the finger of the user while the user is wearing the WCD 1200, which can provide many advantageous features and implementations, as will be described in greater detail below.

[0197] FIG. 12C is a front view of the WCD and FIG. 12D is a cross section of the WCD 1200 along the line A-A of FIG. 12C. As shown, the internal housing 1212 can have a generally U-shaped internal surface 1212a to accommodate one or more internal components and can define a pair of flanges 1212b and 1212c. The external potting 1214 can extend between the flanges 1212b and 1212c of the internal housing to provide an internal space 1220 to accommodate one or more components. By virtue of the external potting 1214, the internal space 1220 defined by the internal surface 1212a

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and the external potting 1214 can be hermetically sealed, thereby preventing debris, dust, moisture, or any other unwanted fluids or materials from interacting with the internal components of the WCD 1200. Although not depicted, the internal components can reside within the internal space 1220, and the external potting 1214 can be disposed immediately atop the components to provide the seal.

[0198] FIG. 12E is a perspective view of the internal housing 1212 without external potting 1214. As shown, the internal surface 1212a defines a generally U- shaped surface for receiving the components.

[0199] FIG. 12F is a perspective view of the internal housing 1212 with a portion of the external potting 1214 removed and showing one or more components 1230 and printed circuit board (PCB) 1240. The components and PCB can be constructed as flex circuits, thereby allowing the components 1230 and PCB 1240 to be geometrically configured within the ring shaped internal space 1220. The PCB 1240 can be any type of flexible material clear to those of skill, such as polyimide, PEEK, etc. Additionally, the PCB could be rigid-flex whereby panels of RF4 are connected together with a flexible substrate.

[0200] As shown, the PCB 1240 and the components 1230 can be disposed within the internal space 1220 generally defined by the internal surface 1220a and the flanges 1220b-c. The PCB 1240 can define one or more folding regions 1242 that allow the PCB 1240 to conform to the circumference and/or perimeter of the internal surface 1212a. The PCB 1240 can extend around at least a portion, or up to an entire circumference, of the internal surface 1212a. In one example, the size of the internal diameter d1 of the WCD can determine the portion of the internal surface 1212a around which the PCB 1240 extends. Illustratively, for a larger ring size and a larger internal diameter d1, the PCB 1240 can extend only a portion (an arc) of the overall circumference, while for smaller ring sizes a greater portion (arc) of the circumference can be employed to accommodate PCB 1240 and the internal components 1230. The adjacent portions of PCB can form an arc angle therebetween by virtue of the folding regions disposed therebetween, allowing for the PCB to be conform to the internal surface 1212a.

[0201] **II. External Housing/Internal Potting**

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[0202] FIG. 13 is a cross section of a WCD 1300 according to another aspect of the disclosure and illustrative embodiments. In this example, the WCD 1300 includes a housing 1310 that includes an external housing 1312 and an internal potting or encapsulant 1314. The external housing 1312 includes an internal surface 1312a that has a generally C-shaped cross section-but alternate cross section shapes, such shapes with an external notch or groove. The external housing includes flanges 1312b-c that extend toward each other, beyond portions of the internal surface 1312a, to define a partially enclosed internal space 1320. In an assembled state, the WCD 1300 can include a battery 1330, a PCB 1340, and components 1350, which can be at least partially or completely disposed within the partially enclosed internal space 1320. The internal potting 1314 can extend between the flanges 1312b-c and can seal the partially enclosed internal space 1320. The components can be encapsulated by the internal potting 1314. The PCB 1340 and components 1350 can extend along an inner circumference of the internal surface 1312a.

[0203] Illustratively, the external housing 1312 can be formed of the same materials as the internal housing 1212 described above, and the internal potting 1314 can be formed of the same materials as the external potting 1214 described above. As also described above, the internal potting 1314 can be transparent and the external housing 1312 can define one or more windows according to one or more aspects of the disclosure.

[0204] FIG. 14A is a cross section of a WCD according to another aspect of the disclosure and illustrative embodiment. In this example, the WCD 1400 includes a housing 1410,internal surface 1412a, an internal or external housing 1412, an internal or external potting 1414, an internal space 1420, a battery 1430, a flexible circuit 1440, and one or more components 1450. This example is similar to the examples described above with respect to FIGs. 12 and 13, except the addition of a stiffener element 1442 and the flanges 1412b-c extend further into the space 1420 toward one another such that the flanges 1412b-c overlap with the stiffener element 1442.

[0205] FIG. 14B is a perspective view of the PCB and stiffener element of FIG. 14A. As shown in FIG. 14B, the stiffener element 1442 extends beyond an overall width w of the PCB 1440 and extends wider than a distance between flanges 1412b-c. The stiffener element is disposed between folding regions 1444. The PCB 1440 can

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include one or more stiffener elements 1442 attached thereto, and the elements 1442 can be disposed periodically (in separated intervals) along a length l of the PCB 1440. As shown in FIG. 14C, the stiffener element 1442 can be disposed underneath the flexible circuit 1440, e.g., on a face of the flexible circuit 1440 opposed to the face on which the components 1450 are disposed, and can be permanently or semi-permanently attached thereto. The stiffener element can be implemented in any of the configurations described, and in particular, with either the internal housing/external potting arrangement or the external housing/internal potting arrangement.

[0206] The stiffener element 1442 can be formed of any material, such as polyamide or thin FR4, depending on construction of the PCB 1440. In particular, the material of the stiffener can be chosen to be more or less flexible than the PCB 1440. In one example, the stiffener element 1442 can be a polyamide stiffener disposed on a back surface of a flexible PCB. In another example, the stiffener element 1442 can be FR4 and can be substantially flush with respect to the flanges 1412b-c. In this regard, the stiffener element can extend substantially the distance between flanges 1412b-c and may not deform upon insertion into the space 1420. The stiffener element can include surface features disposed on an edge thereof, with the edge facing one of the flanges 1412b-c. The surface features can include a sawtooth profile (e.g., intersecting straight lines at acute angles), or any other type of feature capable of providing an interference fit between flanges 1412b-c.

[0207] FIG. 14D shows a cross section of the WCD at a point in time during assembly/manufacture when the PCB 1440 is being inserted into the internal space 1420 and prior to the application of potting 1414. As shown, the stiffener 1442 contacts the flanges 1412b-c of the housing 1410 by virtue of the width w of the stiffener element 1442. Upon an application of force, the PCB 1440 and stiffener 1442 assembly can be inserted into the internal space 1420. In this regard, the stiffener element has a predetermined flexibility that allows for a certain amount of flexion, as shown in FIG. 14D. The flexion allows for the flexible circuit 1440 to be inserted within the internal space 1420 and can prevent the flexible circuit 1440 from being removed or from accidentally falling out once inserted. In this regard, the flexible circuit 1440 is held in place within the space 1420 by virtue of the width of the stiffener element 1442 and the

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distance between the flanges 1412b-c. Once inserted, the potting 1414 can be applied free of the concern of improper positioning of the flexible circuit 1440.

[0208] FIG. 14E is a cross section of the WCD of after a potting material 1414 has been applied subsequent to the WCD of FIG. 14D.

[0209] **III. Inner/outer bands**

[0210] FIG. 15A depicts a perspective view of a WCD 1500 according to another aspect of the disclosure. In this example, the WCD includes a housing 1510 that includes an internal housing 1512 and an external housing 1514. The internal housing 1512 can be similar to the internal housing described above with respect to internal housing 1212, and the external housing can be similar to the external housing described above with respect to external housing 1312. The internal housing 1512 can include one or more windows 1516 that can allow electromagnetic radiation (e.g. visible and near-visible light) to pass therethrough, allowing it to fall incident upon components disposed within the housing 1510 and allowing EM radiation sources (e.g. visible light, RF, IR, etc.) within the housing to exit the housing.

[0211] FIG.15B is an exploded view of the WCD 1500. As shown, the WCD can include internal housing and external housing 1512 and1514. The WCD can further include a PCB 1540 and components 1550. Once the housings 1512-1514 are assembled and the PCB 1540 and components 1550 are assembled within space defined between the housings 1512-414, potting layers 1502 and 1504 can be applied to seal the WCD at both sides thereof to ensure a secure seal.

[0212] **IV. Inner/outer bands with U shaped window**

[0213] FIG. 16A is an exploded view of a housing 1610 and a PCB of a WCD according to one or more aspects of the disclosure. The WCD 1600 comprises a housing 1610 with an integral inner wall and outer wall 1612 and 1614. The housing can be made of any material, such as any material described above with respect to the internal/external housing structures. In this example, the inner and outer walls 1612,1614 each define a window in the shape cutaway portions 1616. The cutaway portions are bounded on three sides by the walls 1612 and 1614 and unbounded at the other side thereof. The cutaway portions 1616 can be aligned with one another to ensure

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transmission of radiation into/out of the housing 1610. The space1620 between the inner and outer walls 1612,1614 can receive a PCB 1640, battery, components, etc.

[0214] FIG.16B is a cross section ofFIG.16A along line B-B. As shown, the inner and outer walls 1612,1614 are directly connected by a floor 1618. The space 1620 is defined by the space between the inner and outer walls 1612,1614 and the floor 1618.

[0215] FIG.16C is a perspective view of the WCD with potting material 1630. As described above, the PCB, battery, and components can be disposed within the space. Once disposed therein, a potting 1630 can be provided atop the components and within the cutaway portion 1616. The potting 1630 can be transparent to allow for transmission of light through the cutaway portions 1616.

[0216] **V. Charging By Concentrated Light Source**

[0217] According to one aspect of the disclosure, the WCD can be charged by an external concentrated light source, e.g., laser light, laser diode, etc. In this regard, the photovoltaic device described above can include a concentrated photovoltaic element (CPV) that is constructed and arranged to receive concentrated light from the concentrated light source, e.g., laser light from a laser diode, light from a light emitting diode (LED), etc., and converting the received concentrated light into an electric current. The photovoltaic device can also generate power from nonconcentrated light sources, such as office lighting and ambient sunlight. The electric current can be used to charge one or more batteries stored within the housing of the WCD.

[0218] FIG.17A depicts a cross section of a WCD employing charging by concentrated light source according to one or more aspects of the disclosure. In this example, the WCD 1700 can include a housing material 1710. The WCD can include a PCB 1720 and a concentrated photovoltaic cell 1730. The WCD can be positioned adjacent a base assembly or base station 1750. The base assembly 1750 can be connected to an external power source 1765 and can have internal circuitry 1760 to power one or more concentrated light sources 1770, e.g., one or more laser diodes and/or one or more LEDs, disposed within the base assembly 1750. In this example, the concentrated light source 1770 comprises one or more laser diodes.

[0219] The base assembly 1750 can define a first opening 1752 at one portion thereof to allow the concentrated light 1780 to exit the housing of the base assembly I

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750. As shown in the diagram of FIG.17A, the concentrated light 1780 is generated by the concentrated light source 1770 and exits the housing of the base assembly 1750 via a first opening 1752. The concentrated light 1780 then enters into the WCD by a second opening 1712 in the housing of the WCD 1700 where it can fall upon the CPV 1730. Once the concentrated laser light falls upon the CPV 1730, the CPV 1730 can convert the incident concentrated light into a current that can be used to directly power one or more components within the WCD and/or can be used to charge one or more rechargeable batteries onboard the WCD.

[0220] The concentrated light source 1770, as described above, can be any type of light source that is arranged to generate concentrated light, such as an LED or a laser diode. The concentrated light can be any type of concentrated and/or coherent electromagnetic radiation, such as laser light and/or LED light. The concentrated light can have any desired intensity or wavelength, according to the characteristics of the CPV 1730.

[0221] In one example, the source 1770 can be a 200 mW laser diode that produces red or green laser light. This can generate approximately 80mW (or typically less) of power in the WCD where the CPV 1730 includes a plurality of groups of photovoltaics configured in series or in parallel with one another. Each group of photovoltaics can include one or more CPV cells. In another example, the CPV can include a single group of photovoltaics.

[0222] The base assembly 1750 described above can include additional components that can interact with the WCD 1700. For example, the base assembly can include one or more antennas that can communicate according to one or more wireless protocols, such as 3G, 4G, WiFi, Bluetooth®, NFC, or the like, for direct or indirect wired or wireless communication with the WCD or mobile device. In addition to the charging methods above, the base assembly can employ inductive charging techniques.

[0223] FIG.17B depicts a cross section of a WCD employing charging by concentrated light source according to another aspect of the disclosure. In this example, the concentrated light source 1770 comprises an LED. Further, the base assembly comprises an optical element 1790 positioned adjacent to the concentrated light source I 770 for focusing the LED light onto the CPV inside the WCD. The optical element 1790

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can be any type of optical element, such as a lens. The lens can be formed of any material, such as glass, plastic, etc., and can be any type of lens, such as concave, convex, piano-concave, piano-convex, etc. In this example, the optical element 1790 includes a piano-concave, with the concave portion facing the concentrated light source 1770. In the example where the source 1770 is an LED, the LED emits light in many directions. The optical element 1790 can focus the emitted LED light to focus as much of the LED light as possible onto the CPV of the WCD. The optical element 1790 can be disposed at least partially or completely within the first opening 1752. In some implementations, the optical element may not be necessary due to LEDs with substantially focused light.

[0224] FIG.17C is a perspective view of a base assembly 1750 and WCD 1700 according to one or more aspects of the disclosure. As shown, the WCD 1700 is in the shape of a ring and the base assembly 1750 includes a post 1754 for receiving the ring. The post 1754 can be cylindrical and can be sized and shaped according to an internal diameter of the WCD in order for the WCD to be received on an external surface of the post. The first opening 1752 of the base assembly 1750 is formed on a portion of the post 1754 such that, when the WCD 1700 is stored on the post, the second opening 1712 can be aligned with the first opening 1752 to ensure alignment of the CPV and the concentrated light source. The base assembly can receive/transmit power and/or data via external input/output 1795, which can be a DC power input, a USB input connection or any other acceptable connection/form factor.

[0225] FIG.17D depicts a perspective view of internal components of the base assembly 1750 and WCD 1700 according to another aspect of the disclosure. In this figure, the respective housings of the base assembly and WCD have been omitted, thereby showing a plurality of concentrated light sources 1770, optical elements 1790, and a plurality of CPVs 1730 disposed on mounting substrates 1775 on a PCB. In this example, the WCD can include a plurality of CPVs and the base assembly can include a plurality of sources. This allows for a greater current to be generated during charging and for faster charging times of the WCD. The CPVs and concentrated light sources can correspondingly be disposed in a line, with a constant or variable pitch between respective elements. In this regard, the optical element can include corresponding concavities with the same pitch.

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[0226] FIGs.17E-F depicts other CPV configurations according to one or more aspects of the disclosure. As shown in FIG.17E, the CPVs 1730 can be arranged in a lx4 array, while FIG.17F depicts the CPVs arranged in a 2x2 array. In addition to the examples shown in the above figures, the WCD can include any number of CPVs according to any number of geometric configurations.

[0227] FIG.17G is perspective view of a WCD and base assembly with a lx3 CPV arrangement. As shown, the WCD can include a lx3 array of CPVs and the base assembly can include a corresponding lx3 array of concentrated light sources. As indicated by the arrow, a user can then rotate the WCD on the base assembly in order to align the respective first and second openings, as well as the CPV and concentrated light sources.

[0228] FIG.18A depicts a cross section of a WCD 1800 employing charging by concentrated light source 1870 according to another aspect of the disclosure. In this example, the WCD includes an internal/external housing portion 1810 and an internal/external potting portion 1820, as described above. In this regard, the base assembly 1850 includes a first opening 1852, but is free of a second opening on the WCD. The concentrated light 1880 passes through the transparent potting portion and falls incident upon the CPV cell 1830. In this example, the source can be a laser diode.

[0229] FIG.18B depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure. In this example, the concentrated light source 1870 includes one or more LEDs and the base includes one or more optical elements 1890 for focusing the concentrated light 1880. The LEDs may be of different wavelengths to provide power to two or more junctions in the triple junction CPV cell.

[0230] FIG.19A depicts a cross section of a WCD 1900 employing charging by concentrated light source 1970 according to another of the disclosure. In this example, the WCD and/or the base assembly 1950 can employ one or more magnetic and/or ferrous materials to ensure alignment between the concentrated light source and the CPV cell. Such alignment can improve charging efficiency of the WCD.

[0231] The base assembly includes a first opening 1952 and the WCD includes a second opening 1912 to allow for concentrated light to fall incident upon the CPV 1930.

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In this example, the second opening is formed on an external housing portion of the WCD. In this arrangement, the base assembly can charge the WCD from an exterior of the WCD, rather than an internal charging method as identified above.

[0232] The WCD can include a ferrous or other suitable (e.g. ferromagnetic) material 1920, such as steel, disposed within the housing 1910. In this example, the ferrous material is disposed in a space defined between an internal housing and an external housing. The ferrous material can surround the CPV.

[0233] The base assembly can include corresponding magnets 1960 that can cause an attractive force between the WCD and the base assembly into an optimal configuration for charging. The magnets can be disposed within the base assembly and can surround the concentrated light source. The magnets 1960 can be formed of a rare earth material, such as neodymium or any other acceptable material that provides a requisite magnetic field strength.

[0234] FIG.19B depicts a cross section of a WCD 1900b employing charging by concentrated light source 1980b according to another of the disclosure. The CPV 1930b of the WCD1900 is charged from an interior portion, such as by a base assembly 1950b with a post 1954b. Similarly, the WCD can include a ferrous material 1920b disposed within the housing1910b and the base assembly1950b can include a magnet 1960b.

[0235] FIG.19C depicts a schematic diagram of magnets 1920c,1960c that can be used in a WCD and/or base assembly, including a CPV 1930d and concentrated light source 1930d, according to one or more aspects of the disclosure. As shown, the magnets and/or ferrous/ferromagnetic materials can be axially polarized, with each having a respective north pole and south pole. In this regard, the WCD can have axially polarized magnets 1920c with a south pole S facing toward the base assembly, and the base assembly can have axially polarized magnets 1960c with a north pole N facing toward the WCD. The attractive force between the north and south poles can ensure alignment of the CPV 1930c of the WCD and the source 1970c base.

[0236] FIG.19D depicts a schematic diagram of magnets that can be used in a WCD and/or base assembly according to one or more aspects of the disclosure. In this example, the base assembly includes axially polarized magnet 1960d, with a north pole

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N facing toward the WCD. The WCD can include ferrous steel 1920d, with an attractive force between the ferrous steel and the north pole of the base assembly magnet.

[0237] FIG.19E is a perspective view of a WCD and a base assembly according to one or more aspects of the disclosure. As shown, the WCD 1900e can be received by a post 1954e of a base assembly 1950e. The respective magnets I960e and/or ferrous materials 1920e are shown in phantom to illustrate their positioning with respect to the WCD and base assembly devices and the CPV1930e as well as the concentrated light source 1970e.

[0238] FIG. 20A is a cross section of a WCD 2000 engaged with a base assembly 2050 according to one or more aspects of the disclosure. In this example, the magnets 2060 can surround the concentrated light source 2070, and the WCD can include a ferrous steel 2020, CPV 2022, and battery 2024 disposed within an internal/external potting 2014 of the WCD. The ferrous steel 2020 can be disposed on a face of the PCB 2040 and can be encapsulated by the internal/external potting 2014. The base assembly can include one or more optical elements 2090 for focusing the concentrated light 2080.

[0239] FIG. 20B is a perspective view of a PCB 2040b with a CPV 2030b and ferrous element 2020b configuration according to one or more aspects of the disclosure. In this example, the ferrous element 2020b comprises a steel ring that can surround a CPV 2030b and can be disposed on the PCB 2040b.

[0240] FIG.20C is a perspective view of a PCB 2040c with a CPV 2030c and ferrous element 2020c configuration according to one or more aspects of the disclosure. In this example, the ferrous element 2020c comprises a plurality of rectangular bars disposed on the PCB. In this way, the ferrous element 2020c can be coated to be reflowed onto the PCB.

[0241] FIG.20D is a perspective view of a magnet 2060d and a concentrated light source 2070d according to one or more aspects of the disclosure. As shown, the magnet 2060d can include a ring that can extend around a circumference of the concentrated light source 2070d. The magnetic ring can be attracted to the ferrous steel ring and/or the rectangular ferrous steel examples set forth in 20A-C above.

[0242] In some examples, the WCD can be adapted to uniquely identify the wearer of the WCD using, for example biometric features unique to the user.

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[0243] FIG.21A is a schematic view of a WCD 2100 showing components used for identifying the wearer of the WCD. As shown, the WCD2100 can include one or more infrared illumination sources 2110 and an infrared CMOS imaging device 2120. The finger 2190 can extend through the finger space of the WCD and the IR source 2110 can illuminate a portion of the skin of the finger 2190. The IR CMOS imaging device 2120 can receive light that has been reflected from the skin surface and produce an image of the skin of the finger 2190. As shown, the IR source2110 and the imaging device 2120 are positioned near the interior surface of the WCD, e.g., the surface facing the skin of the finger. The IR illumination can pass through a window provided on the interior housing or can pass through a transparent potting material.

[0244] During the imaging process, the WCD 2100 can be rotated about an axis passing through the center of the finger space and along the longitudinal direction of the finger. In this regard, the imager 2120 can capture a larger swath of the skin surface than if the WCD 2100 were held stationary with respect to the finger during the imaging process.

[0245] At the time of first use, or any time thereafter, the user can generate a reference capillary map in order to identify himself/herself as the authorized user of the WCD. As described above, the user can rotate the WCD around the finger to capture image data of an analyzed section of skin 2192 and on or more capillaries 2194 of the user currently wearing the WCD. The image data can correspond to an overall analyzed section of the skin 2196 of the wearer. The image data of the capillaries can be used to generate a reference capillary map of the wearer, which can be stored in the memory, such as flash memory or EEPROM, of the WCD.

[0246] When the same user puts the WCD on his or her finger after generation of the reference capillary map, the WCD can capture image data of the wearer's skin surface that can be compared to the reference capillary map stored in the memory. In this regard, the user need not rotate the device around the finger. Instead, the WCD can compare a subset of the gathered image data to a corresponding subset of reference capillary map. If there a match, within a predetermine error tolerance, the WCD can uniquely identify the wearer as an authorized user of the WCD and as the unique individual who generated the reference capillary map. Once authorized, the wearer can have access to certain functions, features, data, or other content that is not otherwise

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available without authorization. In another example, the identification can be a step in a transaction or other type of authorization, such as an electronic payment, bank transaction, etc. If the gathered data does not match the reference capillary map, then the user may be prevented from accessing certain features on the WCD.

[0247] Illustratively, the comparison process between sensed capillaries and some or all of the capillary map can be implemented using basic pattern recognition algorithms (processes) instantiated in the electronics of the WCD. Such processes can rely on edge detection and similar techniques that should be clear to those of skill in the art and can be sourced from various commercial vendors of biometric recognition software.

[0248] In another example, the illumination can include NIR illumination and can project radiation into the skin of the finger. The reflected NIR illumination can then be analyzed to determine one or more characteristics of the blood, such as blood alcohol levels, blood glucose levels, and blood oxygenation levels. In this regard, the WCD analyzes the reflected radiation to identify wavelengths that were absorbed from the projected radiation by the blood of the user. Techniques and processed used in conjunction with commercially available venous oximeters (for example) can be employed to undertake certain readings.

[0249] FIG. 22A is a perspective view of a user employing ECG monitoring according to one or more aspects of the disclosure. In this example, the user can wear the WCD2200 on a first finger 2210 of first hand 2220, and can touch a second finger 2230 of a second hand 2240 to an exterior surface of the WCD 2200. This can provide an electric pathway 2250 through the body, as shown in FIG. 22B, allowing for the transmission of electrical current between distant portions of the body.

[0250] FIG. 22C is a perspective view of a WCD that can employ ECG monitoring according to one aspect of the disclosure. In this example, the WCD 2200 includes an internal/external housing 2250 with a conductive pad2260. The conductive pad 2260 can be electrically isolated from the external/internal housing 2250 of the WCD, thereby providing distinct and isolated electrical contacts on the WCD. The internal/external housing 2250 can be in electrical communication with the first finger2210 of the first hand, while the conductive pad 2260 can be in electrical communication with the

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second finger 2230 of the second hand. In this regard, an electrical path 2250 is formed through the respective hands 2220, 2240 and through the rest of the user's body, particularly through the chest. In this regard, the WCD can take various electrical measurements of the user, such as ECG. The ECG measurement can include measurements of the various waveforms, such as P-U waveforms. The WCD can store such ECG data in a memory and/or can communicate the data to a wirelessly connected mobile device. In another example, the WCD can employ electrically isolated internal and external housings, such as those described above. In this regard, the conductive pad may not be utilized, and the user can wear the WCD on a first finger and apply the second finger anywhere on the external housing.

[0251] The WCD can also serve as a monitor for those who are mobility impaired or who are prone to falls, such as disabled persons and/or retired persons. The accelerometer onboard the WCD detect a fall of the user via a sudden change in acceleration data. The WCD, in conjunction with a mobile device and/or one or more base stations positioned around the home of the user, can determine the position of the user within the house. For example, the mobile device can employ GPS capabilities, and either the mobile device or the base stations can use GPS in combination with WiFi signal strengths to determine the location of the user within the house. The WCD can then issue an alert, either directly or indirectly (via the mobile device or base station) to a third party that a fall has occurred. The alert can be a phone call, text message, e-mail, or any other type of communication. The third party can then take appropriate measures to aid the fallen user.

[0252] The WCD can also monitor heart rate and/or temperature, in addition to the other monitored characteristics described above. If any of the monitored characteristics is abnormal, e.g., measured parameters outside of a predetermined threshold range, an alert can be sent to a third party. In some examples, the third party can be a medical health professional, such as a doctor, nurse, caretaker, etc. It is noted that, for those embodiments which can function as a cardiac monitor (e.g., that measures electrocardiogram (EKG)), it can be necessary to establish a closed loop (e.g., for the electrical measurement of EKG) across the heart. As such, in some of those embodiments, a separate conductive pad or other skin-contacting structure/probe can be coupled to the WCD so that a user can pinch the pad with fingers on an opposite hand.

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[0253] Since the WCD has the form factor of a ring, the WCD is designed to be worn over long periods of time by a user with little to no discomfort or interference. In this regard, the WCD can monitor the above-described, monitored characteristics over long periods of time (e.g. weeks, months, etc.), and determine trends in the data. For example, the WCD can measure heart rate over a long period of time and determine a unique resting heart rate for a user. If the user's heart rate deviates from the resting heart rate, the WCD can be arranged to issue an alert to a third party. In one specific example, the WCD can use appropriate processes to analyze both the trends of monitored characteristics, as well as current accelerometer data. In this way, if a person's heart rate deviates from a resting heart rate, but the accelerometer indicates that the user is exercising and/or engaging in strenuous activity that provides an equivalent workout, then the WCD may not issue an alert in this circumstance.

[0254] FIG.23A is a perspective view of the hand of a user in various positions employing the navigational features of the WCD. As described above, the WCD can communicate with a mobile device though one or more wireless communication protocols. The mobile device can include a processor and a memory and can execute a map application/process that can provide tum-by-tum walking or driving directions to the user based on the user's GPS location. A portion of those directions can include information regarding heading, distance to travel at that heading, waypoints, and the direction of next tum. By way of the wireless communication, the mobile device can communicate one or more of pieces of information relating to directions, such as the heading. Once the heading is received the WCD, the WCD can give feedback to the user regarding the actual heading measured by the onboard magnetometer and the heading set forth in the direction information. In one example, the feedback can be haptic or physical feedback provided by one or more actuators, such as the actuators 670 described above.

[0255] FIG. 23A depicts a user's hand in various positions of navigation, each hand including a WCD worn thereon. In this example, the heading provided by the mobile device is the heading 2335, which represents the direction in front of the hand position2330. In this regard, if the user gestures, e.g., points a ring finger, in the direction of the correct heading, the WCD 2300 can give feedback to the user indicating the correct heading. The feedback can include, for example, an LED indicator 2310

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showing a green visible light. In the example of hand position2320, the finger is gesturing in a direction to the left of the correct course 2325. In this way, the WCD 2300 can provide feedback to correct the heading of the user. Such feedback can include illumination of an LED indicator showing (e.g.) a red visible light. Similarly, hand 2340 is gesturing in direction 2345, which is to the right of the correct/appropriate direction. The WCD can provide (e.g.) a blue indicator informing the user to change heading.

[0256] FIG.23B is a flow chart 2300B depicting a method of providing feedback to a user according to one or more aspects of the disclosure. At block 231OB, a user can establish a communication link between a WCD and a mobile device. At block2320B, the user can generate or request a set of directions at the mobile device, including information/data regarding heading, distance to travel at that heading, and the direction of next tum. At block 2330B, the mobile device can transmit at least one of the information items/datum regarding heading, distance to travel at that heading, and the direction of next tum. At 2340B, the WCD can take a measurement of heading by measuring a heading associated with an explicit gesture by the user's finger donning the ring. Such gesture can include pointing in a proposed heading of travel. At block 2350B, the WCD can compare the measured or proposed heading to the correct heading provided by the mobile device. At 2360B, the WCD can provide feedback to the user based on the comparison at 2350B, e.g., if the user is gesturing in the correct direction, a green LED indicator may appear. In other examples, if the gesture is in a direction that does not correspond with the correct direction, a (e.g.) blue or red indicator can appear. In one specific example, indicators representing left and right course alterations can be different so a user can easily discern a correct direction of travel.

[0257] FIG. 24A is a schematic diagram of a system 2400 for controlling an environment of a user according to one or more aspects of the disclosure. As shown, the WCD can be connected, wired or wirelessly, to one or more appliances in the home of a user. The system 2400 can include a WCD 2410, a thermostat 2420, a wireless access point (e.g., WiFi router) 2430, and a mobile device 2440. The WCD can be wirelessly connected (e.g., link 2415) to both the thermostat and the mobile device by any type of wireless communication protocol, such as Bluetooth. The access point can be wirelessly connected to the thermostat and the mobile device by any type of wireless communication protocol, such as WiFi. It is noted that a wide range of commercially

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available appliances, thermostats, lighting controllers, home controllers, and the like, can interface with the WCD using WiFi or another conventional/proprietary communication protocol, as described further below.

[0258] The WCD 2410 can include one or more temperature sensors. In one example, the WCD can include at least one internal facing temperature sensor 2410a and an at least one outward facing temperature sensor 2410b, as shown at FIG. 24B. The inward facing temperature sensor 2410a can be near the skin of a user when the user is wearing the ring, and can therefore measure the skin temperature of the user. The outward facing temperature sensors 2410b can be disposed away from the finger of the user, and can therefore be arranged to measure an ambient temperature of the room in which the user currently resides with sufficient thermal isolation from the user's hand and his/her body heat. In particular, in order to ensure accurate ambient temperature measurements, the WCD can employ a combination of multiple light sensors 2410c and outward facing temperature sensors 2410b. In this regard, the temperature sensor 2410b associated with the light sensor 2410c that receives the most light can be the most accurate, as it is most likely that this sensor is furthest from the finger or palm of the user. In another example, the WCD can employ multiple outwardly facing temperature sensors 2410b and compare the temperature values of each to the inward facing sensor 2410a. The WCD can then select the most accurate temperature value from the outward facing sensors.

[0259] Based on the measured skin temperature and measured ambient temperature, the WCD can automatically adjust the thermostat 2420 to alter the ambient temperature of the room. In this regard, if a user's skin temperature is too high, the WCD can instruct the thermostat 2420 to lower the ambient temperature. Similarly, if the user's skin temperature is too cold, the WCD can instruct the thermostat 2420 to raise the temperature. The WCD 2410 can instruct the thermostat (and/or an HVAC controller) directly, e.g., via a direct wireless link 2415, or indirectly, e.g., via one or more of the mobile device 2440 and the access point 2430. The WCD can also use historic temperature data to develop trend temperature data.

[0260] In another example, the WCD can be part of a system 2400C for controlling home appliances. The system 2400C can include a WCD 2410C, one or more home appliances 2420C, and an access point 2430C. Such home appliances 2420C can

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include, for example, a television, lights, speakers, microwave, range, stove, oven, etc. Each of the home appliances can include an antenna that allows the respective home appliances to communicate wirelessly with one or more access points 2430C. In one example, the appliances can include a ScenSor DWIO00 chip provided by DecaWave. In this way, the locations of the appliances in the room can be determined to an accuracy of approximately 10 cm. The location of the WCD 2410C can also be determined, using the above-referenced chip, or by using signal strengths of one or more base stations.

[0261] Having established the position of one or more home appliances and the user in a room, the user can make a gesture to control such home appliances 2420C. For example, the user can point at the TV (while wearing the WCD) in order to tum it on/off. Knowing the position of the user and the position of the TV, the direction of the gesture and the type of gesture can indicate what action to take on which device. The accelerometer and/or magnetometer on the WCD can be used to create a vector to the object to control, and a wireless packet can bet sent to a wireless access point to control the respective appliance.

[0262] FIG. 24D is a flow chart depicting a method 2400D of controlling home appliances according to one or more aspects of the disclosure. At block 241OD, the locations of one or more home appliances in a room and/or house can be ascertained/determined. As described above, the appliances can include a processor configured to identify location within a room. At block 2420D, the location of the WCD is determined. At block 2430D, the user can make a gesture toward a home appliance to exert control over the home appliance. Such gesture can include a snap, a point, etc. At block 2440D, the accelerometer and/or magnetometer on the WCD can be used to create a vector to the object to control. At block 2450D, a wireless packet can bet sent to a wireless access point to control the respective appliance. The access point can then issue the command to the respective appliance.

[0263] FIG.25 is a perspective view of the hand of a user employing a two-factor authentication technique according to one or more aspects of the disclosure.

[0264] As shown, the user 2500 is wearing a WCD 2510 and is approaching a locked door 2520 with an access node 2530 associated therewith. The access node 2530

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can be a wireless access node of a conventional or custom arrangement, and can communicate wirelessly according to any type of wireless protocol, such as WiFi or Bluetooth. As the user approaches the door 2520, the WCD 2510 can initiate a communication link, e.g., Bluetooth or WiFi, with the access node 2530. In this way, the WCD and the access node can engage in one or more handshaking or query procedures to verify the WCD. For example, the access node 2530 can detect a MAC address, IP address, or other alphanumeric identifier associated with the WCD and compare it to a list of authorized users. Such network-based communication processes should also be clear to those of skill.

[0265] Once the MAC address or other identifier is verified, the user can engage in a pre-defined gesture 2550 to complete the authentication procedure. The gesture 2550 can be any type of hand and/or finger motion that can be performed by the user. In this regard, the accelerometer or magnetometer can detect the gesture 2550 performed by the user and provide the gesture information to the access node. If the provided gesture information corresponds with an authorized gesture stored at or accessible by the access node, then the user may be granted authorization and the door can be unlocked. The authorized gesture can be a general authorized gesture for all users, or can be a specific gesture authorized only for the particular MAC address.

[0266] In addition to a door, the method above can be used to gain access to other features, such as unlocking a mobile phone, unlocking a car door, starting a car. The authentication technique above is advantageous in that it can eliminate extraneous authentication devices, such as key fobs for a car, a door, keypads for entry control, etc., and can provide a secure two-factor authentication technique to avoid unwanted access. More generally any type of keyless entry system (e.g. a keypad, card-reader, keyless lock, etc.) can be equipped with appropriate communication interfaces (RF, IR, etc.) to communicate with the WCD and operate based on a gesture and/or proximity of the user using the techniques described above. The WCD can also be employed generally in this manner to activate or deactivate a residential or commercial alarm system-substituting, for example, for a key fob used for this purpose.

[0267] FIG. 26A is a schematic view of a charging apparatus for charging the WCD according to one or more aspects of the disclosure. As shown, a mobile device 2610 can be received within a case 2620. The mobile device 2610 can be electrically connected to

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the case 2620 via a port 2610a on the mobile device 2610 and a connector 2620a on the case 2620. As shown in phantom, the case 2620 can include an integrated battery 2630 within the case that can charge the mobile device via the connector or can charge a WCD, as will be described in greater detail below.

[0268] The integrated battery can be connected to an antenna 2640 disposed on or within the case 2620 that can emit an RF signal, as shown in the block diagram in FIG. 26C. The RF signal can have a power of less than 500mW and a frequency of 13.56MHz. The RF signal can be emitted in all directions around the case such that it can be received by a WCD in proximity to the case.

[0269] FIG. 26B shows a WCD 2650 including an RF antenna 2660 and charging circuitry 2670. The RF antenna 2640 can be disposed within the housing 2680 and can receive the RF signal emitted by the case 2620 and convert it to a current that can be used to charge the WCD battery (not shown). This can advantageously allow the user to charge the WCD without removing the WCD from the finger. As shown in FIG. 26D, the charging can occur whenever the WCD is in close proximity to the case, such as when a user talking on the phone or merely handling the phone. In another implementation, the case can utilize inductive charging to charge the WCD. In this regard, the case can include an induction coil subjected to a predetermined current to produce a magnetic field. A corresponding induction coil within the housing of the WCD can be subjected to the magnetic field to produce a current that can charge the onboard battery in accordance with known electromagnetic principles.

[0270] FIG. 27A is a pictorial diagram and FIG. 27B is a block diagram of a WCD employing flash storage according to one or more aspects of the disclosure. As described above, the WCD 2700 can include a housing 2710, an antenna 2720, and an integrated circuit (IC) 2730 including a flash memory 2740. The IC and the flash memory can be disposed within the housing 2710. The flash memory 2740 can be powered by a battery 2750 and connected to the IC 2730, which can be implemented as a system-on-a-chip (SoC) IC 2760. The IC can include Bluetooth Low Energy (BLE) capability to allow for communication with another device. The flash memory can be used to store data, or can be used in any of the authentication techniques described above. The WCD can transmit data stored on the flash memory to another device 2780 via the BLE connection, or can receive data and store the data on the flash memory.

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[0271] FIG. 28A is a schematic diagram of one or more WCDs performing proximity functions according to one or more aspects of the disclosure. The WCD can detect a strength of an RF signal received by its antenna, and calculate a distance to the source of the RF signal using a Received Signal Strength Indicator (RSSI). In one example, the RF signal can be from a mobile device, an access point, or another WCD. The use of RSSI can have many applications in proximity detection. For example, the WCD can be placed on a child and can be connected to mobile device held by a parent. If the WCD travels a predetermined distance from the mobile device, the WCD can issue an alert to the mobile device, thereby alerting the parent that the child has wandered too far. In another example, the parent can wear a first WCD and the child can wear a second WCD. The first WCD can alert the parent that a child has wandered too far.

[0272] A single user can wear a first WCD 2800 on a first finger on a first hand and a second WCD 2810 on a second finger on a second hand. In this regard, the user can measure the relative distance between the first and second fingers using an RSSI via a wireless link 2830 between the WCDs 2800, 2810, such as a BLE connection. This can be used to measure an approximate dimension of an object held in both hands or to estimate a mid-air measurement.

[0273] In some examples, a first user can wear a first WCD 2800 and a second user can wear a second WCD 2810. The RSSI can be collected over a period of time and the processor can analyze the data to develop trends or statistics. For example, the RSSI data can indicate that the first and second users have spent a certain amount of time together and can serve as a relationship monitor.

[0274] The WCD can also detect when the first user and second user are holding hands. FIG. 28B is a schematic diagram of one or more WCDs 2800, 2810 performing proximity functions according to one or more aspects of the disclosure. Similar to the ECG monitoring techniques described above, a circuit can be formed when the users hold hands 2840 (with the respective hands wearing the WCDs). The circuit can be used to transmit data and/or electrical impulses between the respective WCDs via the circuit. The WCDs can collect data regarding the length of time that the users are holding hands and, in combination with the amount of time spent together, monitor the relationship of the two users. In addition, the WCD can collect data regarding communication between

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the users, e.g., e-mail, social media, etc. Based on all of the above factors, the WCD can develop a relationship score between respective WCD users, with a higher relationship score indicating more and more frequent interactions.

[0275] FIG.29A is a flow chart depicting a method of initiating gesture input according to one or more aspects of the disclosure. The WCD can be used to perform one or more commands, or to instruct another device, such as a mobile device, to perform one or more commands. Such commands can include, initiate sleep state of WCD, initiate sleep mode or default mode of WCD, powering off/on of the WCD, turning on/off an LED light of the WCD, powering on/off of a mobile device, placing a phone call on the mobile device, etc. The user can establish one or more custom gestures to initiate any of the commands above. For example, the user can select a command to be customized from a number of commands. Once selected, the user can perform a custom gesture to be associated with that command. In some examples, the user can perform the custom gesture multiple times to allow the WCD to better identify the gesture and to develop error tolerances for registering the gesture.

[0276] At block 2910, the user can perform a first gesture. In this example, the user can perform a finger snap. At block 2920, WCD can register the gesture, via the accelerometer and/or the magnetometer. At block 2930, the accelerometer can send an interrupt signal to the processor. At block 2940, the processor can wake from a sleep or default system state. At block 2950, the processor can monitor the accelerometer for a second gesture, at which point the user can perform a second gesture. If the second gesture matches a gesture in the gesture command database, then the WCD can perform the associated command. If not, the WCD can return to the sleep state.

[0277] FIG.29B is a chart 2900B showing an exemplary graph of acceleration vs. time as measured by the accelerometer of the WCD. As shown at peak2910B, the gesture can only be registered if it reaches a predetermined acceleration threshold. If the gesture performed at 2910 meets the threshold, it can proceed to block2930 where the interrupt procedure is performed.

[0278] FIG. 30 is a perspective view of a WCD 3000 employing an illustrative reset function and associated procedure/process. As shown, the WCD 3000 can be removed from the finger of the user in order to initiate a system reset of the WCD. In one

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example, the system reset can be initiated by spinning about a rotation axis R at a predetermined speed. The predetermined speed can be any value, and in one example is a rotational velocity. Upon performing the reset procedure at the predetermined speed, operation of the WCD 3000 can be interrupted and the onboard components of the 3000 can power off, and revert to factory default settings. Additionally, a series of movements can initiate a rest, such as putting the ring on a table and turning it over several times.

[0279] FIG. 3lA is a perspective view of a WCD including an LED indicator according to one or more aspects of the disclosure. As shown, the WCD 3100 can include an internal/external housing 3112 and an internal/external potting 3114. The WCD can include an LED 3120 that can be visible through the internal/external potting 3114.

[0280] FIGs. 31B and 31C are cross sections along line C-C of a WCD employing an LED indicator according to one or more aspects of the disclosure. As described above, the WCD 3100 can have an internal and/or external potting 3114 that can be transparent. This allows light sources within the housing to pass through the potting without changing, or with minimal change to, the optical properties of the light. In this way, a light source 3120, such as an LED, can be disposed on the PCB 3140 and can be powered at least partially by battery 3130. The LED can be encapsulated by the potting 3112 and can project light through the potting 3112. As shown in FIG. 31B, the LED 3120 can include a vertical LED, while 31C depicts a right angle LED. The vertical LED can project light along direction L1, while the right angle LED can project light along direction L2. When light is projected along L2, the light can travel around a circumference of the finger of the user.. Note that, according to aspects of the disclosure, the potting can be generally adapted in whole or in part to condition, filter or modify the wavelengths and/or projection qualities of light by for example, embedding lensmatic components, applying light-diffusive additives, light attenuating filter materials, etc.

[0281] FIG. 32 is flow chart depicting a method 3200 of communicating with a near field communication (NFC) device according to one or more aspects of the disclosure.

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[0282] In some examples, the WCD can enable or disable NFC or change the functionality of a NFC device. For example, the WCD can itself engage in NFC with another computing device, or the WCD can be connected via wireless link to a computing device that engages in NFC with a different computing device. In certain existing NFC devices, NFC will connect and begin transmitting data as soon as it is queried. In the present example, NFC is enabled or begin transmitting data exclusively upon performing of a pre-determined gesture. However, a variety of other transmission processes can be implemented-for example a periodic chirp or handshake request by the WCD for communication with appropriate devices.

[0283] At block 3210, a NFC capable device is provided. The device can be any type of device, such as a laptop, tablet, mobile device, or dedicated NFC device.

[0284] At block 3220, the WCD initiates a connection with the NFC device. The connection can be a direct connection via NFC, or an indirection connection via an intermediate device. At this point, no data has yet been transmitted between the WCD and the NFC device.

[0285] At block 3230, a user performs a predetermined gesture that is registered by the WCD. The gesture can be any type of gesture, such as a point, a snap, waving the hand, etc.

[0286] At block 3240, data transmission begins between the NFC device and the WCD.

[0287] In other examples, the user can perform another gesture to cease NFC communication. The gesture can be the same gesture as described above or a different gesture. Additionally, the user can remove the ring to disable the NFC. Upon donning the ring the user will be prompted by the application on the mobile device to re-authenticate by entering a PIN, whereby the proper PIN results in re-enabling the NFC functionality.

[0288] In yet another example, the WCD device employing NFC can be configured on the fly to map to different data sets stored thereon. For example, the WCD device employing NFC can employ data thereon to make purchases, e.g., account information, data to access a building, e.g., a key fob, and data thereon to board public transportation, e.g., smart card, metro card, etc. A user can perform a predetermined different gesture

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for each of the above data sets to access the data. Once accessed, the WCD device employing NFC can initiate a link with another computing device to initiate a transaction, to open a door, or to board public transportation, etc.

[0289] **VI. Optical Element and Attachment Frame**

[0290] FIG. 33A depicts a perspective view of a WCD assembly 3300 according to one or more aspects of the disclosure, while FIGs. 33B-D depict exploded views of the WCD assembly and 33E depicts a cross sectional view of the WCD assembly along A-A. In this example, the WCD assembly 3300 includes a WCD 3310, an attachment frame 3320, and an optical element 3330. The WCD 3310 can be any of the WCD examples described above or below in the present application.

[0291] The attachment frame 3320 is releasably attached to the WCD3310. The optical element 3330 is itself releasably attachable to the attachment frame 3320. In this regard, the attachment frame 3320 provides an attachment interface between the WCD 3310 and the optical element 3330, thereby allowing the optical element 3330 to be at a fixed position in space with respect to the WCD 3310 or any portion thereof. The attachment frame3320 can be made of any material, such as a metal, polymer, etc. Any type of polymer can be used, such as thermosetting plastics, thermoplastics, PETE, polycarbonate, polyethylene, LDPE, or any other type of plastic.

[0292] The attachment frame can be sized and shaped to fit along the curved surface of the WCD. For example, the attachment frame can have a curved undersurface to allow a flush fit with the curved surface of the WCD. The attachment frame can have any shape, size, or radius of curvature depending on the size and shape of the WCD.

[0293] The attachment frame 3320 includes a first retaining a portion 3322 and a pair of second retaining portions 3324. The first retaining portion 3322 defines a conical recess 3322a configured to receive the optical element 3330, and provides a generally unoccluded pathway for light to pass through the optical element and onto the WCD. Although depicted as defining a conical or frustoconical shape, the recess 3322a can be any other shape depending on the shape of the optical element 3330. Each of the second retaining portions3324 includes a respective locking feature 3324a. The respective locking features3324 and a extend from the second it retaining portion3324 toward one another such that a distance between the respective locking features is greater than a

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distance between the remaining portions of the second retaining portions. As shown in FIG. 33E, the locking features engage with an inward-facing surface 3350 of the WCD to ensure a secure fit. In one example, the inward-facing surface of the WCD may itself have one or more features 3360 to engage with the locking features of the second retaining portions. Such one or more WCD features can include projected surfaces, recesses, or any other type a feature to allow for engagement with the attachment frame.

[0294] The optical element 3330 can be made of any material capable of modifying, e.g., focusing, incident electromagnetic radiation, such as visible light, ultraviolet light, infrared light, or any other type of electromagnetic radiation. In some examples, the optical element 3330 can be constructed from a polymer, such as any of the polymers identified above. In another example, the optical element can be made of glass, quartz, diamond, zirconium, or any other material capable of focusing light. More generally, the optical element 3330 is formed with a general outward appearance simulative of a faceted jewel with an appropriate tint or coloration (including clear/white). The term "jewel" can also be used in the alternative to describe the optical element 3330 herein.

[0295] The WCD can include CPV cell 3312 that can be disposed directly underneath the attachment frame 3320 and optical element 3330 when assembled. In other examples, the CPV can be positioned within the housing and can receive electromagnetic radiation via a transparent potting material. In this regard, incident light striking the optical element 3330 can be focused on to the CPV cell to allow for charging of the internal battery of the WCD. The optical element 3330 provides an increased charging efficiency when compared to the CPV exclusively receiving ambient light, since the ambient light is collected/gathered from a wider field, and then focused onto the CPV by the optical element 3330. In one example, a focal length of the optical element 3330 is different than a distance between the optical element and the CPV. For example, the focal length can be greater than or less than the distance between the optical element and the CPV. This can be advantageous in various aspects of the disclosure so as to avoid the light from focusing at a focal point directly on the CPV, which could cause damage to the CPV itself by over-concentrating the light at that single point of the overall CPV surface.

[0296] FIGs.34A-B depict a WCD assembly 3400 according to one or more aspects of the disclosure. In this example, the attachment frame 3420 does not extend to an

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inward-facing surface of the WCD 3410, but is instead form entirely on the outside-facing surface of the WCD. In some examples, the attachment frame 3420 can be semi-permanently or permanently affixed to the outward-facing surface of the WCD and can have a plurality of retaining portions (mounting prongs) 3422 that at least partially define a recess 3422a for receiving the optical element. As shown in FIG.34B, the optical element 3430 is releasably attached to the attachment frame 3420. This configuration can be particularly desirable, as it exhibits ornamental similarities to a traditional engagement ring while still having the increased functionality of the WCD. Note that while not shown, the mounting prongs can include small hook ends that springably retain the optical element 3430 when attached, but that can release the optical element based upon a prying motion. A customized grasping tool (not shown) can also be employed to remove (and attach) the optical element in this example.

[0297] **VII. Enclosure/Packaging**

[0298] FIG. 35A depicts an enclosure or case 3500 for storing a WCD according to one or more aspects of the disclosure. As shown, the enclosure3500 includes a lid 3510 and a base 3520. The lid 3510 and base 3520 can engage via a recessed portion 3522 formed in the base 3520 to provide a substantially sealed interior environment.

[0299] The lid 3510 can be cuboidal in external dimensions, or define any other type of geometric shape that allows sufficient internal volume to contain the WCD. For example a custom design shape (polyhedral, etc.) can be employed. In this example, the top portion3510 is substantially cuboidal as shown, including rounded edges rather than vertices. The lid can be substantially transparent to allow viewing of the WCD while enclosed therein, and can be made of any type of material, such as a polymer, glass, etc. The lid can also be mounted with pins on a hinge.

[0300] The base 3520 can be cuboidal, or any other type of geometric shape. In this example, the bottom portion is substantially cuboidal, including rounded edges rather than vertices as shown. The bottom portion can be made of any material and can be transparent or opaque.

[0301] The base 3520 can define a receptacle 3524 for receiving the WCD3505. The receptacle 3524 can be sized and shaped to receive the WCD 3505 and in this example is semicylindrical, e.g., a portion of a cylinder. The radius of the semicylinder

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can be slightly larger than a radius of the WCD in order to accommodate the WCD securely. The receptacle can lined with a soft material to allow for a soft, safe material to receive the WCD, such as a silicone, thermoplastic, fabric, felt, or other material.

[0302] FIG.35B is a cross sectional view of the assembled enclosure3500 shown above along the line B-B. As shown, when assembled, the WCD 3505 fits securely within the receptacle 3524. The interior of the lid3510 can be sized and shaped to conform to the shape of the WCD such that the WCD is completely surrounded and enclosed by the lid 3510, while in other examples, the lid3510 can be sized and shaped to allow for airspace 3514 between the lid surface and the WCD.

[0303] FIG.35C is a cross section of the enclosure along line A-A. As shown, the lid 3510 can include an integral optical element 3512. The optical element3512 can be a lens or any other device to modify, e.g. focus, light that passes therethrough. In this example, the optical element 3512 can be disposed at a predetermined distance away from one or more CPV cells 3507 disposed on the WCD 3505. This distance *d* can be measured from the center of the optical element to the CPV cells 3507, and the optical element can itself have a focal length *f*. In one example, the distance *d* can be greater than the focal length *f*, such that the optical element focuses light at a point above the WCD in the enclosure. In this regard, the light will not focus directly on the CPV cells disposed at the surface of the WCD, thereby avoiding overheating or damage to the CPV cells. In other examples, the distance *d* can be less than the focal length, which can also prevent light from focusing at a surface of the WCD.

[0304] FIG. 36 depicts an enclosure 3600 including air vents 3650 according to one or more aspects of the disclosure. In this example, the enclosure 3600 includes a plurality of vent holes 3650. The vent holes can be arranged on one or more faces of the lid. The vent holes 3650 can prevent overheating within the enclosure during charging of the WCD by allowing for circulation of convective air current. During shipping, the vent holes3650 can be covered by an adhesive and/or adhering (peel-off) polymer sheet of conventional arrangement to prevent debris or moisture from entering the enclosure. The enclosure can include a lid 3610, base 3620, receptacle 3624, and optical element 3612 as in the examples set forth above.

[0305] **VIII. Sizing**

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[0306] FIG. 37 depicts a method 3700 of sizing a finger according to one or more aspects of the disclosure. At block 3710, the hand of a user can be provided. The hand can be held still in mid-air or alternatively can be resting on a surface.

[0307] At block 3720, a first image is taken of the user's hand from a first perspective. The image can be taken by any type of imaging apparatus, such as a CCD or CMOS camera, a digital camera, a camera associated with a mobile phone, etc. The first image can be stored in a memory.

[0308] At block 3730, a second image is taken of the user's hand at a second perspective. In this regard, the second perspective is different from the first perspective so as to provide a distinct view in the second image of the user's hand. Block 3730 can be repeated any number of times. For example, a third image can be taken of the user's hand at a third perspective. In this regard, the third perspective is different from both the first and second perspectives so as to provide a distinct view in the third image of the user's hand, and so on.

[0309] At block 3740, a size of the user's finger can be derived from the plurality of images taken above. In some examples, as few as two images may be required, while in other scenarios, more than three images may be required, depending on a number of circumstances including image quality, selected perspectives, etc. The size can be derived from the plurality of images by any number of techniques, such as stitching the plurality of images together to generate a 3D typography of the fingers, then using photogrammetry algorithms to identify features on the fingers to determine the appropriate ring size. Furthermore, the touch screen of the smart phone can be used to measure the hardness of tissue by measuring the footprint/impression the fingers make while pressing a finger against the touch screen of a mobile phone.

[0310] FIG. 38 is a pictorial diagram showing a plurality of image perspectives of a user's hand 3802. As shown, perspectives 3810, 3820, and 3830, as well as the other perspectives, produce corresponding images (in a strip) 3812, 3822, and 3832. The images can be used to derive a size of the user's finger according to the methods described above.

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[0311] FIG. 39 depicts a sizing tool for sizing the finger of a user. As shown, the tool 2900 can include a plurality of finger holes 3910-3950. The tool 3900 can be made of any material, such as plastic, metal, or cardboard.

[0312] FIG. 40 depicts a sizing tool for sizing the finger of a user according to an alternate example. As shown, the tool 4000 can include a plurality of finger holes 4010-4050. The tool 4000 can be made of any material, such as plastic, metal, or cardboard.

[0313] FIG. 41 depicts yet another alternate example of a sizing tool for sizing the finger of a user. As shown, the tool 4100 can include a plurality of finger holes 4110-4150. The tool 4100 can be made of any material, such as plastic, metal, or cardboard. The thickness of the card reflects the thickness of the ring to ensure proper fit. Additionally, the sizing tool is designed such that it can be easily mailed to the user with a standard mail service such as USPS.

[0314] Any of the tools 3900, 4000, or 4100 can be provided to a user prior to purchase of the ring in order to obtain accurate sizing information prior to purchase. The tools include holes, as shown above, that can come in a plurality of predetermined finger sizes to allow a user to match his or her finger size with the tool. The best match, e.g., closest size that ensures a comfortable fit, can be identified using the tools. Alternatively, the tools can be provided at retail locations to size the finger of the user on site prior to purchase. More generally, a variety of other sizing techniques, such as those employed by conventional jewelers can be employed according to further aspects of the disclosure.

[0315] In another embodiment, a packaging or enclosure of the WCD can include a sizing diagram or interface embodied therein to allow a user to size a finger during the purchase process.

[0316] FIG. 42 depicts a method 4200 of monitoring activity according to one or more aspects of the disclosure.

[0317] At block 4210, a user can don or place the WCD onto the finger to secure it in the wearing position.

[0318] At block 4220, a user can perform any number of daily activities, such as running on a treadmill, walking, exercising, typing, etc.

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[0319] At block 4230, the WCD, contemporaneous with block 3220, can use one or more sensors to sense the activities of the user. For example, the sensors can detect location, speed, acceleration, orientation, heart rate, etc.

[0320] At block 4240, the WCD, or another computing device, can generate an entry in an activity log at the conclusion of a detected activity. If the activity detected by the sensors has a profile that has not yet been identified, the WCD can prompt the user to identify the activity. For example, the user can identify profiles such as "Run in Central Park," "Typing," "Run on Treadmill," etc. The WCD can associate the identity provided by the user with the activity profile identified by the sensors and store the identified activity in the WCD memory, or any other memory. Later, if the user performs the same activity and the WCD detects the activity profile as being similar to a saved activity, the WCD can identify the activity while the user is performing the activity and save the activity in the activity log. Each of the activities performed can be saved in the overall activity log and can be stored in a memory on the WCD, or other device, for later v1ewmg.

[0321] FIG.43 depicts a method 4300 of determining whether a user is wearing gloves according to one or more aspects of the disclosure. At block 4310, a user is provided while wearing the WCD, where such user may or may not be wearing gloves.

[0322] At block 4320, one or more light sensors on board the WCD can detect surrounding ambient light. Such light sensors could include, for example, a CPV or other light sensitive element.

[0323] At block 4330, one or more additional measurements maybe made. Such additional measurements can include, for example, an ambient temperature measurement and or a proximity measurement, e.g., detecting proximity of an object to the WCD via reflected electromagnetic radiation in the form of IR light.

[0324] At block 4340, a measured ambient temperature and ambient light measurements are compared to predetermined thresholds. If the ambient temperature measurement is above a certain predetermined temperature threshold and the ambient light measurement is below a certain threshold, it can be determined that the user is wearing a glove over the WCD.

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[0325] At block 4350, a measured proximity and ambient light measurements are compared to respective predetermined thresholds. If the proximity measurement is below a certain distance threshold (e.g., determines an item is in close proximity to the WCD) and the ambient light measurement is below threshold, it can determined that the user is wearing a glove over the WCD. In any of the above examples, an intensity of LED indicators of the WCD can be adjusted according to a detected ambient light using an appropriate algorithm or process that compares the ambient light to a scale and adjusts a desired driving current/voltage for the LEDs according to a predetermined formula (e.g. a proportional adjustment using an adjustment coefficient) or scale (e.g. a lookup table). For example, where there is abundant ambient light (e.g., detected ambient light above a predetermined threshold), the intensity of the LED indicators can be increased. In the same way, where there is little ambient light (detected ambient light below a predetermined threshold), the intensity of the LED indicators can be decreased.

[0326] In one example, the WCD can detect whether it is removed and or installed on the finger of the user. In this regard, as mentioned above, the WCD can have inward-facing light sensors, CPV, or temperature sensors. When a user installs a ring on his finger the measure of ambient light may decrease or the temperature may increase. Such changes in ambient light and/or temperature can be detected by one or more sensors onboard the WCD and a determination can be made that the user has removed and or installed the ring on his finger.

[0327] FIG.44 depicts a method 4400 of securing data onboard the WCD according to one or more aspects of the disclosure. At block 4410, a user may don the WCD on the finger. At block 4420, a user may execute an application on a mobile device, or other computing device, that can be previously associated and authenticated with the WCD. At block 4430, the user can enter an authorization code into the application running on the mobile device, such as a PIN code. At block 4440 the mobile device may transmit the authorization code to the WCD by any means of communication, such as, wired, wireless, Bluetooth, NFC, etc. At block 4450, the user wearing the WCD can now be again authenticated and associated with the WCD and can be granted access to certain functions and/or data storage of the WCD. At block 4460 a user may remove the WCD. At block4470 the WCD can detect that it is removed such as bio detection (including e.g., biometric identification) techniques described above with respect to inward facing

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sensor changes, temperature changes, or heart rate decreasing to zero. At block 4480, the authorization code previously stored on the WCD can be automatically deleted upon detection of removal to avoid unauthorized access to such information by a subsequent wearer or other querying party. Further or alternatively, additional information can be automatically deleted upon removal of the WCD, for example any data and or instructions stored on the onboard memory of the WCD such as personal information, banking information, confidential information, or other sensitive data.

[0328] **IX. Timepiece System**

[0329] FIG. 45A is a timepiece system 4500 according to one or more aspects of the disclosure. As shown, the timepiece system 4500 can include a conventional timepiece 4510 and a timepiece computing device (TCD) 4520. The TCD can be any shape, and in this example is in the shape of a cylinder. The radius can be significantly greater than a height of the TCD to provide the shape of a puck. The TCD can have one or more structural and/or functional components, and can be similar to the WCD described above with respect to hardware features, components, sensors, etc. Although depicted as cylindrical, the TCD can have any shape depending on the shape of the conventional timepiece. For example, where the timepiece has a rectangular or square face, the TCD can similarly have a rectangular or square profile.

[0330] A top surface 4520a of the TCD can include a pressure sensitive adhesive (PSA) layer 4522 to allow for adhesion of the TCD to the under surface of the timepiece 4510. The TCD 4520 can have a radius or circumference that does not exceed radius or circumference of the face of the conventional timepiece so as not to be seen when a user is wearing the timepiece system 4500. The TCD can enhance the conventional timepiece with many of the features described above with respect to the WCD such as, heart rate sensing, temperature sensing pedometer, activity sensing, gesture sensing and control, without having to alter the look of the conventional timepiece.

[0331] Fig 45B is a bottom view of the TCD. As shown, the TCD can include a battery 4540, any printed circuit board 4550 with one or more components attached thereto (not shown) such as motion sensors, power management circuitry, charging circuitry, etc. As with the WCD, the printed circuit board of the TCD can be overmolded 4560. The overmold can be transparent or substantially transparent to allow

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electromagnetic radiation to pass through to be incident upon one or more components of the TCD.

[0332] As shown, the TCD can include a light pipe 4524 around the perimeter thereof. The light pipe 4524 can be substantially annular in shape and can be formed in part by the overmold of the TCD. The light pipe can be constructed from a conventional transparent or translucent moldable material (e.g. acrylic, polycarbonate, etc.), and can be arranged to focus ambient light onto a CPV disposed onboard the TCD for additional charging capability. The optical arrangement/geometry of the light pipe can be implemented using skill in the art to achieve the desired optical characteristics. In another example, excess heat generated by the TCD or excess body heat emitted from the skin of the user can be converted to electrical energy via a thermoelectric (TEG) module, such as a Peltier module, disposed onboard the TCD.

[0333] The TCD can also include any number of CPV cells, either on a top surface or bottom surface, to allow for charging. For example, a CPV cell can be placed on the underside of the TCD to allow for docking with a charging/docking station.

[0334] FIG.46 depicts a WCD 4600 with a pair of LED indicators 4610-4620 disposed at an inward-facing portion of the WCD. As shown, the WCD 4600 can include a pair of transparent regions 4640-3650 and an opaque region 4630. The LEDs 4610- 3620 can be positioned under the transparent regions 4640-3650 to allow light from the LEDs to exit the WCD. In one example, the LEDs 4610-3620 can create a subtle diffuse glow to the skin to provide a desirable visual effect to user. In another example, a user feedback LED can be placed at an inward facing surface and a second can be placed at an outward facing surface of the WCD. Depending on the circumstances, one of the LEDs may be disabled to save battery life. For example, LEDs that are facing away from a user e.g. facing down or away from user's line of sight, may be disabled. As described above, the WCD can determine its orientation based on onboard sensors, such as the magnetometer, accelerometer, GPS, etc.

[0335] FIG. 47A is a system for generating and managing alerts according to one or more aspects of the disclosure. As shown, the system can include a WCD 4710A, one or more networks 4720A, and one or more server computers 4730A according to one or more aspects of the disclosure. The WCD 4710A can communicate directly and/or

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indirectly with the server 4730A via the network 4720A. In this regard, data generated and/or stored at the WCD 4710A can be transmitted to the server 4730A and vice versa. In one example, such data can include biometric data pertaining to a user wearing the WCD that is detected and stored by the WCD.

[0336] FIG. 47B depicts a block process diagram for generating and managing alerts according to one or more aspects of the disclosure and FIG. 47C is a flow chart depicting a method for generating and managing alerts according to one or more aspects of the disclosure.

[0337] At block 4710C, and as shown at process block 4710B, the user is authenticated with respect to the WCD. In this regard, a single user can be associated with a single WCD and can be associated with a predetermine identifier, such as an alphanumeric number. If the user is not authenticated or the authentication process is not conclusive, the WCD may invite the user to retry authentication at block 4715C until the user is successfully authenticated. In some examples, the WCD may timeout the authentication process, lock the WCD, or place the WCD in safe mode in the event of too many unsuccessful authentication attempts as a security measure.

[0338] The user can be authenticated according to any of the authentication methods described in the present application, such as via a unique capillary map, a unique ECG profile, etc.

[0339] If the user is authenticated, biometric data can be transmitted to the server at block 4720C. The captured biometric data 4720B can be transmitted to the server via network 4720A, 47222B

[0340] Once received at the server, the biometric data can be aggregated, sorted, categorized, or profiled at block 4730C and as shown at process block 4730B. In this regard, a profile (corresponding to the alphanumeric identifier) may be created at a database at the server that stores data for a particular user. The profile can store transmitted biometric data, as well as other data, such as user gender, height, weight, age, family history, disease information, location, etc.

[0341] In some examples, identifying information may be removed from the data and/or not transmitted to allow for anonymity and/or to comply with regulations regarding transmission of medical data. The transmitted biometric data can be

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normalized in order to comply with predetermined data requirements in order to be added to the profile. In one example, a minimum amount of data may be required in order to be considered viable for association with the profile. The biometric data of a single profile can be aggregated, or in other examples multiple profiles can be aggregated simultaneously.

[0342] Aggregation of the user's biometric data into a single profile allows for the profile to be visualized or analyzed according to any number of methods. For example, a timeline can be created showing biometric data over a period of time. The data can also be synthesized or analyzed to calculate trend data, or other mathematical features.

[0343] Although only one WCD is depicted, it is contemplated that a plurality of WCDs can exist, with each WCD corresponding to a distinct user (and distinct alphanumeric identifier) and therefore resulting in a plurality of distinct profiles at the server. Accordingly, each of the distinct users/WCDs may be authenticated separately according to the methods described herein.

[0344] At block 4740C, once the transmitted data has been associated with the user profile, the updated profile can be correlated with one or more other profiles stored at the server as shown as process block 4740B. The profiles may be correlated according to any number of correlation standards, such as correlating users with similar traits such as age, gender, location, profession, or by any other data stored at the server. In some examples, one or more of the traits can be used to make such a correlation. The biometric data from the one or more users that are correlated with one another can be combined to form a group profile. The group profile can be the aggregation, average, range, or sum of individual profiles that form the group profile. For example, for a particular group profile, a range of resting heart can be generated by taking the maximum and minimum values of resting heart from the individual profiles. In other examples, an average (and standard deviation or standard deviation of the mean) can be generated for each trait, such as average resting heart rate, average active heart rate, average blood pressure, average blood sugar, average skin temperature, ECG profiles, as well as any other features capable of being detected by the WCD as described above.

[0345] At block 4750C, transmitted biometric data can be compared to the established values from the group profile. In this way, if a user's heart rate deviates by a

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predetermined threshold (such as by predetermined magnitude or standard deviation), an alert can be generated at process block 4750B. The comparison process can occur at the server after transmission of the biometric data. In another example, the group profile data can be transmitted to the WCD for comparison at the WCD. This advantageously allows the comparison to be made where the WCD cannot establish a network link. The group profile can be updated on a continuous basis or a predetermined time interval or at each transmission of biometric data.

[0346] At block 4760C, the alert is transmitted to the WCD and displayed to the user at process block 4760B. The alert can indicate that the user's biometric data has deviated from the profile group and may advise the user to seek medical attention. In another example, the server can directly contact a medical health professional. In the example where block 4750C occurs at the WCD, transmission of alert information from the server may not be necessary.

[0347] The alert at the WCD can be any type of audio or visual indicator, such as an LED, haptic feedback, audible alarm, etc. The indicator may also invite the user to rest, make an appointment with a medical health professional, recommend a particular medication, or suggest certain physical activities that may health condition that caused the alert.

[0348] As shown in FIG. 47B, the authentication 4710B, aggregation 4730B, and correlation 4740B can occur at server 4730A, which can include a process, memory, and any other features of a general purpose computer. The authentication 471OB, aggregation 4730B, and correlation 4740B can access a database stored at the memory, where profiles, group profiles, and biometric data can be stored.

[0349] FIG. 48A is a method for variable sampling according to one or more aspects of the disclosure. As described above, the processor module of the WCD can determine (e.g., based on identified physical activities, routine pattern, and/or time) a frequency at which one or more sensors in the sensor modules should operate.

[0350] At block 4810A, one or more sensors of the WCD may take one or more measurements. For example, the WCD can detect temperature, heart rate, acceleration, as described above.

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[0351] At block 4820A, the WCD can calculate an activity level of a user. For example, the WCD can compare to a number of stored activity profiles (as described above) stored by the user, or can compare the sensor measurements to sensor threshold values corresponding to different activities, such as sitting, running, sleeping etc. In one example, the WCD detect acceleration values over time to generate an activity level for a particular time period.

[0352] At block 4830A, the WCD may compare the identified activity level to a predetermine activity threshold value. In one example, the WCD may categorize the detected activity as either a high level activity or a low level activity. High level activities can include running, swimming, biking etc., while low level activities may include sitting, standing still, or sleeping.

[0353] At block 4840A, the WCD can set a first sample rate for high level activities and at block 4850A, the WCD can set a second sample rate for low level activities. The first sample rate can be a shorter time interval than the second sample rate, resulting in more data being detected and generated during a set amount of time while the user is active. This allows for increased power efficiency of the WCD while also providing the advantage of generating more data when a user is more active, thereby providing added biometric data for later analysis.

[0354] In another example, the sample rate can be scaled according to activity level. For example, the sample rate can be scaled to be directly proportional to heart rate. This results in a shorter time interval for sampling (more frequent data gather) for running than for walking.

[0355] As activity level changes, the method above can be repeated a plurality of times at certain intervals in order to quick or abrupt activity changes.

[0356] FIG. 48B and 48c are graphs depicting one or more aspects of the sample method of FIG. 48A. As shown in FIG. 48B, the WCD may determine a user is engaging in a high level activity by detecting acceleration values that are above a predetermined threshold value. In this regard, a shorter time interval (more frequent data gathering) can be set. As shown in FIG. 48C, the user is engaging in a low level activity since the acceleration values are below a predetermined threshold. A longer sample rate (less frequent data gathering) can be set in this instance.

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[0357] FIG. 49 a diagrammatic representation of a machine in the example form of a computer system 4900 within which a set of instructions, for causing the machine to perform any one or more of the methodologies discussed herein, may be executed. Specifically, FIG. 49 shows a diagrammatic representation of a machine in the example form of a computer system within which instructions (e.g., software or program code) for causing the machine to perform any one or more of the methodologies discussed herein may be executed. In alternative embodiments, the machine operates as a standalone device or may be connected (e.g., networked) to other machines. In a networked deployment, the machine may operate in the capacity of a server machine or a client machine in a server-client network environment, or as a peer machine in a peer-to-peer (or distributed) network environment.

[0358] The machine may be a server computer, a client computer, a personal computer (PC), a tablet PC, a set-top box (STB), a personal digital assistant (PDA), a cellular telephone, a smartphone, a web appliance, a network router, switch or bridge, or any machine capable of executing instructions (sequential or otherwise) that specify actions to be taken by that machine. Further, while only a single machine is illustrated, the term "machine" shall also be taken to include any collection of machines that individually or jointly execute instructions to perform any one or more of the methodologies discussed herein.

[0359] The example computer system includes a processor (e.g., a central processing unit (CPU), a graphics processing unit (GPU), a digital signal processor (DSP), one or more application specific integrated circuits (ASICs), one or more radio-frequency integrated circuits (RFICs), or any combination of these), a main memory, and a non-volatile memory, which are configured to communicate with each other via a bus. The computer system may further include graphics display unit (e.g., a plasma display panel (PDP), a liquid crystal display (LCD), a projector, or a cathode ray tube (CRT)). The computer system may also include alphanumeric input device (e.g., a keyboard), a cursor control device (e.g., a mouse, a trackball, a joystick, a motion sensor, a touch screen, or other pointing instrument), a storage unit, a signal generation device (e.g., a speaker), and a network interface device, which also are configured to communicate via the bus.

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[0360] The storage unit includes a non-transitory machine-readable medium on which is stored instructions embodying any one or more of the methodologies or functions described herein. The instructions may also reside, completely or at least partially, within the main memory or within the processor (e.g., within a processor's cache memory) during execution thereof by the computer system, the main memory and the processor also constituting machine-readable media. The instructions may be transmitted or received over a network via the network interface device.

[0361] While machine-readable medium is shown in an example embodiment to be a single medium, the term "machine-readable medium" should be taken to include a single medium or multiple media (e.g., a centralized or distributed database, or associated caches and servers) able to store instructions. The term "machine-readable medium" shall also be taken to include any medium that is capable of storing instructions for execution by the machine and that cause the machine to perform any one or more of the methodologies disclosed herein. The term "machine-readable medium" includes, but not be limited to, data repositories in the form of solid-state memories, optical media, magnetic media, or other non-transitory machine readable medium.

[0362] **X. Conclusion**

[0363] It should be clear that the WCD and TCD arrangements described according to various aspects of the disclosure provide a highly versatile and useful item of wearable electronics that is comfortable and convenient to wear, conveniently charged, and weatherproof for all-purpose and all-condition wearing. Various options for style and appearance can be implemented, as well as a variety of storage options. The functions and structure of the device lend themselves to both a ring version and a wrist-worn version. All versions are designed for long-life with minimal maintenance, and are adaptable to interoperate with a variety of networked devices including computers, smartphones, home controllers, security systems, and virtually any other device capable of communicating over a wireless link-including another WCD or TCD.

[0364] The foregoing has been a detailed description of illustrative embodiments of the invention. Various modifications and additions can be made without departing from the spirit and scope of this invention. Features of each of the various embodiments

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described above may be combined with features of other described embodiments as appropriate in order to provide a multiplicity of feature combinations in associated new embodiments. Furthermore, while the foregoing describes a number of separate embodiments of the apparatus and method of the present invention, what has been described herein is merely illustrative of the application of the principles of the present invention. For example, as used herein various directional and orientational terms such as "vertical", "horizontal", "up", "down", "bottom", "top", "side", "front", "rear", "left", "right", and the like, are used only as relative conventions and not as absolute orientations with respect to a fixed coordinate system, such as the acting direction of gravity. Note also, as used herein the terms "process" and/or "processor" should be taken broadly to include a variety of electronic hardware and/or software based functions and components. Moreover, a depicted process or processor can be combined with other processes and/or processors or divided into various sub-processes or processors. Such sub-processes and/or sub-processors can be variously combined according to embodiments herein. Likewise, it is expressly contemplated that any function, process, application, and/or processor here herein can be implemented using electronic hardware, software consisting of a non-transitory computer-readable medium of program instructions, or a combination of hardware and software. Also, while a variety of visible and near-visible radiation sources are described as LEDs, it is expressly contemplated that other types of sources can be employed according to aspects of the disclosure-for example plasma discharge sources and bioluminescent sources, as well as sources that are based upon developing technologies. Electronic circuits and RF components can similarly be based on alternate and/or developing technologies. Accordingly, this description is meant to be taken only by way of example, and not to otherwise limit the scope of this invention.

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WEARABLE COMPUTING DEVICE

CROSS REFERENCE

[0001] The present Application for Patent is a Continuation of U.S. Patent Application No. 18/179,272, by von Badinski et al., entitled "WEARABLE COMPUTING DEVICE," filed March 6, 2023, which is a Continuation of U.S. Patent Application No. 17/519,201, by von Badinski et al., entitled "WEARABLE COMPUTING DEVICE," filed November 4, 2021, which is a Continuation of U.S. Patent Application No. 17/013,348, by von Badinski et al., entitled "WEARABLE COMPUTING DEVICE," filed September 4, 2020, which is a Continuation of U.S. Patent Application No. 16/224,686, by von Badinski et al, entitled "WEARABLE COMPUTING DEVICE," filed December 18, 2018, which is a Division of U.S. Patent Application No. 15/444,217, by von Badinski et al., entitled "WEARABLE COMPUTING DEVICE," filed February 27, 2017, which is a Division of U.S. Patent Application No. 14/556,062, by von Badinski et al, entitled "WEARABLE COMPUTING DEVICE," filed November 28, 2014, which claims the benefit of United States Provisional Application Serial No. 62/006,835, by von Badinski et al., entitled "WEARABLE COMPUTING DEVICE," filed June 2, 2014, and United States Provisional Application Serial No. 61/910,201, by von Badinski et al., entitled "FINGER RING DEVICE FOR ACTIVITY MONITORING OR GESTURAL INPUT," filed November 29, 2013, each of which is expressly incorporated by reference herein.

FIELD OF TECHNOLOGY

[0002] This invention is in the field of wearable electronic devices.

BACKGROUND

[0003] Wearable electronics are an emerging technology with many applications for the wearer. They can improve lifestyles, ease access to technology and help monitor activity within the wearer's body. However, many current wearable electronics are bulky and can be intrusive or interfere with a person's daily life. In this regard, the wearer may not be comfortable wearing the device for extended periods of time.

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SUMMARY OF THE INVENTION

[0004] This invention overcomes the disadvantages of the prior art by providing a wearable computing device (WCD) in the shape of a ring. The wearable computing device can be worn for extended periods of time and can take many measurements and perform various functions because of its form factor and position on the finger of a user.

[0005] One aspect of the disclosure provides a wearable computing device, comprising: an interior wall; an exterior wall; a flexible printed circuit board disposed between the interior wall and the exterior wall; at least one component disposed on the flexible printed circuit board; and wherein at least one of the interior wall and the exterior wall defines a window that facilitates at least one of data transmission, battery recharge, and status indication.

[0006] In one example, the window comprises an internal window defined by the interior wall.

[0007] In one example, the window comprises an exterior window defined by the exterior wall.

[0008] In one example, the window comprises a plurality of exterior windows defined by the exterior wall.

[0009] In one example, the plurality of exterior windows comprises a first exterior window and a second exterior window, wherein the first exterior window facilities battery charging and the second exterior window facilities data transmission.

[0010] In one example, at least one concentrated photovoltaic cell, an antenna, and at least one LED are accessible via the window.

[0011] Another aspect of the disclosure provides a wearable computing device, comprising: an internal housing portion configured to be disposed near a finger of a user; a flexible printed circuit board arranged around a portion of a circumference of an interior surface of the internal housing; at least one component disposed on the flexible printed circuit board; and an external housing portion configured to seal the at least one component and the printed circuit board in an internal space defined by the interior surface of the internal housing.

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[0012] In one example, the external housing portion comprises a substantially transparent external potting.

[0013] In one example, the at least one component comprises at least one LED configured to emit at least one of visible light, infrared radiation, and ultraviolet radiation through the external potting.

[0014] In one example, the at least one component comprises a concentrated photovoltaic cell configured to receive concentrated light through the transparent external potting.

[0015] In one example, the flexible printed circuit board includes a plurality of stiffener elements configured to engage with a corresponding plurality of flanges disposed on the internal housing portion.

[0016] Another aspect of the disclosure provides a wearable computing device, comprising: an external housing portion; a flexible printed circuit board arranged around a portion of a circumference of an interior surface of the external housing; at least one component disposed on the flexible printed circuit board; and an internal housing portion configured to seal the at least one component and the printed circuit board in an internal space defined by the interior surface of the external housing.

[0017] In one example, the internal housing portion comprises a substantially transparent internal potting.

[0018] In one example, the at least one component comprises at least one LED configured to emit at least one of visible light, infrared radiation, and ultraviolet radiation through the internal potting.

[0019] In one example, the at least one component comprises a concentrated photovoltaic cell configured to receive concentrated light through the transparent internal potting.

[0020] In one example, the flexible printed circuit board includes a plurality of stiffener elements configured to engage with a corresponding plurality of flanges disposed on the external housing portion.

[0021] Another aspect of the disclosure provides a system, comprising: a wearable computing device, including a housing and a photovoltaic element disposed at least

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partially within the housing; and a base assembly, the base assembly including a concentrated light source directed at the photovoltaic element.

[0022] In one example, the wearable computing device includes at least one ferrous element disposed within the housing, and wherein the base assembly includes at least one magnetic element disposed therein.

[0023] In one example, the concentrated light source is arranged circumferentially around the wearable computing device when the wearable computing device is engaged with the base assembly.

[0024] In one example, the concentrated light source comprises at least one of a laser diode and a light emitting diode (LED).

[0025] In one example, a housing of the WCD defines an opening through which the WCD is configured to receive concentrated light.

[0026] In one example, the base assembly comprises an optical element for focusing concentrated light emitted from the concentrated light source.

[0027] In one example, the optical element comprises a lens and is selected from the group consisting of concave, convex, piano-concave, piano-convex.

[0028] In one example, the WCD comprises at least one transparent potting configured to allow concentrated light to pass therethrough.

[0029] In one example, the WCD is ring-shaped and the base assembly comprises at least one post configured to engaged with a finger space of the WCD.

[0030] In one example, the photovoltaic cell comprises a plurality of photovoltaic cells.

[0031] Another aspect of the disclosure provides an enclosure for a wearable computing device, the enclosure comprising: a base defining a receptacle for receiving the wearable computing; a lid configured to engage with the base to substantially enclose the wearable computing device, the lid having an optical element configured to direct incident electromagnetic radiation to photovoltaic cell disposed on the wearable computing device to allow charging thereof.

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[0032] In one example, the lid includes a plurality of vent holes that prevent overheating within the enclosure.

[0033] In one example, the optical element comprises a lens.

[0034] In one example, the lens has a focal length and wherein a distance between a central portion of the lens and the photovoltaic cell is greater than or less than the focal length.

[0035] Another aspect of the disclosure provides a timepiece system, comprising: a timepiece having a substantially planar under surface; and a timepiece computing device adhered to the planar under surface, the timepiece computing device being substantially cylindrical and comprising: a processor; a memory; and at least one sensor.

[0036] Another aspect of the disclosure provides a wearable computing device system, comprising: a wearable computing device; an attachment frame coupled to the wearable computing device; and an optical element removably coupled to the attachment frame, wherein the optical element is configured to direct electromagnetic radiation to a photovoltaic cell disposed on a surface of the wearable computing device to allow for charging of the wearable computing device.

[0037] In one example, the attachment frame is removably coupled to the wearable computing device.

[0038] In one example, the attachment frame engages with an inward-facing surface of the wearable computing device.

[0039] Another aspect of the disclosure provides a method of identifying an authorized user of a wearable computing device, comprising: illuminating a portion of a skin surface of the user; imaging the portion of the skin surface of the user to generate at least one first image; generating a reference capillary map corresponding to the user based at least in part on the at least one image.

[0040] In one example, the method further includes rotating the wearable computing device during the illuminating and imaging steps.

[0041] In one example, the method further includes imaging the portion of the skin surface of the user to generate at least one second image; and comparing the at least one second image to the reference capillary map in order to authenticate the user.

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[0042] Another aspect of the disclosure provides a method of navigating, comprising: gesturing in a first direction while wearing a wearable computing device; comparing the first direction to a predetermined direction in a predetermined set of directions; providing feedback based on the comparison of the first direction of the predetermined direction.

[0043] In one example, the gesture comprises pointing a finger and the first direction comprises a first heading.

[0044] Another aspect of the disclosure provides a method of regulating temperature, comprising: measuring a skin temperature of a user via a first temperature sensor; measuring an ambient temperature via a second temperature sensor; comparing the skin temperature to a predetermined threshold temperature; and adjusting the ambient temperature based in part on the comparison.

[0045] In one example, measuring the skin temperature comprises measuring the skin temperature via a first temperature sensor disposed at an inward facing surface of a wearable computing device.

[0046] In one example, measuring the ambient temperature comprises measuring the ambient temperature via a second temperature sensor disposed at an outward facing surface of the wearable computing device.

[0047] Another aspect of the disclosure provides a method for controlling appliances, comprising: identifying a position of a first appliance in a room; gesturing a first gesture in a direction of the first appliance; identifying the direction of the first direction via a wearable computing device; issuing a controlling command to the first appliance based in part on the identified direction of the gesture.

[0048] Another aspect of the disclosure provides a method of generating an alert, comprising: authenticating a first wearer of a first wearable computing device as a first authenticated user; transmitting first biometric data associated with the first wearer; associating the first biometric data with a first profile associated with the first wearer of the first wearable computing device; comparing the first biometric data with a group profile comprising aggregated biometric data from a plurality of distinct wearers of a plurality of distinct wearable computing devices; and generating an alert if the first

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biometric data falls outside of a predetermined threshold set by the aggregated biometric data.

[0049] In one example, the biometric data comprises at least one of heart rate; ECG profile; blood sugar, and blood pressure.

[0050] In one example, the plurality of distinct wearers share a common trait, resulting in their aggregation into the group profile.

[0051] In one example, the common trait comprises at least one of: age, gender, profession, and location.

[0052] Another aspect of the disclosure provides a method of determine a sampling rate of a wearable computing device, comprising: determining an activity level of a wearer of a wearable computing device based at least in part on data from at least one sensor disposed onboard the wearable computing device; comparing the activity level to a predetermined activity threshold; and increasing a first sensor sampling rate if the activity level is above a predetermined activity threshold.

[0053] In one example, the method further includes decreasing the first sensor sampling rate if the activity level is below a predetermined activity threshold.

[0054] In one example, the predetermined activity threshold comprises an acceleration measurement.

BRIEF DESCRIPTION OF THE DRAWINGS

[0055] The invention description below refers to the accompanying drawings, of which:

[0056] FIG. 1A is a perspective view of a WCD illustrating an exterior window in accordance with some embodiments;

[0057] FIG. 1B is a perspective view of the WCD of FIG. IA illustrating an interior window in accordance with some embodiments;

[0058] FIG. 1C is a perspective view of an alternative WCD design of the ring of FIG. IA in accordance with some embodiments;

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[0059] FIG. 2 is an abstract functional diagram illustrating example components within the WCD in accordance with some embodiments;

[0060] FIG. 3A is a view of an exterior window of a WCD with example components exposed in accordance with some embodiments;

[0061] FIG. 3B is a view of an interior window of a WCD with example components exposed in accordance with some embodiments;

[0062] FIG. 3C is a view of the exterior windows of an alternative WCD with example components exposed in accordance with some embodiments;

[0063] FIG. 4 is an exploded view of a WCD illustrating a battery and a flexible circuit which are configured to fit inside the housing of the WCD in accordance with some embodiments;

[0064] FIG. 5 is a perspective view of the flexible circuit of FIG. 4 in accordance with some embodiments;

[0065] FIG. 6 is an exploded view of a WCD with an alternative charging mechanism in accordance with some embodiments;

[0066] FIG. 7 is a perspective view of an alternative design of a WCD in accordance with some embodiments;

[0067] FIG. 8 is an exploded view of the WCD of FIG. 7 illustrating another alternative charging mechanism in accordance with some embodiments;

[0068] FIG. 9A is a perspective view of a charging device for the ring station in accordance with some embodiments;

[0069] FIG. 9B is an abstract diagram illustrating a partial structure of the charging station of FIG. 9A in accordance with some embodiments;

[0070] FIG. 10 is an example screenshot illustrating a user interface of a mobile application coupled to the WCD and displaying fitness monitoring readings in accordance with some embodiments;

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[0071] FIG. 11 is an example screenshot illustrating a user interface of a mobile application coupled to the WCD and displaying sensor readings (e.g., for calibration purposes) in accordance with some embodiments;

[0072] FIG. 12A is a perspective view of a wearable computing device (WCD) according to one or more aspects of the disclosure;

[0073] FIG. 12B is a side view of a WCD according to one or more aspects of the disclosure;

[0074] FIG. 12C is a front view of the WCD according to one or more aspects of the disclosure;

[0075] FIG. 12D is a cross section of the WCD along the line A-A of FIG. 12C;

[0076] FIG. 12E is a perspective view of the internal housing without external potting;

[0077] FIG. 12F is a perspective view of the internal housing with a portion of the external potting removed and showing one or more components and printed circuit board (PCB);

[0078] FIG. 13 is a cross section of a WCD according to another aspect of the disclosure;

[0079] FIG. 14A is a cross section of a WCD according to another aspect of the disclosure;

[0080] FIG. 14B is a perspective view of the PCB and stiffener element of FIG. 14A;

[0081] FIG. 14C is a perspective view of the PCB and stiffener element of FIG. 14A;

[0082] FIG. 14D shows a cross section of the WCD at a point in time when the PCB is being inserted into the internal space and prior to the application of potting;

[0083] FIG. 14E is a cross section of the WCD of after a potting material has been applied subsequent to the WCD of FIG. 14D;

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[0084] FIG. 15A depicts a perspective view of a WCD according to another aspect of the disclosure;

[0085] FIG. 15B is a side view of the WCD of FIG. 15A;

[0086] FIG. 16A is an exploded view of a housing and a PCB of a WCD according to one or more aspects of the disclosure;

[0087] FIG. 16B is a cross section of FIG. 16A along line B-B;

[0088] FIG. 16C is a perspective view of the WCD with potting material;

[0089] FIG. 17A depicts a cross section of a WCD employing charging by concentrated light source according to one or more aspects of the disclosure;

[0090] FIG. 17B depicts a cross section of a WCD employing charging by concentrated light source according to another aspect of the disclosure;

[0091] FIG. 17C is a perspective view of a base assembly and WCD 700 according to one or more aspects of the disclosure;

[0092] FIG. 17D depicts a perspective view of internal components of the base assembly 750 and WCD 700 according to another aspect of the disclosure;

[0093] FIGs. 17E-F depict other CPV configurations according to one or more aspects of the disclosure;

[0094] FIG. 17G is perspective view of a WCD and base assembly with a lx3 CPV arrangement;

[0095] FIG. 18A depicts a cross section of a WCD 800 employing charging by concentrated light source according to another of the disclosure;

[0096] FIG. 18B depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure;

[0097] FIG. 19A depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure;

[0098] FIG. 19B depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure;

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[0099] FIG. 19C depicts a schematic diagram of magnets that can be used in a WCD and/or base assembly according to one or more aspects of the disclosure;

[0100] FIG. 19D depicts a schematic diagram of magnets that can be used in a WCD and/or base assembly according to one or more aspects of the disclosure;

[0101] FIG. 19E is a perspective view of a WCD and a base assembly according to one or more aspects of the disclosure;

[0102] FIG. 20A is a cross section of a WCD engaged with a base assembly 1050 according to one or more aspects of the disclosure;

[0103] FIG. 20B is a perspective view of a PCB 1040b with a CPV 1030b and ferrous element 1020b configuration according to one or more aspects of the disclosure;

[0104] FIG. 20C is a perspective view of a PCB with a CPV 1030c and ferrous element 1020c configuration according to one or more aspects of the disclosure;

[0105] FIG. 20D is a perspective view of a magnet and a concentrated light source 1070d according to one or more aspects of the disclosure;

[0106] FIG. 21A is a schematic view of a WCD showing components used for identifying the wearer of the WCD;

[0107] FIGs. 21B-C are perspective views of a skin surface according to one or more aspects of the disclosure;

[0108] FIG. 22A is a perspective view of a user employing ECG monitoring according to one or more aspects of the disclosure;

[0109] FIG. 22B is a view of a human with an electric pathway though his body according to one or more aspects of the disclosure;

[0110] FIG. 22C is a perspective view of a WCD that can employ ECG monitoring according to one aspect of the disclosure;

[0111] FIG. 23A is a perspective view of the hand of a user in various positions employing the navigational features of the WCD;

[0112] FIG. 23B is a flow chart depicting a method of providing feedback to a user according to one or more aspects of the disclosure;

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[0113] FIG. 24A is a schematic diagram of a system 1400 for controlling an environment of a user according to one or more aspects of the disclosure;

[0114] FIG. 24B is a side view of a WCD showing one or more temperatures sensors according to one or more aspects of the disclosure;

[0115] FIG. 24C is a system diagram of a system for controlling home appliances according to one or more aspects of the disclosure;

[0116] FIG. 24D is a flow chart depicting a method of controlling home appliances according to one or more aspects of the disclosure;

[0117] FIG. 25 is a perspective view of the hand of a user employing a two-factor authentication technique according to one or more aspects of the disclosure;

[0118] FIG. 26A is a schematic view of a charging apparatus for charging the WCD according to one or more aspects of the disclosure;

[0119] FIG. 26B shows a WCD including an RF antenna and charging circuitry;

[0120] FIG. 26C is a block diagram of the charging apparatus according to one aspect of the disclosure;

[0121] FIG. 26D is a pictorial diagram showing of the WCD according to one or more aspects of the disclosure;

[0122] FIG. 27A is a pictorial diagram and FIG. 27B is a block diagram of a WCD employing flash storage according to one or more aspects of the disclosure;

[0123] FIG. 28A is a schematic diagram of one or more WCDs performing proximity functions according to one or more aspects of the disclosure;

[0124] FIG. 28B is a schematic diagram of one or more WCDs performing proximity functions according to one or more aspects of the disclosure;

[0125] FIG. 29A is a flow chart depicting a method of initiating gesture input according to one or more aspects of the disclosure;

[0126] FIG. 29B is a chart showing acceleration vs. time as measured by the accelerometer of the WCD;

[0127] FIG. 30 is a perspective view of a WCD 2000 employing a reset function;

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[0128] FIG. 31A is a perspective view of a WCD including an LED indicator according to one or more aspects of the disclosure;

[0129] FIGs. 31B and 31C are cross sections along line C-C of a WCD employing an LED indicator according to one or more aspects of the disclosure;

[0130] FIG. 32 is flow chart depicting a method of communicating with a near field communication (NFC) device according to one or more aspects of the disclosure;

[0131] FIG. 33A depicts a perspective view of a WCD assembly according to one or more aspects of the disclosure;

[0132] FIGs. 33B-D depict exploded views of the WCD assembly of FIG. 33A;

[0133] FIG. 33E depicts a cross sectional view of the WCD assembly along A-A;

[0134] FIGs. 34A-B depict a WCD assembly according to one or more aspects of the disclosure;

[0135] FIG. 35A depicts an enclosure or case for storing a WCD according to one or more aspects of the disclosure;

[0136] FIG. 35B is a cross sectional view of the assembled enclosure of FIG. 35A along the line B-B;

[0137] FIG. 35C depicts a cross sectional view of the assembled enclosure of FIG. 35B along line A-A;

[0138] FIG. 36 depicts an enclosure including air vents according to one or more aspects of the disclosure;

[0139] FIG. 37 depicts a method of sizing a finger according to one or more aspects of the disclosure;

[0140] FIG. 38 is a pictorial diagram showing a plurality of image perspectives of a user's hand;

[0141] FIG. 39 depicts a sizing tool for sizing the finger of a user;

[0142] FIG. 40 depicts a sizing tool for sizing the finger of a user according to an alternate example;

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[0143] FIG. 41 depicts yet another alternate example of a sizing tool for sizing the finger of a user;

[0144] FIG. 42 depicts a method of monitoring activity according to one or more aspects of the disclosure;

[0145] FIG. 43 depicts a method of determining whether a user is wearing gloves according to one or more aspects of the disclosure;

[0146] FIG. 44 depicts a method of securing data onboard the WCD according to one or more aspects of the disclosure;

[0147] FIG. 45A is a timepiece system according to one or more aspects of the disclosure;

[0148] FIG 45B is a bottom view of the TCD;

[0149] FIG. 46 depicts a WCD with a pair of LED indicators disposed at an inward-facing portion of the WCD;

[0150] FIG. 47A is a system for generating and managing alerts according to one or more aspects of the disclosure;

[0151] FIG. 47B depicts a block process diagram for generating and managing alerts according to one or more aspects of the disclosure;

[0152] FIG. 47C is a flow chart depicting a method for generating and managing alerts according to one or more aspects of the disclosure;

[0153] FIG. 48A is a method for variable sampling according to one or more aspects of the disclosure; FIG. 48B and 48c are graphs depicting one or more aspects of the sample method of FIG. 48A; and

[0154] FIG. 49 is a diagrammatic representation of a machine in the example form of a computer system within which a set of instructions, for causing the machine to perform any one or more of the methodologies discussed herein, may be executed.

DETAILED DESCRIPTION

[0155] The present disclosure describes a wearable computing device (WCD) that enables a wearable fitness monitor(s)/computer(s) which is suitable for prolonged usage

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with accurate results. The WCD can be in the form of a ring that can be worn on the finger of a human (or animal) user. Although the WCD of the present disclosure is depicted as a ring that can be worn on the finger of a user, other shapes, designs, and form factors can be utilized for the WCD. For example, the WCD can be in the form of a wrist band, bracelet, necklace, earring, or any other type of wearable accessory. In this regard, references to the finger of a user in the present application can be considered to apply to other portions of a human body depending on the form of the WCD, such as wrist, neck, ear, etc.

[0156] The term "coupled" as used herein means connected directly to or connected through one or more intervening components or circuits. Any of the signals provided over various buses described herein may be time-multiplexed with other signals and provided over one or more common buses. Additionally, the interconnection between circuit elements or software blocks may be shown as buses or as single signal lines. Each of the buses may alternatively be a single signal line, and each of the single signal lines may alternatively be buses, and a single line or bus might represent any one or more of a myriad of physical or logical mechanisms for communication (e.g., a network) between components. The present embodiments are not to be construed as limited to specific examples described herein but rather to include within their scope all embodiments defined by the appended claims.

[0157] FIG. 1A is a perspective view of 100 of a WCD 110 illustrating an exterior window 120 in accordance with some embodiments, and FIG. 1B is a perspective view 102 of the WCD 110 of FIG. 1A illustrating an interior window 130.

[0158] As previously mentioned, it is recognized in the present disclosure that conventional wearable fitness monitors such as clip-on devices, wristbands, or watch-type monitors still often suffer from inaccuracy mainly because they lack constant and consistent ways to read from the body areas they aim to monitor. It can also be an extra burden for the person to remember and wear such conventional fitness monitors each time the person perform exercises in order to create an accurate history tracking the exercise activities.

[0159] Accordingly, the present embodiments of the WCD 110 can function as fitness monitors/computer which is suitable for prolonged usage so as to create accurate

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results. In addition or as an alternative to fitness monitoring, as will be discussed in more detail below, the WCD 110 can function as a remote input device through, for example, gesture recognition. In some embodiments, the WCD 110 can further function as a sleep monitor, a heart rate sensor, a cardiac monitor a body temperature detector, or the like. It is noted that, for those embodiments which can function as a cardiac monitor (e.g., that measures electrocardiogram (EKG)), it may be necessary to establish a closed loop (e.g., for the electrical measurement of EKG) across the heart. As such, in some of those embodiments, a separate conductive pad can be coupled to the WCD 110 so that a user can pinch the pad with fingers on an opposite hand,

[0160] Specifically, in some embodiments of the present disclosure, the WCD 110 can be worn by the user (e.g., on a finger) for fitness, physical activity, biological data monitoring as well as for gestural input or other suitable purposes. As shown in FIGS. 1A and 1B, the WCD 110 can include the exterior window 120 on its exterior wall for input/output data transmission and reception, battery recharge, or status indication. The WCD 110 can also include the interior window 130 on its interior wall for various monitoring or sensing activities. The form factor of the WCD 110 allows it to be worn for prolonged hours with constant and consistent contact with the skin area, thereby creating a more reliable and extended recording (e.g., as compared to aforementioned conventional fitness monitors) of the user's fitness activity, physical exercise, as well as health information such as heart rates and body temperature. More implementation details regarding the WCD 110 are discussed below.

[0161] FIG. 1C is a perspective view of an alternative design of the WCD 110 of FIG. IA in accordance with some embodiments. As shown in FIG. IC, the WCD 112 includes a second exterior window 124 in addition to a first exterior window 122. The two exterior windows 122 and 124 can include spacing between the two windows 122 and 124 so that the mechanical strength of the housing structure of the WCD 112 may be stronger than that of the WCD 110, which is shown to include one single exterior window 120. Further, in some embodiments, radio antennas (e.g., Bluetooth) or other sensitive circuitry can be positioned in the second exterior window 124 away from the first exterior window 122 so that quality of reception may be improved.

[0162] FIG. 2 is an abstract functional diagram 200 illustrating example components within the WCD (e.g., WCD 110) in accordance with some embodiments.

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As shown in diagram 200, the WCD 110 can include a processor module 210, a plurality of sensor modules 220, a status indicator module 230, a power generation and management module 240, a communication module 250, a memory 260, and miscellaneous modules 270 (e.g., a real-time clock (RTC) crystal oscillator as illustrated in FIG. 2). The WCD 110 can also include a battery 280 module that provides electrical power for the WCD 110. In some embodiments, the battery 280 can be of a lithium-polymer type or a zinc-polymer type. It is noted that modules illustrated in diagram 200 are for purposes of facilitating a better understanding of the present embodiments; other suitable modules may be included in the WCD 110 and are not shown for simplicity. As used herein, the term "components" is considered to generally include any of the modules depicted and/or described in FIG. 2, as well as any other modules described herein.

[0163] It is noted that the aforementioned modules are intended for purposes of enabling the present embodiments, rather than limiting. As such, a person of ordinary skill in the art will understand that the present disclosure covers apparent alternatives, modifications, and equivalents (e.g., combining or separating the modules) made to the techniques described herein. For example, in some embodiments, a portion of the communication module 250 (e.g., the Bluetooth Chip as shown in FIG. 2) can be combined into the processor module 210. For another example, one or more modules herein can be combined into one to form a system-on-the-chip (SOC).

[0164] The processor module 210 can have generic characteristics similar to general purpose processors or may be application specific integrated circuitry that provides arithmetic and control functions to the WCD 110. The processor can be any type of processor, such as a processor manufactured by AMtel, Freescale, Nordic Semiconductor, Intel®, AMD®, or an ARM® type processor. The processor module 210 can include a dedicated cache memory (not shown for simplicity). The processor module 210 is coupled to all modules 220-270 in the WCD 110, either directly or indirectly, for data and control signal transmission.

[0165] The memory 260 may include any suitable type of storage device including, for example, ROM, such as Mask ROM, PROM, EPROM, EEPROM; NVRAM, such as Flash memory; Early stage NVRAM, such as nvSRAM, FeRAM, MRAM, or PRAM, or any other type, such as, CBRAM, SONOS, RRAM, Racetrack memory, NRAM,

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Millipede memory, or FJG. Other types of data memory can be employed as such are available in the form factor desired.

[0166] In addition to storing instructions which can be executed by the processor module 210, the memory 260 can also store data generated from the processor module 210. It is noted that the memory 260 can be an abstract representation of a generic storage environment. According to some embodiments, the memory 260 may be comprised of one or more actual memory chips or modules. In some embodiments, the memory 260 can function as a temporary storage (e.g., for firmware updates, and/or for avoiding accidental malfunctions (such as so-called "bricking")).

[0167] In accordance with one or more embodiments, the sensor modules 220 can include various sub-modules for the WCD 110 to perform different monitoring or sensing activities. A view 302 of the interior window (e.g., window 130) of a WCD (e.g., WCD 110) with example components exposed is shown in FIG. 3B. As shown in the example of FIG. 3B, the sensor modules 220 can include a temperature sensor 320a, a red light emitting diode (LED) 320b, a light sensor 320c, and an infra-red LED 320d. Among the sensors in the sensor modules 220, those sensors (e.g., sensors 320a-320d) which are directly related to biological sign monitoring can be configured and positioned in a way that is close to the skin (e.g., facing the interior window 130 of the WCD 110). Although not shown in FIG. 3B for simplicity, the sensor modules 220 can further include sensors that are not directly related to biological sign monitoring; some examples of these sensors include accelerometers, gyroscopes, vibration, sensors (e.g., a magnetometer or a digital compass), or other suitable sensors (e.g., for gesture recognition). The magnetometer can measure the strength and/or direction of a prevailing magnetic field. In this regard, the magnetometer can be used during global positioning and/or navigation. In particular, the magnetometer can be used to measure a directional heading when the WCD is in motion and can supplement position data where the WCD is out of communication range. In one or more embodiments, the accelerometers in the sensor modules 220 can detect movements in multiple (e.g., 3) dimensions or axes. The accelerometer can measure force of acceleration of the WCD and can measure gestures performed by a user while wearing the WCD. In other examples, the accelerometer can detect acceleration of the user while wearing the WCD.

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This can permit tracking of activity level, such as steps taken or number of laps swum in a pool.

[0168] The temperature sensor can be any type of sensor that detects temperature, such as a thermistor, PTC, NTC, etc. In another example, the temperature sensor can use IR light emitted from an object to calculate a surface temperature of the object in a manner clear to those of ordinary skill in the art.

[0169] Together, the processor module 210 and the sensor modules 220 can enable the WCD 110 to perform multiple functions including, for example, pedometer, sleep monitor (e.g., which monitors sleep quality), heart rate sensor, pulse oximetry, skin (and in select embodiments, ambient) temperature. In addition, some embodiments of the WCD 110 can further function as a gesture input device. In particular, the present embodiments recognize that the WCD 110 can detect finger motions or gestures which may be difficult for conventional fitness sensors to detect, such as a tap, a snap, a knock on the table, and the like. In some embodiments, the WCD 110 can utilize the accelerometer to measure the activity level (e.g., arm movement) in conjunction with the measured heart rate to determine if the user is walking horizontally, running, swimming, or climbing stairs. Other activities can be identified by the WCD 110 may include biking or sleeping.

[0170] In some embodiments, the WCD 110 can also be programmed to learn particular gestures or physical exercise from the user using, for example, a training mode. For example, the user can instruct (e.g., using a computer or a mobile device of the user) the WCD 110 to enter the training mode and perform the gesture or physical exercise; the WCD 110 can record the readings from the sensor modules 220, recognize patterns therefrom, and store the result in, for example the memory 260, so that such gesture or exercise can be recognized by the WCD 110 after the training. The WCD 110 can be configured (e.g., via a mobile application running on a mobile device of the user) so that the recognized gestures can perform functions designated by the user, such as clicks, swipes, unlocks, or media player controls. In one embodiment, the WCD 110 can include near field communication (NFC) chips so that certain functions (e.g., unlocking a smart phone) can be performed when the WCD 110 touches upon or otherwise be detected by another NFC device. In some embodiments, the unlocking function of the

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WCD 110 can also unlock a user device (e.g., a phone) via the communication module 250 (e.g., Bluetooth) by the WCD 110 transmitting a proper unlock code.

[0171] Moreover, the WCD 110 can function as a key or a control device for keyless access to home, automobile, or other suitable user authentication processes. The WCD 110 can also be integrated with games and game consoles so that it can function as an input device to those games and consoles. In some embodiments, the WCD 110 can be adapted for use in medical and home health monitoring, or as a transportation safety device (e.g., that broadcasts emergency messages to relevant authorities). Additional examples of sensors/functionalities of the WCD 110 can include an inertial measurement unit (IMU) (e.g., for more complex gesture recognition, a near-infrared (NIR) spectrometer (e.g., for measuring light absorption and deriving blood glucose/ blood alcohol/ CO2 content), a Galvanic skin response sensor (e.g., for measuring sweat/ nervousness), an electrocardiogram (ECG or EKG), and so forth.

[0172] In some embodiments, the processor module 210 can determine (e.g., based on identified physical activities, routine pattern, and/or time) a frequency at which one or more sensors in the sensor modules 220 should operate. Because it is recognized in the present disclosure that the heart rate of a human being typically does not vary too widely (e.g., beyond a certain percentage of what has been previously measured), in some embodiments, the WCD 110 can automatically adjust the sensor modules 220 (e.g., to slow down) so as to save power. More specifically, some embodiments of the WCD 110 can include a phase-locked loop or logic to predict the pulse width by determining lower and upper ranges in which the heart rate is predicted to be, thus only powering up the sensor modules 220 at the time of the predicted heartbeats. For one example, if the WCD 110 determines that the user is at sleep (e.g., based on the heart rate, the body temperature, together with the movements detected by the accelerometer and/or the vibration detector), the WCD 110 can slow down its heart rate detection frequency (e.g., from 1 measurement per second to 1 measurement per 10 seconds) and skip the measurement of several heartbeats because it is unlikely that the heart rate will change drastically during that period. Conversely, if the WCD 110 determines that the user is performing a high intensity physical exercise, the WCD 110 can increase the frequency of monitoring and recording of the sensor modules 220.

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[0173] In accordance with one or more embodiments, the WCD 110 also includes various modules coupled to the processor module 210 for, by way of example but not limitation, input/output data transmission, battery recharge, or status indication. A view 300 of the exterior window (e.g., window 120) of a WCD (e.g., WCD 110) with example components exposed is shown in FIG. 3A. As shown in the example of FIG. 3A, the modules configured to face the exterior window 120 of the WCD 110 can include parts from the status indicator module 230, the power generation and management module 240, and the communication module 250.

[0174] Specifically, one embodiment of the WCD 110 includes the status indicator module 230 coupled to the processor module 210 to indicate various statuses. In some embodiments, the status indicator module 230 includes a light emitting diode (LED) 330, such as shown in FIG. 3A. The LED 330 can be a single red/green/blue (RGB) LED. In other embodiments, the status indicator module 230 can include other suitable types of indicator devices including, for example, a single color LED, an electrophoretic ink (or "e-ink") display, a persistent display, or the like. In accordance with some embodiments, the WCD 110 can utilize the indicator module 230 (e.g., via the RGB LED 330 through the exterior window 120) to visually communicate with the user. For example, a red color can be displayed (e.g., for a predetermined period of time) by the LED 330 that the WCD 110 needs to be recharged, and a green color can be displayed to indicate that the WCD 110 is fully charged. For another example, a blue color can be displayed when the communication module 250 is in use. In one or more embodiments, the user can program a fitness goal (e.g., a target heart rate) to the WCD 110 so that, for example, a green color can be displayed when the heart rate is below the target, a yellow color can be displayed when the target is reached, and a red color can be displayed when the heart rate is above a certain percentage of the set target. Some embodiments of the WCD 110 include the communication module 250 for wireless data transmission. Particularly, in some embodiments, the communication module 250 includes one Bluetooth chip and a Bluetooth antenna 350, such as shown in FIG. 3A. One or more embodiments of the WCD 110 also provides the capability of storing activity logs (e.g., in the memory 260). More specifically, fitness activities, exercise histories, as well as recorded biological signs such as heart rate and body temperature, can be stored onboard in the memory 260 of the WCD 110. Each data entry in the activity logs can be time- stamped using, for example, an onboard real-time clock (e.g., which may be

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included in miscellaneous modules 270). For power saving and other purposes, the activity log can be downloaded (e.g., via the communication module 250) when requested by the user. In other embodiments, the activity log can be pushed (e.g., via email or other suitable means) by the WCD 110 to a user device at a time designated by the user. In some embodiments, the memory 260 can store up to a full week worth of activity logs.

[0175] The WCD 110 can include the power generation and management module 240 for recharging the battery 280 and for providing electrical power to various modules 210-270 in the WCD 110. Particularly, in some embodiments, the power generation and management module 240 includes one or more concentrated photovoltaic (CPV) cells 340, such as shown in FIG. 3A. The CPV cells 340 can be high-efficiency tandem solar cells and can be attached on the flexible printed circuit (e.g., circuit 415,515). Because the small form factor of the embodiments of the WCD 110, CPV cells 340, which can absorb more light energy from a wider spectrum of light than the traditional solar cells, are used. In some embodiments, multiple (e.g., 3) CPV cells 340 can be configured in series to provide sufficient voltage and/or current for charging the battery 280.

[0176] According to some embodiments, the WCD can include one or more sensing or imaging devices that can be any type of device capable of detecting electromagnetic radiation, such as visible light, IR, NIR, UV, etc. In one example, the device is an imaging device, such as a CMOS or CCD camera.

[0177] According to some embodiments, the WCD 110 can be placed or docked into a charging station for recharging. A perspective view 900 of an example charging station 910 for the WCD 110 is shown in FIG. 9A. The charging station 910 can have concentrated light source circumferentially around the WCD 110 so that the user does not have to be concerned with whether the WCD 110 is facing the right direction for charging. Some embodiments of the charging station 910 can include a light distribution means that takes a single light source and distributes the light all around. An abstract diagram illustrating a partial structure of the light distribution means inside the charging device of FIG. 9A is shown in FIG. 9B. It is noted that, even with the charging station 910, for some embodiments, regular outdoor sunlight or other ambient light source can

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still function as a secondary source of energy so that the CPV cells 340 on the WCD 110 can extend the operational time provided by the battery 280.

[0178] Additionally or alternatively, energy source attached to the power generation and management module 240 can be passive; for example, some embodiments provides that a clip with a concentrator lens can be attached to the WCD 110 in a way such that the power generation and management module 240 can charge the battery 280 using natural sunlight. In an alternative embodiment, gemstone(s) (e.g., sapphire, diamond, or other suitable materials) in the shape of a dome or with faceted protrusion can be configured to concentrate/magnify light energy while also serving as a decorative feature.

[0179] In some alternative embodiments, the power generation and management module 240 can include electromagnetic induction charging coil so that a WCD (e.g., ring 610) can be charged using an inductive charger. FIG. 6 shows an exploded view 600 of such alternative embodiment of WCD with the inductive charging mechanism including the charging coil 640, as well as battery 680, housing 612, and rigid-flex PCBA 615. However, it is noted that there may be a need to manufacture the inductive charging coil 640 in different sizes that correspond to different ring sizes. Further, it is noted that the efficiency of the electromagnetic induction charging mechanism may be adversely affected by the adoption of a metallic housing. Additionally or alternatively, to avoid multiple sized coils mounted to the edge of the ring, the coil can be placed on the inner or outer sides of the ring by positioning the coil beneath a window in the metal housing of the ring.

[0180] In order to achieve optimal power management of the WCD, one or more of the components can be selected to minimize power usage. For example, a processor, memory, or any other component can be selected based on rated power usage. In one example, it may be desirable to select components that draw current on the order of microamps in order to extend the battery life of the WCD and to allow the WCD to perform health/activity monitoring functions between charging sessions.

[0181] In still some other alternative embodiments, the power generation and management module 240 can include thermoelectric generator (TEG) modules so that a WCD (e.g., WCD 710,810) can be charged by the difference between the body

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temperature and the ambient temperature. FIG. 7 is a perspective view 700 of such alternative design, and FIG. 8 is an exploded view 800 of the WCD 710 of FIG. 7. Also shown in FIGS. 7 and 8 is an alternative design of the housing for the WCD where the ring includes an outer ring 812a, an inner ring 812b, and insulators 814a and 814b. However, it is noted that utilizing TEGs for charging the battery may be less than ideal since the difference between body temperature and ambient temperature might not be great enough to fully charge the battery, and that in many occasions (e.g., during sleep), the temperature difference needed for TEG to generate electricity may quickly disappear (e.g., since the WCD 710, 810 may be covered inside the comforter).

[0182] The battery can be any type of battery, such as a rechargeable battery. The battery can be a thin, flexible lithium ceramic chemistry battery. In another example, the battery can be a circular formed lithium polymer or lithium ion battery. The battery can provide power to any of the components described above. In one example, the battery can be a lithium cell integrated directly with the flexible PCB described above. Other implementations can integrated the battery directly onto the housing to reduce the volume of space taken up by battery packaging.

[0183] The WCD can also include one or more polymer or piezo actuators for providing appropriate haptic or physical feedback and alerts to a user while the user is wearing the ring. The piezo actuator can also provide audible feedback to a user.

[0184] As previously mentioned, the WCD 110 can be used with a software application (e.g., a mobile phone application for the Apple iOS or the Google Android OS) which can run on the user's computing device (e.g., a mobile device such as a smart phone). Specifically, the software application can facilitate the mobile device of the user to couple to the WCD 110 (e.g., via the communication module 250) for data communication, such as downloading activity logs, changing configuration and preferences, training the WCD. The software application can also generate a user interface showing the results or readings from the health and fitness tracking performed by the WCD 110. FIG. 10 is an example screenshot illustrating such user interface 1000 displaying fitness monitoring readings in accordance with some embodiments.

[0185] Further, the WCD 110 can be used for gesture input, and the software application can facilitate the user to customize gesture input and control. FIG. 11 is an

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example screenshot illustrating such user interface 1100 displaying sensor readings (e.g., for calibration purposes) in accordance with some embodiments. In one or more embodiments, the WCD 110 can also be used directly with other Bluetooth enabled devices such as electronic locks or keyless car entry. In other examples, the WCD 110 can also control other devices via a smartphone and other Wireless LAN enabled devices such as home automation systems.

[0186] FIG. 3C is a view 304 of two exterior windows of an alternative WCD (e.g., WCD 112 of FIG. 3C) with example components exposed in accordance with some embodiments. The components 330, 340, and 350 shown in FIG. 3C function similarly to those components described in FIG. 3A. However, some components (e.g., antenna 350) can be positioned to face a different exterior window than the exterior window the rest of the components face. This may increase the mechanical strength of the housing structure of the ring, and/or may reduce signal interference among the components.

[0187] FIG. 4 is an exploded view 400 showing an exemplary WCD 410 (e.g., WCD 110) illustrating a battery 480 and a flexible circuit 415 which are configured to fit inside a housing 412 of the WCD 410. It is recognized by the present disclosure that a human being's finger can come in various different sizes and so should the WCD 410. In order to reduce the cost of manufacturing different sizes of printed circuits, in some embodiments, the modules 210-270 (of FIG. 2) are formed on a flexible or rigid-flex printed circuit (FPC) board, an example 500 of which is shown as FPC 515 in FIG. 5. In particular, one or more embodiments provide that the FPC 515 and the battery 480 are not specific to a ring size, and that the same circuitry and/or battery can fit a multitude of sizes.

[0188] According to some embodiments, the WCD 410 provides a desirable form factor for a user to wear it for a prolonged period of time. The edges and the shape of the WCD 410 can be configured in a way that is comfortable and ergonomic; for example, the finished parts of the embodiments are to be free from burrs and sharp edges. The material which forms the housing portion of the WCD 410 can include medical grade metallic alloys that reduce the likelihood of allergic reactions. Examples of the housing material include stainless steel, tungsten carbide, titanium alloy, silver, platinum or gold.

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[0189] In the examples shown in FIG. 4, the U-shape of the ring housing 412 allows for the flexible PCB 415 to be inserted into the edge of the WCD 410. The windows (e.g., windows 120, 130) on the walls of the WCD 410 can align with the operating circuitry to allow, for example, battery charging, Bluetooth connection, and user feedback LED/micro display on the outer wall, and biological feedback sensors (e.g., pulse oximetry, temperature sensor) on the inner wall. In one or more embodiments, the WCD 410 can be completely sealed using potting epoxy. The sealing epoxy can be transparent to allow light to pass through for the CPVs and sensors. In some embodiments, the WCD 410 can be potted with two different compounds. In these embodiments, the body of the WCD 410 can be filled with clear material, and the edge of the WCD 410 can be filled with an opaque material so that different colors can be incorporated (e.g., as a decorative element). It is noted that sealing the assembly using potting epoxy can also bring the additional benefit of making the WCD 410 completely or almost completely waterproof as well as increasing the structural rigidity of the WCD 410.

[0190] **I. Internal Housing/External Potting**

[0191] FIG. 12A is a perspective view and FIG. 12B is a side view of a WCD 1200 according to one or more aspects of the disclosure. The WCD 1200 can be in the shape of a ring and can be worn on any of the five fingers (including the thumb) of (typically) a human user. In this regard, the WCD 1200 can define an interior diameter d1 and exterior diameter d2. The interior diameter d1 can be defined as the distance between opposing points on the interior surface of the ring, with the interior surface being the portion of the WCD facing the finger of a user while the device is worn by the user. The interior surface of the WCD can generally define a finger space for receiving the finger of the user. The exterior diameter d2 can be defined as the diameter between opposing points on the exterior surface of the ring, with the exterior surface being the portion of the WCD opposed to the interior surface and facing away from the finger of the user.

[0192] The interior diameter d1 and exterior diameter d2 can be any size to accommodate any finger size. In one example, d2 is determined by d1 plus a thickness of any components and/or flexible circuit boards disposed within the WCD. Additionally, although depicted as being circular, the finger space of the WCD 1200 can be any shape, such as ovular, elliptical, or the like, to accommodate users with atypical

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finger profiles. In these examples, the dimensions of the interior and/or exterior diameter may be measured according to other variables, such as length, width, major diameter, minor diameter, etc. By way of non-limiting example, the WCD interior diameter d1 (the diameter generally defining the ring size) can be in an approximate range of 12mm to 24mm so as to accommodate finger sizes ranging from a small child to a larger adult, and on any acceptable finger, including the thumb. The exterior diameter d2 can also be any reasonable size or shape, and can define an approximate range of between 18mm and 30mm. Likewise, the thickness between diameters d1 and d2 can vary widely, but can typically reside in an approximate range of 1.5mm to 3 mm. The width WR of the WCD along the direction of finger extension (finger longitudinal direction) is widely variable, and can be selected, in part to accommodate internal and external components. In a non-limiting example, the width WR is in a range of approximately 3mm to 8mm.

[0193] The WCD 1200 can include an overall housing 1210 that includes an internal housing 1212 and an external potting or encapsulant 1214. Together, the internal housing 1212 and external potting 1214 combine to form the overall form factor of the WCD 1200, in addition to providing a housing for one or more electronic components stored within the housing 1210 of the WCD 1200, as will be described in greater detail below.

[0194] The internal housing 1212 can be formed of any material, such as a nonconductive material, a conductive material, a ferrous material and/or a nonferrous metal, composite material (e.g. carbon-fiber and/or glass fiber composite) a dielectric material, or a combination of any of the above. In one example, the material of the inner housing 1212 is conductive and nonferrous, such as aluminum, titanium, or stainless steel. In other examples, the internal housing can be formed of a polymer, such as plastic. The external potting 1214 can be formed of any material, solid or gelatinous, that can provide resistance to shock and/or vibration and can prevent moisture and/or debris from entering the housing 1210 of the WCD 1200, such as silicone, epoxy, polyester resin or any other polymer.

[0195] In one example, the external potting 1214 can be transparent. In this regard, the transparent external potting can allow electromagnetic radiation, such as visible, IR, or UV light sources from inside the housing 1210 to pass through the external potting

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1214 without the need of a window or discontinuity in the external potting 1214 and without changing the optical properties of the radiation. In the same vein, electromagnetic radiation sources, such as visible, IR, or UV light, external to the housing can pass through the external potting 1214 and can be detected by, sensed by, or fall incident upon internal components of the WCD 1200 without the need for a window or discontinuity in the housing and without changing the optical properties of the radiation. In another example, the external potting 1214 can be tinted. The tint can be cosmetic and can prevent the internal components of the WCD to be visible by the user. In this regard, depending on the tint, optical properties of light passing therethough may be slightly changed. For example, certain colors of the light can be filtered and can result in decreased power transmission. The above description regarding external potting 1214 can be applied to any of the pottings described below.

[0196] The internal housing 1212 can define a window 1216. In one example, the internal housing is formed of a material that completely or partially prevents light (or other electromagnetic radiation) from passing through the internal housing 1212. In this regard, the internal housing 1212 can define the window 1216 to allow for such radiation to pass through the housing 1212. As shown, the window 1216 can be generally elliptical-shaped, but can be any other suitable shape according to other examples, such as rectangular, circular, ovular, etc. Since the window 116 is defined by the internal housing 1212, the window 1216 can face the finger of the user while the user is wearing the WCD 1200, which can provide many advantageous features and implementations, as will be described in greater detail below.

[0197] FIG. 12C is a front view of the WCD and FIG. 12D is a cross section of the WCD 1200 along the line A-A of FIG. 12C. As shown, the internal housing 1212 can have a generally U-shaped internal surface 1212a to accommodate one or more internal components and can define a pair of flanges 1212b and 1212c. The external potting 1214 can extend between the flanges 1212b and 1212c of the internal housing to provide an internal space 1220 to accommodate one or more components. By virtue of the external potting 1214, the internal space 1220 defined by the internal surface 1212a and the external potting 1214 can be hermetically sealed, thereby preventing debris, dust, moisture, or any other unwanted fluids or materials from interacting with the internal components of the WCD 1200. Although not depicted, the internal components

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can reside within the internal space 1220, and the external potting 1214 can be disposed immediately atop the components to provide the seal.

[0198] FIG. 12E is a perspective view of the internal housing 1212 without external potting 1214. As shown, the internal surface 1212a defines a generally U- shaped surface for receiving the components.

[0199] FIG. 12F is a perspective view of the internal housing 1212 with a portion of the external potting 1214 removed and showing one or more components 1230 and printed circuit board (PCB) 1240. The components and PCB can be constructed as flex circuits, thereby allowing the components 1230 and PCB 1240 to be geometrically configured within the ring shaped internal space 1220. The PCB 1240 can be any type of flexible material clear to those of skill, such as polyimide, PEEK, etc. Additionally, the PCB could be rigid-flex whereby panels of RF4 are connected together with a flexible substrate.

[0200] As shown, the PCB 1240 and the components 1230 can be disposed within the internal space 1220 generally defined by the internal surface 1220a and the flanges 1220b-c. The PCB 1240 can define one or more folding regions 1242 that allow the PCB 1240 to conform to the circumference and/or perimeter of the internal surface 1212a. The PCB 1240 can extend around at least a portion, or up to an entire circumference, of the internal surface 1212a. In one example, the size of the internal diameter d1 of the WCD can determine the portion of the internal surface 1212a around which the PCB 1240 extends. Illustratively, for a larger ring size and a larger internal diameter d1, the PCB 1240 can extend only a portion (an arc) of the overall circumference, while for smaller ring sizes a greater portion (arc) of the circumference can be employed to accommodate PCB 1240 and the internal components 1230. The adjacent portions of PCB can form an arc angle therebetween by virtue of the folding regions disposed therebetween, allowing for the PCB to be conform to the internal surface 1212a.

[0201] **II. External Housing/Internal Potting**

[0202] FIG. 13 is a cross section of a WCD 1300 according to another aspect of the disclosure and illustrative embodiments. In this example, the WCD 1300 includes a housing 1310 that includes an external housing 1312 and an internal potting or

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encapsulant 1314. The external housing 1312 includes an internal surface 1312a that has a generally C-shaped cross section-but alternate cross section shapes, such shapes with an external notch or groove. The external housing includes flanges 1312b-c that extend toward each other, beyond portions of the internal surface 1312a, to define a partially enclosed internal space 1320. In an assembled state, the WCD 1300 can include a battery 1330, a PCB 1340, and components 1350, which can be at least partially or completely disposed within the partially enclosed internal space 1320. The internal potting 1314 can extend between the flanges 1312b-c and can seal the partially enclosed internal space 1320. The components can be encapsulated by the internal potting 1314. The PCB 1340 and components 1350 can extend along an inner circumference of the internal surface 1312a.

[0203] Illustratively, the external housing 1312 can be formed of the same materials as the internal housing 1212 described above, and the internal potting 1314 can be formed of the same materials as the external potting 1214 described above. As also described above, the internal potting 1314 can be transparent and the external housing 1312 can define one or more windows according to one or more aspects of the disclosure.

[0204] FIG. 14A is a cross section of a WCD according to another aspect of the disclosure and illustrative embodiment. In this example, the WCD 1400 includes a housing 1410,internal surface 1412a, an internal or external housing 1412, an internal or external potting 1414, an internal space 1420, a battery 1430, a flexible circuit 1440, and one or more components 1450. This example is similar to the examples described above with respect to FIGs. 12 and 13, except the addition of a stiffener element 1442 and the flanges 1412b-c extend further into the space 1420 toward one another such that the flanges 1412b-c overlap with the stiffener element 1442.

[0205] FIG. 14B is a perspective view of the PCB and stiffener element of FIG. 14A. As shown in FIG. 14B, the stiffener element 1442 extends beyond an overall width w of the PCB 1440 and extends wider than a distance between flanges 1412b-c. The stiffener element is disposed between folding regions 1444. The PCB 1440 can include one or more stiffener elements 1442 attached thereto, and the elements 1442 can be disposed periodically (in separated intervals) along a length l of the PCB 1440. As shown in FIG. 14C, the stiffener element 1442 can be disposed underneath the flexible

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circuit 1440, e.g., on a face of the flexible circuit 1440 opposed to the face on which the components 1450 are disposed, and can be permanently or semi-permanently attached thereto. The stiffener element can be implemented in any of the configurations described, and in particular, with either the internal housing/external potting arrangement or the external housing/internal potting arrangement.

[0206] The stiffener element 1442 can be formed of any material, such as polyamide or thin FR4, depending on construction of the PCB 1440. In particular, the material of the stiffener can be chosen to be more or less flexible than the PCB 1440. In one example, the stiffener element 1442 can be a polyamide stiffener disposed on a back surface of a flexible PCB. In another example, the stiffener element 1442 can be FR4 and can be substantially flush with respect to the flanges 1412b-c. In this regard, the stiffener element can extend substantially the distance between flanges 1412b-c and may not deform upon insertion into the space 1420. The stiffener element can include surface features disposed on an edge thereof, with the edge facing one of the flanges 1412b-c. The surface features can include a sawtooth profile (e.g., intersecting straight lines at acute angles), or any other type of feature capable of providing an interference fit between flanges 1412b-c.

[0207] FIG. 14D shows a cross section of the WCD at a point in time during assembly/manufacture when the PCB 1440 is being inserted into the internal space 1420 and prior to the application of potting 1414. As shown, the stiffener 1442 contacts the flanges 1412b-c of the housing 1410 by virtue of the width w of the stiffener element 1442. Upon an application of force, the PCB 1440 and stiffener 1442 assembly can be inserted into the internal space 1420. In this regard, the stiffener element has a predetermined flexibility that allows for a certain amount of flexion, as shown in FIG. 14D. The flexion allows for the flexible circuit 1440 to be inserted within the internal space 1420 and can prevent the flexible circuit 1440 from being removed or from accidentally falling out once inserted. In this regard, the flexible circuit 1440 is held in place within the space 1420 by virtue of the width of the stiffener element 1442 and the distance between the flanges 1412b-c. Once inserted, the potting 1414 can be applied free of the concern of improper positioning of the flexible circuit 1440.

[0208] FIG. 14E is a cross section of the WCD of after a potting material 1414 has been applied subsequent to the WCD of FIG. 14D.

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[0209] **III. Inner/outer bands**

[0210] FIG. 15A depicts a perspective view of a WCD 1500 according to another aspect of the disclosure. In this example, the WCD includes a housing 1510 that includes an internal housing 1512 and an external housing 1514. The internal housing 1512 can be similar to the internal housing described above with respect to internal housing 1212, and the external housing can be similar to the external housing described above with respect to external housing 1312. The internal housing 1512 can include one or more windows 1516 that can allow electromagnetic radiation (e.g. visible and near-visible light) to pass therethrough, allowing it to fall incident upon components disposed within the housing 1510 and allowing EM radiation sources (e.g. visible light, RF, IR, etc.) within the housing to exit the housing.

[0211] FIG.15B is an exploded view of the WCD 1500. As shown, the WCD can include internal housing and external housing 1512 and1514. The WCD can further include a PCB 1540 and components 1550. Once the housings 1512-1514 are assembled and the PCB 1540 and components 1550 are assembled within space defined between the housings 1512-414, potting layers 1502 and 1504 can be applied to seal the WCD at both sides thereof to ensure a secure seal.

[0212] **IV. Inner/outer bands with U shaped window**

[0213] FIG. 16A is an exploded view of a housing 1610 and a PCB of a WCD according to one or more aspects of the disclosure. The WCD 1600 comprises a housing 1610 with an integral inner wall and outer wall 1612 and 1614. The housing can be made of any material, such as any material described above with respect to the internal/external housing structures. In this example, the inner and outer walls 1612,1614 each define a window in the shape cutaway portions 1616. The cutaway portions are bounded on three sides by the walls 1612 and 1614 and unbounded at the other side thereof. The cutaway portions 1616 can be aligned with one another to ensure transmission of radiation into/out of the housing 1610. The space1620 between the inner and outer walls 1612,1614 can receive a PCB 1640, battery, components, etc.

[0214] FIG.16B is a cross section ofFIG.16A along line B-B. As shown, the inner and outer walls 1612,1614 are directly connected by a floor 1618. The space 1620 is defined by the space between the inner and outer walls 1612,1614 and the floor 1618.

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[0215] FIG.16C is a perspective view of the WCD with potting material 1630. As described above, the PCB, battery, and components can be disposed within the space. Once disposed therein, a potting 1630 can be provided atop the components and within the cutaway portion 1616. The potting 1630 can be transparent to allow for transmission of light through the cutaway portions 1616.

[0216] **V. Charging By Concentrated Light Source**

[0217] According to one aspect of the disclosure, the WCD can be charged by an external concentrated light source, e.g., laser light, laser diode, etc. In this regard, the photovoltaic device described above can include a concentrated photovoltaic element (CPV) that is constructed and arranged to receive concentrated light from the concentrated light source, e.g., laser light from a laser diode, light from a light emitting diode (LED), etc., and converting the received concentrated light into an electric current. The photovoltaic device can also generate power from nonconcentrated light sources, such as office lighting and ambient sunlight. The electric current can be used to charge one or more batteries stored within the housing of the WCD.

[0218] FIG.17A depicts a cross section of a WCD employing charging by concentrated light source according to one or more aspects of the disclosure. In this example, the WCD 1700 can include a housing material 1710. The WCD can include a PCB 1720 and a concentrated photovoltaic cell 1730. The WCD can be positioned adjacent a base assembly or base station 1750. The base assembly 1750 can be connected to an external power source 1765 and can have internal circuitry 1760 to power one or more concentrated light sources 1770, e.g., one or more laser diodes and/or one or more LEDs, disposed within the base assembly 1750. In this example, the concentrated light source 1770 comprises one or more laser diodes.

[0219] The base assembly 1750 can define a first opening 1752 at one portion thereof to allow the concentrated light 1780 to exit the housing of the base assembly I 750. As shown in the diagram of FIG.17A, the concentrated light 1780 is generated by the concentrated light source 1770 and exits the housing of the base assembly 1750 via a first opening 1752. The concentrated light 1780 then enters into the WCD by a second opening 1712 in the housing of the WCD 1700 where it can fall upon the CPV 1730. Once the concentrated laser light falls upon the CPV 1730, the CPV 1730 can convert

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the incident concentrated light into a current that can be used to directly power one or more components within the WCD and/or can be used to charge one or more rechargeable batteries onboard the WCD.

[0220] The concentrated light source 1770, as described above, can be any type of light source that is arranged to generate concentrated light, such as an LED or a laser diode. The concentrated light can be any type of concentrated and/or coherent electromagnetic radiation, such as laser light and/or LED light. The concentrated light can have any desired intensity or wavelength, according to the characteristics of the CPV 1730.

[0221] In one example, the source 1770 can be a 200 mW laser diode that produces red or green laser light. This can generate approximately 80mW (or typically less) of power in the WCD where the CPV 1730 includes a plurality of groups of photovoltaics configured in series or in parallel with one another. Each group of photovoltaics can include one or more CPV cells. In another example, the CPV can include a single group of photovoltaics.

[0222] The base assembly 1750 described above can include additional components that can interact with the WCD 1700. For example, the base assembly can include one or more antennas that can communicate according to one or more wireless protocols, such as 3G, 4G, WiFi, Bluetooth®, NFC, or the like, for direct or indirect wired or wireless communication with the WCD or mobile device. In addition to the charging methods above, the base assembly can employ inductive charging techniques.

[0223] FIG.17B depicts a cross section of a WCD employing charging by concentrated light source according to another aspect of the disclosure. In this example, the concentrated light source 1770 comprises an LED. Further, the base assembly comprises an optical element 1790 positioned adjacent to the concentrated light source I 770 for focusing the LED light onto the CPV inside the WCD. The optical element 1790 can be any type of optical element, such as a lens. The lens can be formed of any material, such as glass, plastic, etc., and can be any type of lens, such as concave, convex, piano-concave, piano-convex, etc. In this example, the optical element 1790 includes a piano-concave, with the concave portion facing the concentrated light source 1770. In the example where the source 1770 is an LED, the LED emits light in many

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directions. The optical element 1790 can focus the emitted LED light to focus as much of the LED light as possible onto the CPV of the WCD. The optical element 1790 can be disposed at least partially or completely within the first opening 1752. In some implementations, the optical element may not be necessary due to LEDs with substantially focused light.

[0224] FIG.17C is a perspective view of a base assembly 1750 and WCD 1700 according to one or more aspects of the disclosure. As shown, the WCD 1700 is in the shape of a ring and the base assembly 1750 includes a post 1754 for receiving the ring. The post 1754 can be cylindrical and can be sized and shaped according to an internal diameter of the WCD in order for the WCD to be received on an external surface of the post. The first opening 1752 of the base assembly 1750 is formed on a portion of the post 1754 such that, when the WCD 1700 is stored on the post, the second opening 1712 can be aligned with the first opening 1752 to ensure alignment of the CPV and the concentrated light source. The base assembly can receive/transmit power and/or data via external input/output 1795, which can be a DC power input, a USB input connection or any other acceptable connection/form factor.

[0225] FIG.17D depicts a perspective view of internal components of the base assembly 1750 and WCD 1700 according to another aspect of the disclosure. In this figure, the respective housings of the base assembly and WCD have been omitted, thereby showing a plurality of concentrated light sources 1770, optical elements 1790, and a plurality of CPVs 1730 disposed on mounting substrates 1775 on a PCB. In this example, the WCD can include a plurality of CPVs and the base assembly can include a plurality of sources. This allows for a greater current to be generated during charging and for faster charging times of the WCD. The CPVs and concentrated light sources can correspondingly be disposed in a line, with a constant or variable pitch between respective elements. In this regard, the optical element can include corresponding concavities with the same pitch.

[0226] FIGs.17E-F depicts other CPV configurations according to one or more aspects of the disclosure. As shown in FIG.17E, the CPVs 1730 can be arranged in a lx4 array, while FIG.17F depicts the CPVs arranged in a 2x2 array. In addition to the examples shown in the above figures, the WCD can include any number of CPVs according to any number of geometric configurations.

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[0227] FIG.17G is perspective view of a WCD and base assembly with a lx3 CPV arrangement. As shown, the WCD can include a lx3 array of CPVs and the base assembly can include a corresponding lx3 array of concentrated light sources. As indicated by the arrow, a user can then rotate the WCD on the base assembly in order to align the respective first and second openings, as well as the CPV and concentrated light sources.

[0228] FIG.18A depicts a cross section of a WCD 1800 employing charging by concentrated light source 1870 according to another aspect of the disclosure. In this example, the WCD includes an internal/external housing portion 1810 and an internal/external potting portion 1820, as described above. In this regard, the base assembly 1850 includes a first opening 1852, but is free of a second opening on the WCD. The concentrated light 1880 passes through the transparent potting portion and falls incident upon the CPV cell 1830. In this example, the source can be a laser diode.

[0229] FIG.18B depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure. In this example, the concentrated light source 1870 includes one or more LEDs and the base includes one or more optical elements 1890 for focusing the concentrated light 1880. The LEDs may be of different wavelengths to provide power to two or more junctions in the triple junction CPV cell.

[0230] FIG.19A depicts a cross section of a WCD 1900 employing charging by concentrated light source 1970 according to another of the disclosure. In this example, the WCD and/or the base assembly 1950 can employ one or more magnetic and/or ferrous materials to ensure alignment between the concentrated light source and the CPV cell. Such alignment can improve charging efficiency of the WCD.

[0231] The base assembly includes a first opening 1952 and the WCD includes a second opening 1912 to allow for concentrated light to fall incident upon the CPV 1930. In this example, the second opening is formed on an external housing portion of the WCD. In this arrangement, the base assembly can charge the WCD from an exterior of the WCD, rather than an internal charging method as identified above.

[0232] The WCD can include a ferrous or other suitable (e.g. ferromagnetic) material 1920, such as steel, disposed within the housing 1910. In this example, the

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ferrous material is disposed in a space defined between an internal housing and an external housing. The ferrous material can surround the CPV.

[0233] The base assembly can include corresponding magnets 1960 that can cause an attractive force between the WCD and the base assembly into an optimal configuration for charging. The magnets can be disposed within the base assembly and can surround the concentrated light source. The magnets 1960 can be formed of a rare earth material, such as neodymium or any other acceptable material that provides a requisite magnetic field strength.

[0234] FIG.19B depicts a cross section of a WCD 1900b employing charging by concentrated light source 1980b according to another of the disclosure. The CPV 1930b of the WCD1900 is charged from an interior portion, such as by a base assembly 1950b with a post 1954b. Similarly, the WCD can include a ferrous material 1920b disposed within the housing1910b and the base assembly1950b can include a magnet 1960b.

[0235] FIG.19C depicts a schematic diagram of magnets 1920c,1960c that can be used in a WCD and/or base assembly, including a CPV 1930d and concentrated light source 1930d, according to one or more aspects of the disclosure. As shown, the magnets and/or ferrous/ferromagnetic materials can be axially polarized, with each having a respective north pole and south pole. In this regard, the WCD can have axially polarized magnets 1920c with a south pole S facing toward the base assembly, and the base assembly can have axially polarized magnets 1960c with a north pole N facing toward the WCD. The attractive force between the north and south poles can ensure alignment of the CPV 1930c of the WCD and the source 1970c base.

[0236] FIG.19D depicts a schematic diagram of magnets that can be used in a WCD and/or base assembly according to one or more aspects of the disclosure. In this example, the base assembly includes axially polarized magnet 1960d, with a north pole N facing toward the WCD. The WCD can include ferrous steel 1920d, with an attractive force between the ferrous steel and the north pole of the base assembly magnet.

[0237] FIG.19E is a perspective view of a WCD and a base assembly according to one or more aspects of the disclosure. As shown, the WCD 1900e can be received by a post 1954e of a base assembly 1950e. The respective magnets I960e and/or ferrous materials 1920e are shown in phantom to illustrate their positioning with respect to the

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WCD and base assembly devices and the CPV1930e as well as the concentrated light source 1970e.

[0238] FIG. 20A is a cross section of a WCD 2000 engaged with a base assembly 2050 according to one or more aspects of the disclosure. In this example, the magnets 2060 can surround the concentrated light source 2070, and the WCD can include a ferrous steel 2020, CPV 2022, and battery 2024 disposed within an internal/external potting 2014 of the WCD. The ferrous steel 2020 can be disposed on a face of the PCB 2040 and can be encapsulated by the internal/external potting 2014. The base assembly can include one or more optical elements 2090 for focusing the concentrated light 2080.

[0239] FIG. 20B is a perspective view of a PCB 2040b with a CPV 2030b and ferrous element 2020b configuration according to one or more aspects of the disclosure. In this example, the ferrous element 2020b comprises a steel ring that can surround a CPV 2030b and can be disposed on the PCB 2040b.

[0240] FIG.20C is a perspective view of a PCB 2040c with a CPV 2030c and ferrous element 2020c configuration according to one or more aspects of the disclosure. In this example, the ferrous element 2020c comprises a plurality of rectangular bars disposed on the PCB. In this way, the ferrous element 2020c can be coated to be reflowed onto the PCB.

[0241] FIG.20D is a perspective view of a magnet 2060d and a concentrated light source 2070d according to one or more aspects of the disclosure. As shown, the magnet 2060d can include a ring that can extend around a circumference of the concentrated light source 2070d. The magnetic ring can be attracted to the ferrous steel ring and/or the rectangular ferrous steel examples set forth in 20A-C above.

[0242] In some examples, the WCD can be adapted to uniquely identify the wearer of the WCD using, for example biometric features unique to the user.

[0243] FIG.21A is a schematic view of a WCD 2100 showing components used for identifying the wearer of the WCD. As shown, the WCD2100 can include one or more infrared illumination sources 2110 and an infrared CMOS imaging device 2120. The finger 2190 can extend through the finger space of the WCD and the IR source 2110 can illuminate a portion of the skin of the finger 2190. The IR CMOS imaging device 2120 can receive light that has been reflected from the skin surface and produce an image of

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the skin of the finger 2190. As shown, the IR source2110 and the imaging device 2120 are positioned near the interior surface of the WCD, e.g., the surface facing the skin of the finger. The IR illumination can pass through a window provided on the interior housing or can pass through a transparent potting material.

[0244] During the imaging process, the WCD 2100 can be rotated about an axis passing through the center of the finger space and along the longitudinal direction of the finger. In this regard, the imager 2120 can capture a larger swath of the skin surface than if the WCD 2100 were held stationary with respect to the finger during the imaging process.

[0245] At the time of first use, or any time thereafter, the user can generate a reference capillary map in order to identify himself/herself as the authorized user of the WCD. As described above, the user can rotate the WCD around the finger to capture image data of an analyzed section of skin 2192 and on or more capillaries 2194 of the user currently wearing the WCD. The image data can correspond to an overall analyzed section of the skin 2196 of the wearer. The image data of the capillaries can be used to generate a reference capillary map of the wearer, which can be stored in the memory, such as flash memory or EEPROM, of the WCD.

[0246] When the same user puts the WCD on his or her finger after generation of the reference capillary map, the WCD can capture image data of the wearer's skin surface that can be compared to the reference capillary map stored in the memory. In this regard, the user need not rotate the device around the finger. Instead, the WCD can compare a subset of the gathered image data to a corresponding subset of reference capillary map. If there a match, within a predetermine error tolerance, the WCD can uniquely identify the wearer as an authorized user of the WCD and as the unique individual who generated the reference capillary map. Once authorized, the wearer can have access to certain functions, features, data, or other content that is not otherwise available without authorization. In another example, the identification can be a step in a transaction or other type of authorization, such as an electronic payment, bank transaction, etc. If the gathered data does not match the reference capillary map, then the user may be prevented from accessing certain features on the WCD.

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[0247] Illustratively, the comparison process between sensed capillaries and some or all of the capillary map can be implemented using basic pattern recognition algorithms (processes) instantiated in the electronics of the WCD. Such processes can rely on edge detection and similar techniques that should be clear to those of skill in the art and can be sourced from various commercial vendors of biometric recognition software.

[0248] In another example, the illumination can include NIR illumination and can project radiation into the skin of the finger. The reflected NIR illumination can then be analyzed to determine one or more characteristics of the blood, such as blood alcohol levels, blood glucose levels, and blood oxygenation levels. In this regard, the WCD analyzes the reflected radiation to identify wavelengths that were absorbed from the projected radiation by the blood of the user. Techniques and processed used in conjunction with commercially available venous oximeters (for example) can be employed to undertake certain readings.

[0249] FIG. 22A is a perspective view of a user employing ECG monitoring according to one or more aspects of the disclosure. In this example, the user can wear the WCD2200 on a first finger 2210 of first hand 2220, and can touch a second finger 2230 of a second hand 2240 to an exterior surface of the WCD 2200. This can provide an electric pathway 2250 through the body, as shown in FIG. 22B, allowing for the transmission of electrical current between distant portions of the body.

[0250] FIG. 22C is a perspective view of a WCD that can employ ECG monitoring according to one aspect of the disclosure. In this example, the WCD 2200 includes an internal/external housing 2250 with a conductive pad2260. The conductive pad 2260 can be electrically isolated from the external/internal housing 2250 of the WCD, thereby providing distinct and isolated electrical contacts on the WCD. The internal/external housing 2250 can be in electrical communication with the first finger2210 of the first hand, while the conductive pad 2260 can be in electrical communication with the second finger 2230 of the second hand. In this regard, an electrical path 2250 is formed through the respective hands 2220, 2240 and through the rest of the user's body, particularly through the chest. In this regard, the WCD can take various electrical measurements of the user, such as ECG. The ECG measurement can include measurements of the various waveforms, such as P-U waveforms. The WCD can store

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such ECG data in a memory and/or can communicate the data to a wirelessly connected mobile device. In another example, the WCD can employ electrically isolated internal and external housings, such as those described above. In this regard, the conductive pad may not be utilized, and the user can wear the WCD on a first finger and apply the second finger anywhere on the external housing.

[0251] The WCD can also serve as a monitor for those who are mobility impaired or who are prone to falls, such as disabled persons and/or retired persons. The accelerometer onboard the WCD detect a fall of the user via a sudden change in acceleration data. The WCD, in conjunction with a mobile device and/or one or more base stations positioned around the home of the user, can determine the position of the user within the house. For example, the mobile device can employ GPS capabilities, and either the mobile device or the base stations can use GPS in combination with WiFi signal strengths to determine the location of the user within the house. The WCD can then issue an alert, either directly or indirectly (via the mobile device or base station) to a third party that a fall has occurred. The alert can be a phone call, text message, e-mail, or any other type of communication. The third party can then take appropriate measures to aid the fallen user.

[0252] The WCD can also monitor heart rate and/or temperature, in addition to the other monitored characteristics described above. If any of the monitored characteristics is abnormal, e.g., measured parameters outside of a predetermined threshold range, an alert can be sent to a third party. In some examples, the third party can be a medical health professional, such as a doctor, nurse, caretaker, etc. It is noted that, for those embodiments which can function as a cardiac monitor (e.g., that measures electrocardiogram (EKG)), it can be necessary to establish a closed loop (e.g., for the electrical measurement of EKG) across the heart. As such, in some of those embodiments, a separate conductive pad or other skin-contacting structure/probe can be coupled to the WCD so that a user can pinch the pad with fingers on an opposite hand.

[0253] Since the WCD has the form factor of a ring, the WCD is designed to be worn over long periods of time by a user with little to no discomfort or interference. In this regard, the WCD can monitor the above-described, monitored characteristics over long periods of time (e.g. weeks, months, etc.), and determine trends in the data. For example, the WCD can measure heart rate over a long period of time and determine a

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unique resting heart rate for a user. If the user's heart rate deviates from the resting heart rate, the WCD can be arranged to issue an alert to a third party. In one specific example, the WCD can use appropriate processes to analyze both the trends of monitored characteristics, as well as current accelerometer data. In this way, if a person's heart rate deviates from a resting heart rate, but the accelerometer indicates that the user is exercising and/or engaging in strenuous activity that provides an equivalent workout, then the WCD may not issue an alert in this circumstance.

[0254] FIG.23A is a perspective view of the hand of a user in various positions employing the navigational features of the WCD. As described above, the WCD can communicate with a mobile device though one or more wireless communication protocols. The mobile device can include a processor and a memory and can execute a map application/process that can provide tum-by-tum walking or driving directions to the user based on the user's GPS location. A portion of those directions can include information regarding heading, distance to travel at that heading, waypoints, and the direction of next tum. By way of the wireless communication, the mobile device can communicate one or more of pieces of information relating to directions, such as the heading. Once the heading is received the WCD, the WCD can give feedback to the user regarding the actual heading measured by the onboard magnetometer and the heading set forth in the direction information. In one example, the feedback can be haptic or physical feedback provided by one or more actuators, such as the actuators 670 described above.

[0255] FIG. 23A depicts a user's hand in various positions of navigation, each hand including a WCD worn thereon. In this example, the heading provided by the mobile device is the heading 2335, which represents the direction in front of the hand position2330. In this regard, if the user gestures, e.g., points a ring finger, in the direction of the correct heading, the WCD 2300 can give feedback to the user indicating the correct heading. The feedback can include, for example, an LED indicator 2310 showing a green visible light. In the example of hand position2320, the finger is gesturing in a direction to the left of the correct course 2325. In this way, the WCD 2300 can provide feedback to correct the heading of the user. Such feedback can include illumination of an LED indicator showing (e.g.) a red visible light. Similarly, hand 2340

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is gesturing in direction 2345, which is to the right of the correct/appropriate direction. The WCD can provide (e.g.) a blue indicator informing the user to change heading.

[0256] FIG.23B is a flow chart 2300B depicting a method of providing feedback to a user according to one or more aspects of the disclosure. At block 231OB, a user can establish a communication link between a WCD and a mobile device. At block2320B, the user can generate or request a set of directions at the mobile device, including information/data regarding heading, distance to travel at that heading, and the direction of next tum. At block 2330B, the mobile device can transmit at least one of the information items/datum regarding heading, distance to travel at that heading, and the direction of next tum. At 2340B, the WCD can take a measurement of heading by measuring a heading associated with an explicit gesture by the user's finger donning the ring. Such gesture can include pointing in a proposed heading of travel. At block 2350B, the WCD can compare the measured or proposed heading to the correct heading provided by the mobile device. At 2360B, the WCD can provide feedback to the user based on the comparison at 2350B, e.g., if the user is gesturing in the correct direction, a green LED indicator may appear. In other examples, if the gesture is in a direction that does not correspond with the correct direction, a (e.g.) blue or red indicator can appear. In one specific example, indicators representing left and right course alterations can be different so a user can easily discern a correct direction of travel.

[0257] FIG. 24A is a schematic diagram of a system 2400 for controlling an environment of a user according to one or more aspects of the disclosure. As shown, the WCD can be connected, wired or wirelessly, to one or more appliances in the home of a user. The system 2400 can include a WCD 2410, a thermostat 2420, a wireless access point (e.g., WiFi router) 2430, and a mobile device 2440. The WCD can be wirelessly connected (e.g., link 2415) to both the thermostat and the mobile device by any type of wireless communication protocol, such as Bluetooth. The access point can be wirelessly connected to the thermostat and the mobile device by any type of wireless communication protocol, such as WiFi. It is noted that a wide range of commercially available appliances, thermostats, lighting controllers, home controllers, and the like, can interface with the WCD using WiFi or another conventional/proprietary communication protocol, as described further below.

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[0258] The WCD 2410 can include one or more temperature sensors. In one example, the WCD can include at least one internal facing temperature sensor 2410a and an at least one outward facing temperature sensor 2410b, as shown at FIG. 24B. The inward facing temperature sensor 2410a can be near the skin of a user when the user is wearing the ring, and can therefore measure the skin temperature of the user. The outward facing temperature sensors 2410b can be disposed away from the finger of the user, and can therefore be arranged to measure an ambient temperature of the room in which the user currently resides with sufficient thermal isolation from the user's hand and his/her body heat. In particular, in order to ensure accurate ambient temperature measurements, the WCD can employ a combination of multiple light sensors 2410c and outward facing temperature sensors 2410b. In this regard, the temperature sensor 2410b associated with the light sensor 2410c that receives the most light can be the most accurate, as it is most likely that this sensor is furthest from the finger or palm of the user. In another example, the WCD can employ multiple outwardly facing temperature sensors 2410b and compare the temperature values of each to the inward facing sensor 2410a. The WCD can then select the most accurate temperature value from the outward facing sensors.

[0259] Based on the measured skin temperature and measured ambient temperature, the WCD can automatically adjust the thermostat 2420 to alter the ambient temperature of the room. In this regard, if a user's skin temperature is too high, the WCD can instruct the thermostat 2420 to lower the ambient temperature. Similarly, if the user's skin temperature is too cold, the WCD can instruct the thermostat 2420 to raise the temperature. The WCD 2410 can instruct the thermostat (and/or an HVAC controller) directly, e.g., via a direct wireless link 2415, or indirectly, e.g., via one or more of the mobile device 2440 and the access point 2430. The WCD can also use historic temperature data to develop trend temperature data.

[0260] In another example, the WCD can be part of a system 2400C for controlling home appliances. The system 2400C can include a WCD 2410C, one or more home appliances 2420C, and an access point 2430C. Such home appliances 2420C can include, for example, a television, lights, speakers, microwave, range, stove, oven, etc. Each of the home appliances can include an antenna that allows the respective home appliances to communicate wirelessly with one or more access points 2430C. In one

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example, the appliances can include a ScenSor DWIO00 chip provided by DecaWave. In this way, the locations of the appliances in the room can be determined to an accuracy of approximately 10 cm. The location of the WCD 2410C can also be determined, using the above-referenced chip, or by using signal strengths of one or more base stations.

[0261] Having established the position of one or more home appliances and the user in a room, the user can make a gesture to control such home appliances 2420C. For example, the user can point at the TV (while wearing the WCD) in order to tum it on/off. Knowing the position of the user and the position of the TV, the direction of the gesture and the type of gesture can indicate what action to take on which device. The accelerometer and/or magnetometer on the WCD can be used to create a vector to the object to control, and a wireless packet can bet sent to a wireless access point to control the respective appliance.

[0262] FIG. 24D is a flow chart depicting a method 2400D of controlling home appliances according to one or more aspects of the disclosure. At block 241OD, the locations of one or more home appliances in a room and/or house can be ascertained/determined. As described above, the appliances can include a processor configured to identify location within a room. At block 2420D, the location of the WCD is determined. At block 2430D, the user can make a gesture toward a home appliance to exert control over the home appliance. Such gesture can include a snap, a point, etc. At block 2440D, the accelerometer and/or magnetometer on the WCD can be used to create a vector to the object to control. At block 2450D, a wireless packet can bet sent to a wireless access point to control the respective appliance. The access point can then issue the command to the respective appliance.

[0263] FIG.25 is a perspective view of the hand of a user employing a two-factor authentication technique according to one or more aspects of the disclosure.

[0264] As shown, the user 2500 is wearing a WCD 2510 and is approaching a locked door 2520 with an access node 2530 associated therewith. The access node 2530 can be a wireless access node of a conventional or custom arrangement, and can communicate wirelessly according to any type of wireless protocol, such as WiFi or Bluetooth. As the user approaches the door 2520, the WCD 2510 can initiate a

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communication link, e.g., Bluetooth or WiFi, with the access node 2530. In this way, the WCD and the access node can engage in one or more handshaking or query procedures to verify the WCD. For example, the access node 2530 can detect a MAC address, IP address, or other alphanumeric identifier associated with the WCD and compare it to a list of authorized users. Such network-based communication processes should also be clear to those of skill.

[0265] Once the MAC address or other identifier is verified, the user can engage in a pre-defined gesture 2550 to complete the authentication procedure. The gesture 2550 can be any type of hand and/or finger motion that can be performed by the user. In this regard, the accelerometer or magnetometer can detect the gesture 2550 performed by the user and provide the gesture information to the access node. If the provided gesture information corresponds with an authorized gesture stored at or accessible by the access node, then the user may be granted authorization and the door can be unlocked. The authorized gesture can be a general authorized gesture for all users, or can be a specific gesture authorized only for the particular MAC address.

[0266] In addition to a door, the method above can be used to gain access to other features, such as unlocking a mobile phone, unlocking a car door, starting a car. The authentication technique above is advantageous in that it can eliminate extraneous authentication devices, such as key fobs for a car, a door, keypads for entry control, etc., and can provide a secure two-factor authentication technique to avoid unwanted access. More generally any type of keyless entry system (e.g. a keypad, card-reader, keyless lock, etc.) can be equipped with appropriate communication interfaces (RF, IR, etc.) to communicate with the WCD and operate based on a gesture and/or proximity of the user using the techniques described above. The WCD can also be employed generally in this manner to activate or deactivate a residential or commercial alarm system-substituting, for example, for a key fob used for this purpose.

[0267] FIG. 26A is a schematic view of a charging apparatus for charging the WCD according to one or more aspects of the disclosure. As shown, a mobile device 2610 can be received within a case 2620. The mobile device 2610 can be electrically connected to the case 2620 via a port 2610a on the mobile device 2610 and a connector 2620a on the case 2620. As shown in phantom, the case 2620 can include an integrated battery 2630

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within the case that can charge the mobile device via the connector or can charge a WCD, as will be described in greater detail below.

[0268] The integrated battery can be connected to an antenna 2640 disposed on or within the case 2620 that can emit an RF signal, as shown in the block diagram in FIG. 26C. The RF signal can have a power of less than 500mW and a frequency of 13.56MHz. The RF signal can be emitted in all directions around the case such that it can be received by a WCD in proximity to the case.

[0269] FIG. 26B shows a WCD 2650 including an RF antenna 2660 and charging circuitry 2670. The RF antenna 2640 can be disposed within the housing 2680 and can receive the RF signal emitted by the case 2620 and convert it to a current that can be used to charge the WCD battery (not shown). This can advantageously allow the user to charge the WCD without removing the WCD from the finger. As shown in FIG. 26D, the charging can occur whenever the WCD is in close proximity to the case, such as when a user talking on the phone or merely handling the phone. In another implementation, the case can utilize inductive charging to charge the WCD. In this regard, the case can include an induction coil subjected to a predetermined current to produce a magnetic field. A corresponding induction coil within the housing of the WCD can be subjected to the magnetic field to produce a current that can charge the onboard battery in accordance with known electromagnetic principles.

[0270] FIG. 27A is a pictorial diagram and FIG. 27B is a block diagram of a WCD employing flash storage according to one or more aspects of the disclosure. As described above, the WCD 2700 can include a housing 2710, an antenna 2720, and an integrated circuit (IC) 2730 including a flash memory 2740. The IC and the flash memory can be disposed within the housing 2710. The flash memory 2740 can be powered by a battery 2750 and connected to the IC 2730, which can be implemented as a system-on-a-chip (SoC) IC 2760. The IC can include Bluetooth Low Energy (BLE) capability to allow for communication with another device. The flash memory can be used to store data, or can be used in any of the authentication techniques described above. The WCD can transmit data stored on the flash memory to another device 2780 via the BLE connection, or can receive data and store the data on the flash memory.

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[0271] FIG. 28A is a schematic diagram of one or more WCDs performing proximity functions according to one or more aspects of the disclosure. The WCD can detect a strength of an RF signal received by its antenna, and calculate a distance to the source of the RF signal using a Received Signal Strength Indicator (RSSI). In one example, the RF signal can be from a mobile device, an access point, or another WCD. The use of RSSI can have many applications in proximity detection. For example, the WCD can be placed on a child and can be connected to mobile device held by a parent. If the WCD travels a predetermined distance from the mobile device, the WCD can issue an alert to the mobile device, thereby alerting the parent that the child has wandered too far. In another example, the parent can wear a first WCD and the child can wear a second WCD. The first WCD can alert the parent that a child has wandered too far.

[0272] A single user can wear a first WCD 2800 on a first finger on a first hand and a second WCD 2810 on a second finger on a second hand. In this regard, the user can measure the relative distance between the first and second fingers using an RSSI via a wireless link 2830 between the WCDs 2800, 2810, such as a BLE connection. This can be used to measure an approximate dimension of an object held in both hands or to estimate a mid-air measurement.

[0273] In some examples, a first user can wear a first WCD 2800 and a second user can wear a second WCD 2810. The RSSI can be collected over a period of time and the processor can analyze the data to develop trends or statistics. For example, the RSSI data can indicate that the first and second users have spent a certain amount of time together and can serve as a relationship monitor.

[0274] The WCD can also detect when the first user and second user are holding hands. FIG. 28B is a schematic diagram of one or more WCDs 2800, 2810 performing proximity functions according to one or more aspects of the disclosure. Similar to the ECG monitoring techniques described above, a circuit can be formed when the users hold hands 2840 (with the respective hands wearing the WCDs). The circuit can be used to transmit data and/or electrical impulses between the respective WCDs via the circuit. The WCDs can collect data regarding the length of time that the users are holding hands and, in combination with the amount of time spent together, monitor the relationship of the two users. In addition, the WCD can collect data regarding communication between

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the users, e.g., e-mail, social media, etc. Based on all of the above factors, the WCD can develop a relationship score between respective WCD users, with a higher relationship score indicating more and more frequent interactions.

[0275] FIG.29A is a flow chart depicting a method of initiating gesture input according to one or more aspects of the disclosure. The WCD can be used to perform one or more commands, or to instruct another device, such as a mobile device, to perform one or more commands. Such commands can include, initiate sleep state of WCD, initiate sleep mode or default mode of WCD, powering off/on of the WCD, turning on/off an LED light of the WCD, powering on/off of a mobile device, placing a phone call on the mobile device, etc. The user can establish one or more custom gestures to initiate any of the commands above. For example, the user can select a command to be customized from a number of commands. Once selected, the user can perform a custom gesture to be associated with that command. In some examples, the user can perform the custom gesture multiple times to allow the WCD to better identify the gesture and to develop error tolerances for registering the gesture.

[0276] At block 2910, the user can perform a first gesture. In this example, the user can perform a finger snap. At block 2920, WCD can register the gesture, via the accelerometer and/or the magnetometer. At block 2930, the accelerometer can send an interrupt signal to the processor. At block 2940, the processor can wake from a sleep or default system state. At block 2950, the processor can monitor the accelerometer for a second gesture, at which point the user can perform a second gesture. If the second gesture matches a gesture in the gesture command database, then the WCD can perform the associated command. If not, the WCD can return to the sleep state.

[0277] FIG.29B is a chart 2900B showing an exemplary graph of acceleration vs. time as measured by the accelerometer of the WCD. As shown at peak2910B, the gesture can only be registered if it reaches a predetermined acceleration threshold. If the gesture performed at 2910 meets the threshold, it can proceed to block2930 where the interrupt procedure is performed.

[0278] FIG. 30 is a perspective view of a WCD 3000 employing an illustrative reset function and associated procedure/process. As shown, the WCD 3000 can be removed from the finger of the user in order to initiate a system reset of the WCD. In one

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example, the system reset can be initiated by spinning about a rotation axis R at a predetermined speed. The predetermined speed can be any value, and in one example is a rotational velocity. Upon performing the reset procedure at the predetermined speed, operation of the WCD 3000 can be interrupted and the onboard components of the 3000 can power off, and revert to factory default settings. Additionally, a series of movements can initiate a rest, such as putting the ring on a table and turning it over several times.

[0279] FIG. 3lA is a perspective view of a WCD including an LED indicator according to one or more aspects of the disclosure. As shown, the WCD 3100 can include an internal/external housing 3112 and an internal/external potting 3114. The WCD can include an LED 3120 that can be visible through the internal/external potting 3114.

[0280] FIGs. 31B and 31C are cross sections along line C-C of a WCD employing an LED indicator according to one or more aspects of the disclosure. As described above, the WCD 3100 can have an internal and/or external potting 3114 that can be transparent. This allows light sources within the housing to pass through the potting without changing, or with minimal change to, the optical properties of the light. In this way, a light source 3120, such as an LED, can be disposed on the PCB 3140 and can be powered at least partially by battery 3130. The LED can be encapsulated by the potting 3112 and can project light through the potting 3112. As shown in FIG. 31B, the LED 3120 can include a vertical LED, while 31C depicts a right angle LED. The vertical LED can project light along direction L1, while the right angle LED can project light along direction L2. When light is projected along L2, the light can travel around a circumference of the finger of the user.. Note that, according to aspects of the disclosure, the potting can be generally adapted in whole or in part to condition, filter or modify the wavelengths and/or projection qualities of light by for example, embedding lensmatic components, applying light-diffusive additives, light attenuating filter materials, etc.

[0281] FIG. 32 is flow chart depicting a method 3200 of communicating with a near field communication (NFC) device according to one or more aspects of the disclosure.

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[0282] In some examples, the WCD can enable or disable NFC or change the functionality of a NFC device. For example, the WCD can itself engage in NFC with another computing device, or the WCD can be connected via wireless link to a computing device that engages in NFC with a different computing device. In certain existing NFC devices, NFC will connect and begin transmitting data as soon as it is queried. In the present example, NFC is enabled or begin transmitting data exclusively upon performing of a pre-determined gesture. However, a variety of other transmission processes can be implemented-for example a periodic chirp or handshake request by the WCD for communication with appropriate devices.

[0283] At block 3210, a NFC capable device is provided. The device can be any type of device, such as a laptop, tablet, mobile device, or dedicated NFC device.

[0284] At block 3220, the WCD initiates a connection with the NFC device. The connection can be a direct connection via NFC, or an indirection connection via an intermediate device. At this point, no data has yet been transmitted between the WCD and the NFC device.

[0285] At block 3230, a user performs a predetermined gesture that is registered by the WCD. The gesture can be any type of gesture, such as a point, a snap, waving the hand, etc.

[0286] At block 3240, data transmission begins between the NFC device and the WCD.

[0287] In other examples, the user can perform another gesture to cease NFC communication. The gesture can be the same gesture as described above or a different gesture. Additionally, the user can remove the ring to disable the NFC. Upon donning the ring the user will be prompted by the application on the mobile device to re-authenticate by entering a PIN, whereby the proper PIN results in re-enabling the NFC functionality.

[0288] In yet another example, the WCD device employing NFC can be configured on the fly to map to different data sets stored thereon. For example, the WCD device employing NFC can employ data thereon to make purchases, e.g., account information, data to access a building, e.g., a key fob, and data thereon to board public transportation, e.g., smart card, metro card, etc. A user can perform a predetermined different gesture

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for each of the above data sets to access the data. Once accessed, the WCD device employing NFC can initiate a link with another computing device to initiate a transaction, to open a door, or to board public transportation, etc.

[0289] **VI. Optical Element and Attachment Frame**

[0290] FIG. 33A depicts a perspective view of a WCD assembly 3300 according to one or more aspects of the disclosure, while FIGs. 33B-D depict exploded views of the WCD assembly and 33E depicts a cross sectional view of the WCD assembly along A-A. In this example, the WCD assembly 3300 includes a WCD 3310, an attachment frame 3320, and an optical element 3330. The WCD 3310 can be any of the WCD examples described above or below in the present application.

[0291] The attachment frame 3320 is releasably attached to the WCD3310. The optical element 3330 is itself releasably attachable to the attachment frame 3320. In this regard, the attachment frame 3320 provides an attachment interface between the WCD 3310 and the optical element 3330, thereby allowing the optical element 3330 to be at a fixed position in space with respect to the WCD 3310 or any portion thereof. The attachment frame3320 can be made of any material, such as a metal, polymer, etc. Any type of polymer can be used, such as thermosetting plastics, thermoplastics, PETE, polycarbonate, polyethylene, LDPE, or any other type of plastic.

[0292] The attachment frame can be sized and shaped to fit along the curved surface of the WCD. For example, the attachment frame can have a curved undersurface to allow a flush fit with the curved surface of the WCD. The attachment frame can have any shape, size, or radius of curvature depending on the size and shape of the WCD.

[0293] The attachment frame 3320 includes a first retaining a portion 3322 and a pair of second retaining portions 3324. The first retaining portion 3322 defines a conical recess 3322a configured to receive the optical element 3330, and provides a generally unoccluded pathway for light to pass through the optical element and onto the WCD. Although depicted as defining a conical or frustoconical shape, the recess 3322a can be any other shape depending on the shape of the optical element 3330. Each of the second retaining portions3324 includes a respective locking feature 3324a. The respective locking features3324 and a extend from the second it retaining portion3324 toward one another such that a distance between the respective locking features is greater than a

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distance between the remaining portions of the second retaining portions. As shown in FIG. 33E, the locking features engage with an inward-facing surface 3350 of the WCD to ensure a secure fit. In one example, the inward-facing surface of the WCD may itself have one or more features 3360 to engage with the locking features of the second retaining portions. Such one or more WCD features can include projected surfaces, recesses, or any other type a feature to allow for engagement with the attachment frame.

[0294] The optical element 3330 can be made of any material capable of modifying, e.g., focusing, incident electromagnetic radiation, such as visible light, ultraviolet light, infrared light, or any other type of electromagnetic radiation. In some examples, the optical element 3330 can be constructed from a polymer, such as any of the polymers identified above. In another example, the optical element can be made of glass, quartz, diamond, zirconium, or any other material capable of focusing light. More generally, the optical element 3330 is formed with a general outward appearance simulative of a faceted jewel with an appropriate tint or coloration (including clear/white). The term "jewel" can also be used in the alternative to describe the optical element 3330 herein.

[0295] The WCD can include CPV cell 3312 that can be disposed directly underneath the attachment frame 3320 and optical element 3330 when assembled. In other examples, the CPV can be positioned within the housing and can receive electromagnetic radiation via a transparent potting material. In this regard, incident light striking the optical element 3330 can be focused on to the CPV cell to allow for charging of the internal battery of the WCD. The optical element 3330 provides an increased charging efficiency when compared to the CPV exclusively receiving ambient light, since the ambient light is collected/gathered from a wider field, and then focused onto the CPV by the optical element 3330. In one example, a focal length of the optical element 3330 is different than a distance between the optical element and the CPV. For example, the focal length can be greater than or less than the distance between the optical element and the CPV. This can be advantageous in various aspects of the disclosure so as to avoid the light from focusing at a focal point directly on the CPV, which could cause damage to the CPV itself by over-concentrating the light at that single point of the overall CPV surface.

[0296] FIGs.34A-B depict a WCD assembly 3400 according to one or more aspects of the disclosure. In this example, the attachment frame 3420 does not extend to an

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inward-facing surface of the WCD 3410, but is instead form entirely on the outside-facing surface of the WCD. In some examples, the attachment frame 3420 can be semi-permanently or permanently affixed to the outward-facing surface of the WCD and can have a plurality of retaining portions (mounting prongs) 3422 that at least partially define a recess 3422a for receiving the optical element. As shown in FIG.34B, the optical element 3430 is releasably attached to the attachment frame 3420. This configuration can be particularly desirable, as it exhibits ornamental similarities to a traditional engagement ring while still having the increased functionality of the WCD. Note that while not shown, the mounting prongs can include small hook ends that springably retain the optical element 3430 when attached, but that can release the optical element based upon a prying motion. A customized grasping tool (not shown) can also be employed to remove (and attach) the optical element in this example.

[0297] **VII. Enclosure/Packaging**

[0298] FIG. 35A depicts an enclosure or case 3500 for storing a WCD according to one or more aspects of the disclosure. As shown, the enclosure3500 includes a lid 3510 and a base 3520. The lid 3510 and base 3520 can engage via a recessed portion 3522 formed in the base 3520 to provide a substantially sealed interior environment.

[0299] The lid 3510 can be cuboidal in external dimensions, or define any other type of geometric shape that allows sufficient internal volume to contain the WCD. For example a custom design shape (polyhedral, etc.) can be employed. In this example, the top portion3510 is substantially cuboidal as shown, including rounded edges rather than vertices. The lid can be substantially transparent to allow viewing of the WCD while enclosed therein, and can be made of any type of material, such as a polymer, glass, etc. The lid can also be mounted with pins on a hinge.

[0300] The base 3520 can be cuboidal, or any other type of geometric shape. In this example, the bottom portion is substantially cuboidal, including rounded edges rather than vertices as shown. The bottom portion can be made of any material and can be transparent or opaque.

[0301] The base 3520 can define a receptacle 3524 for receiving the WCD3505. The receptacle 3524 can be sized and shaped to receive the WCD 3505 and in this example is semicylindrical, e.g., a portion of a cylinder. The radius of the semicylinder

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can be slightly larger than a radius of the WCD in order to accommodate the WCD securely. The receptacle can lined with a soft material to allow for a soft, safe material to receive the WCD, such as a silicone, thermoplastic, fabric, felt, or other material.

[0302] FIG.35B is a cross sectional view of the assembled enclosure3500 shown above along the line B-B. As shown, when assembled, the WCD 3505 fits securely within the receptacle 3524. The interior of the lid3510 can be sized and shaped to conform to the shape of the WCD such that the WCD is completely surrounded and enclosed by the lid 3510, while in other examples, the lid3510 can be sized and shaped to allow for airspace 3514 between the lid surface and the WCD.

[0303] FIG.35C is a cross section of the enclosure along line A-A. As shown, the lid 3510 can include an integral optical element 3512. The optical element3512 can be a lens or any other device to modify, e.g. focus, light that passes therethrough. In this example, the optical element 3512 can be disposed at a predetermined distance away from one or more CPV cells 3507 disposed on the WCD 3505. This distance *d* can be measured from the center of the optical element to the CPV cells 3507, and the optical element can itself have a focal length *f*. In one example, the distance *d* can be greater than the focal length *f*, such that the optical element focuses light at a point above the WCD in the enclosure. In this regard, the light will not focus directly on the CPV cells disposed at the surface of the WCD, thereby avoiding overheating or damage to the CPV cells. In other examples, the distance *d* can be less than the focal length, which can also prevent light from focusing at a surface of the WCD.

[0304] FIG. 36 depicts an enclosure 3600 including air vents 3650 according to one or more aspects of the disclosure. In this example, the enclosure 3600 includes a plurality of vent holes 3650. The vent holes can be arranged on one or more faces of the lid. The vent holes 3650 can prevent overheating within the enclosure during charging of the WCD by allowing for circulation of convective air current. During shipping, the vent holes3650 can be covered by an adhesive and/or adhering (peel-off) polymer sheet of conventional arrangement to prevent debris or moisture from entering the enclosure. The enclosure can include a lid 3610, base 3620, receptacle 3624, and optical element 3612 as in the examples set forth above.

[0305] **VIII. Sizing**

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[0306] FIG. 37 depicts a method 3700 of sizing a finger according to one or more aspects of the disclosure. At block 3710, the hand of a user can be provided. The hand can be held still in mid-air or alternatively can be resting on a surface.

[0307] At block 3720, a first image is taken of the user's hand from a first perspective. The image can be taken by any type of imaging apparatus, such as a CCD or CMOS camera, a digital camera, a camera associated with a mobile phone, etc. The first image can be stored in a memory.

[0308] At block 3730, a second image is taken of the user's hand at a second perspective. In this regard, the second perspective is different from the first perspective so as to provide a distinct view in the second image of the user's hand. Block 3730 can be repeated any number of times. For example, a third image can be taken of the user's hand at a third perspective. In this regard, the third perspective is different from both the first and second perspectives so as to provide a distinct view in the third image of the user's hand, and so on.

[0309] At block 3740, a size of the user's finger can be derived from the plurality of images taken above. In some examples, as few as two images may be required, while in other scenarios, more than three images may be required, depending on a number of circumstances including image quality, selected perspectives, etc. The size can be derived from the plurality of images by any number of techniques, such as stitching the plurality of images together to generate a 3D typography of the fingers, then using photogrammetry algorithms to identify features on the fingers to determine the appropriate ring size. Furthermore, the touch screen of the smart phone can be used to measure the hardness of tissue by measuring the footprint/impression the fingers make while pressing a finger against the touch screen of a mobile phone.

[0310] FIG. 38 is a pictorial diagram showing a plurality of image perspectives of a user's hand 3802. As shown, perspectives 3810, 3820, and 3830, as well as the other perspectives, produce corresponding images (in a strip) 3812, 3822, and 3832. The images can be used to derive a size of the user's finger according to the methods described above.

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[0311] FIG. 39 depicts a sizing tool for sizing the finger of a user. As shown, the tool 2900 can include a plurality of finger holes 3910-3950. The tool 3900 can be made of any material, such as plastic, metal, or cardboard.

[0312] FIG. 40 depicts a sizing tool for sizing the finger of a user according to an alternate example. As shown, the tool 4000 can include a plurality of finger holes 4010-4050. The tool 4000 can be made of any material, such as plastic, metal, or cardboard.

[0313] FIG. 41 depicts yet another alternate example of a sizing tool for sizing the finger of a user. As shown, the tool 4100 can include a plurality of finger holes 4110-4150. The tool 4100 can be made of any material, such as plastic, metal, or cardboard. The thickness of the card reflects the thickness of the ring to ensure proper fit. Additionally, the sizing tool is designed such that it can be easily mailed to the user with a standard mail service such as USPS.

[0314] Any of the tools 3900, 4000, or 4100 can be provided to a user prior to purchase of the ring in order to obtain accurate sizing information prior to purchase. The tools include holes, as shown above, that can come in a plurality of predetermined finger sizes to allow a user to match his or her finger size with the tool. The best match, e.g., closest size that ensures a comfortable fit, can be identified using the tools. Alternatively, the tools can be provided at retail locations to size the finger of the user on site prior to purchase. More generally, a variety of other sizing techniques, such as those employed by conventional jewelers can be employed according to further aspects of the disclosure.

[0315] In another embodiment, a packaging or enclosure of the WCD can include a sizing diagram or interface embodied therein to allow a user to size a finger during the purchase process.

[0316] FIG. 42 depicts a method 4200 of monitoring activity according to one or more aspects of the disclosure.

[0317] At block 4210, a user can don or place the WCD onto the finger to secure it in the wearing position.

[0318] At block 4220, a user can perform any number of daily activities, such as running on a treadmill, walking, exercising, typing, etc.

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[0319] At block 4230, the WCD, contemporaneous with block 3220, can use one or more sensors to sense the activities of the user. For example, the sensors can detect location, speed, acceleration, orientation, heart rate, etc.

[0320] At block 4240, the WCD, or another computing device, can generate an entry in an activity log at the conclusion of a detected activity. If the activity detected by the sensors has a profile that has not yet been identified, the WCD can prompt the user to identify the activity. For example, the user can identify profiles such as "Run in Central Park," "Typing," "Run on Treadmill," etc. The WCD can associate the identity provided by the user with the activity profile identified by the sensors and store the identified activity in the WCD memory, or any other memory. Later, if the user performs the same activity and the WCD detects the activity profile as being similar to a saved activity, the WCD can identify the activity while the user is performing the activity and save the activity in the activity log. Each of the activities performed can be saved in the overall activity log and can be stored in a memory on the WCD, or other device, for later v1ewmg.

[0321] FIG.43 depicts a method 4300 of determining whether a user is wearing gloves according to one or more aspects of the disclosure. At block 4310, a user is provided while wearing the WCD, where such user may or may not be wearing gloves.

[0322] At block 4320, one or more light sensors on board the WCD can detect surrounding ambient light. Such light sensors could include, for example, a CPV or other light sensitive element.

[0323] At block 4330, one or more additional measurements maybe made. Such additional measurements can include, for example, an ambient temperature measurement and or a proximity measurement, e.g., detecting proximity of an object to the WCD via reflected electromagnetic radiation in the form of IR light.

[0324] At block 4340, a measured ambient temperature and ambient light measurements are compared to predetermined thresholds. If the ambient temperature measurement is above a certain predetermined temperature threshold and the ambient light measurement is below a certain threshold, it can be determined that the user is wearing a glove over the WCD.

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[0325] At block 4350, a measured proximity and ambient light measurements are compared to respective predetermined thresholds. If the proximity measurement is below a certain distance threshold (e.g., determines an item is in close proximity to the WCD) and the ambient light measurement is below threshold, it can determined that the user is wearing a glove over the WCD. In any of the above examples, an intensity of LED indicators of the WCD can be adjusted according to a detected ambient light using an appropriate algorithm or process that compares the ambient light to a scale and adjusts a desired driving current/voltage for the LEDs according to a predetermined formula (e.g. a proportional adjustment using an adjustment coefficient) or scale (e.g. a lookup table). For example, where there is abundant ambient light (e.g., detected ambient light above a predetermined threshold), the intensity of the LED indicators can be increased. In the same way, where there is little ambient light (detected ambient light below a predetermined threshold), the intensity of the LED indicators can be decreased.

[0326] In one example, the WCD can detect whether it is removed and or installed on the finger of the user. In this regard, as mentioned above, the WCD can have inward-facing light sensors, CPV, or temperature sensors. When a user installs a ring on his finger the measure of ambient light may decrease or the temperature may increase. Such changes in ambient light and/or temperature can be detected by one or more sensors onboard the WCD and a determination can be made that the user has removed and or installed the ring on his finger.

[0327] FIG.44 depicts a method 4400 of securing data onboard the WCD according to one or more aspects of the disclosure. At block 4410, a user may don the WCD on the finger. At block 4420, a user may execute an application on a mobile device, or other computing device, that can be previously associated and authenticated with the WCD. At block 4430, the user can enter an authorization code into the application running on the mobile device, such as a PIN code. At block 4440 the mobile device may transmit the authorization code to the WCD by any means of communication, such as, wired, wireless, Bluetooth, NFC, etc. At block 4450, the user wearing the WCD can now be again authenticated and associated with the WCD and can be granted access to certain functions and/or data storage of the WCD. At block 4460 a user may remove the WCD. At block4470 the WCD can detect that it is removed such as bio detection (including e.g., biometric identification) techniques described above with respect to inward facing

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sensor changes, temperature changes, or heart rate decreasing to zero. At block 4480, the authorization code previously stored on the WCD can be automatically deleted upon detection of removal to avoid unauthorized access to such information by a subsequent wearer or other querying party. Further or alternatively, additional information can be automatically deleted upon removal of the WCD, for example any data and or instructions stored on the onboard memory of the WCD such as personal information, banking information, confidential information, or other sensitive data.

[0328] **IX. Timepiece System**

[0329] FIG. 45A is a timepiece system 4500 according to one or more aspects of the disclosure. As shown, the timepiece system 4500 can include a conventional timepiece 4510 and a timepiece computing device (TCD) 4520. The TCD can be any shape, and in this example is in the shape of a cylinder. The radius can be significantly greater than a height of the TCD to provide the shape of a puck. The TCD can have one or more structural and/or functional components, and can be similar to the WCD described above with respect to hardware features, components, sensors, etc. Although depicted as cylindrical, the TCD can have any shape depending on the shape of the conventional timepiece. For example, where the timepiece has a rectangular or square face, the TCD can similarly have a rectangular or square profile.

[0330] A top surface 4520a of the TCD can include a pressure sensitive adhesive (PSA) layer 4522 to allow for adhesion of the TCD to the under surface of the timepiece 4510. The TCD 4520 can have a radius or circumference that does not exceed radius or circumference of the face of the conventional timepiece so as not to be seen when a user is wearing the timepiece system 4500. The TCD can enhance the conventional timepiece with many of the features described above with respect to the WCD such as, heart rate sensing, temperature sensing pedometer, activity sensing, gesture sensing and control, without having to alter the look of the conventional timepiece.

[0331] Fig 45B is a bottom view of the TCD. As shown, the TCD can include a battery 4540, any printed circuit board 4550 with one or more components attached thereto (not shown) such as motion sensors, power management circuitry, charging circuitry, etc. As with the WCD, the printed circuit board of the TCD can be overmolded 4560. The overmold can be transparent or substantially transparent to allow

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electromagnetic radiation to pass through to be incident upon one or more components of the TCD.

[0332] As shown, the TCD can include a light pipe 4524 around the perimeter thereof. The light pipe 4524 can be substantially annular in shape and can be formed in part by the overmold of the TCD. The light pipe can be constructed from a conventional transparent or translucent moldable material (e.g. acrylic, polycarbonate, etc.), and can be arranged to focus ambient light onto a CPV disposed onboard the TCD for additional charging capability. The optical arrangement/geometry of the light pipe can be implemented using skill in the art to achieve the desired optical characteristics. In another example, excess heat generated by the TCD or excess body heat emitted from the skin of the user can be converted to electrical energy via a thermoelectric (TEG) module, such as a Peltier module, disposed onboard the TCD.

[0333] The TCD can also include any number of CPV cells, either on a top surface or bottom surface, to allow for charging. For example, a CPV cell can be placed on the underside of the TCD to allow for docking with a charging/docking station.

[0334] FIG.46 depicts a WCD 4600 with a pair of LED indicators 4610-4620 disposed at an inward-facing portion of the WCD. As shown, the WCD 4600 can include a pair of transparent regions 4640-3650 and an opaque region 4630. The LEDs 4610- 3620 can be positioned under the transparent regions 4640-3650 to allow light from the LEDs to exit the WCD. In one example, the LEDs 4610-3620 can create a subtle diffuse glow to the skin to provide a desirable visual effect to user. In another example, a user feedback LED can be placed at an inward facing surface and a second can be placed at an outward facing surface of the WCD. Depending on the circumstances, one of the LEDs may be disabled to save battery life. For example, LEDs that are facing away from a user e.g. facing down or away from user's line of sight, may be disabled. As described above, the WCD can determine its orientation based on onboard sensors, such as the magnetometer, accelerometer, GPS, etc.

[0335] FIG. 47A is a system for generating and managing alerts according to one or more aspects of the disclosure. As shown, the system can include a WCD 4710A, one or more networks 4720A, and one or more server computers 4730A according to one or more aspects of the disclosure. The WCD 4710A can communicate directly and/or

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indirectly with the server 4730A via the network 4720A. In this regard, data generated and/or stored at the WCD 4710A can be transmitted to the server 4730A and vice versa. In one example, such data can include biometric data pertaining to a user wearing the WCD that is detected and stored by the WCD.

[0336] FIG. 47B depicts a block process diagram for generating and managing alerts according to one or more aspects of the disclosure and FIG. 47C is a flow chart depicting a method for generating and managing alerts according to one or more aspects of the disclosure.

[0337] At block 4710C, and as shown at process block 4710B, the user is authenticated with respect to the WCD. In this regard, a single user can be associated with a single WCD and can be associated with a predetermine identifier, such as an alphanumeric number. If the user is not authenticated or the authentication process is not conclusive, the WCD may invite the user to retry authentication at block 4715C until the user is successfully authenticated. In some examples, the WCD may timeout the authentication process, lock the WCD, or place the WCD in safe mode in the event of too many unsuccessful authentication attempts as a security measure.

[0338] The user can be authenticated according to any of the authentication methods described in the present application, such as via a unique capillary map, a unique ECG profile, etc.

[0339] If the user is authenticated, biometric data can be transmitted to the server at block 4720C. The captured biometric data 4720B can be transmitted to the server via network 4720A, 47222B

[0340] Once received at the server, the biometric data can be aggregated, sorted, categorized, or profiled at block 4730C and as shown at process block 4730B. In this regard, a profile (corresponding to the alphanumeric identifier) may be created at a database at the server that stores data for a particular user. The profile can store transmitted biometric data, as well as other data, such as user gender, height, weight, age, family history, disease information, location, etc.

[0341] In some examples, identifying information may be removed from the data and/or not transmitted to allow for anonymity and/or to comply with regulations regarding transmission of medical data. The transmitted biometric data can be

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normalized in order to comply with predetermined data requirements in order to be added to the profile. In one example, a minimum amount of data may be required in order to be considered viable for association with the profile. The biometric data of a single profile can be aggregated, or in other examples multiple profiles can be aggregated simultaneously.

[0342] Aggregation of the user's biometric data into a single profile allows for the profile to be visualized or analyzed according to any number of methods. For example, a timeline can be created showing biometric data over a period of time. The data can also be synthesized or analyzed to calculate trend data, or other mathematical features.

[0343] Although only one WCD is depicted, it is contemplated that a plurality of WCDs can exist, with each WCD corresponding to a distinct user (and distinct alphanumeric identifier) and therefore resulting in a plurality of distinct profiles at the server. Accordingly, each of the distinct users/WCDs may be authenticated separately according to the methods described herein.

[0344] At block 4740C, once the transmitted data has been associated with the user profile, the updated profile can be correlated with one or more other profiles stored at the server as shown as process block 4740B. The profiles may be correlated according to any number of correlation standards, such as correlating users with similar traits such as age, gender, location, profession, or by any other data stored at the server. In some examples, one or more of the traits can be used to make such a correlation. The biometric data from the one or more users that are correlated with one another can be combined to form a group profile. The group profile can be the aggregation, average, range, or sum of individual profiles that form the group profile. For example, for a particular group profile, a range of resting heart can be generated by taking the maximum and minimum values of resting heart from the individual profiles. In other examples, an average (and standard deviation or standard deviation of the mean) can be generated for each trait, such as average resting heart rate, average active heart rate, average blood pressure, average blood sugar, average skin temperature, ECG profiles, as well as any other features capable of being detected by the WCD as described above.

[0345] At block 4750C, transmitted biometric data can be compared to the established values from the group profile. In this way, if a user's heart rate deviates by a

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predetermined threshold (such as by predetermined magnitude or standard deviation), an alert can be generated at process block 4750B. The comparison process can occur at the server after transmission of the biometric data. In another example, the group profile data can be transmitted to the WCD for comparison at the WCD. This advantageously allows the comparison to be made where the WCD cannot establish a network link. The group profile can be updated on a continuous basis or a predetermined time interval or at each transmission of biometric data.

[0346] At block 4760C, the alert is transmitted to the WCD and displayed to the user at process block 4760B. The alert can indicate that the user's biometric data has deviated from the profile group and may advise the user to seek medical attention. In another example, the server can directly contact a medical health professional. In the example where block 4750C occurs at the WCD, transmission of alert information from the server may not be necessary.

[0347] The alert at the WCD can be any type of audio or visual indicator, such as an LED, haptic feedback, audible alarm, etc. The indicator may also invite the user to rest, make an appointment with a medical health professional, recommend a particular medication, or suggest certain physical activities that may health condition that caused the alert.

[0348] As shown in FIG. 47B, the authentication 4710B, aggregation 4730B, and correlation 4740B can occur at server 4730A, which can include a process, memory, and any other features of a general purpose computer. The authentication 471OB, aggregation 4730B, and correlation 4740B can access a database stored at the memory, where profiles, group profiles, and biometric data can be stored.

[0349] FIG. 48A is a method for variable sampling according to one or more aspects of the disclosure. As described above, the processor module of the WCD can determine (e.g., based on identified physical activities, routine pattern, and/or time) a frequency at which one or more sensors in the sensor modules should operate.

[0350] At block 4810A, one or more sensors of the WCD may take one or more measurements. For example, the WCD can detect temperature, heart rate, acceleration, as described above.

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[0351] At block 4820A, the WCD can calculate an activity level of a user. For example, the WCD can compare to a number of stored activity profiles (as described above) stored by the user, or can compare the sensor measurements to sensor threshold values corresponding to different activities, such as sitting, running, sleeping etc. In one example, the WCD detect acceleration values over time to generate an activity level for a particular time period.

[0352] At block 4830A, the WCD may compare the identified activity level to a predetermine activity threshold value. In one example, the WCD may categorize the detected activity as either a high level activity or a low level activity. High level activities can include running, swimming, biking etc., while low level activities may include sitting, standing still, or sleeping.

[0353] At block 4840A, the WCD can set a first sample rate for high level activities and at block 4850A, the WCD can set a second sample rate for low level activities. The first sample rate can be a shorter time interval than the second sample rate, resulting in more data being detected and generated during a set amount of time while the user is active. This allows for increased power efficiency of the WCD while also providing the advantage of generating more data when a user is more active, thereby providing added biometric data for later analysis.

[0354] In another example, the sample rate can be scaled according to activity level. For example, the sample rate can be scaled to be directly proportional to heart rate. This results in a shorter time interval for sampling (more frequent data gather) for running than for walking.

[0355] As activity level changes, the method above can be repeated a plurality of times at certain intervals in order to quick or abrupt activity changes.

[0356] FIG. 48B and 48c are graphs depicting one or more aspects of the sample method of FIG. 48A. As shown in FIG. 48B, the WCD may determine a user is engaging in a high level activity by detecting acceleration values that are above a predetermined threshold value. In this regard, a shorter time interval (more frequent data gathering) can be set. As shown in FIG. 48C, the user is engaging in a low level activity since the acceleration values are below a predetermined threshold. A longer sample rate (less frequent data gathering) can be set in this instance.

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[0357] FIG. 49 a diagrammatic representation of a machine in the example form of a computer system 4900 within which a set of instructions, for causing the machine to perform any one or more of the methodologies discussed herein, may be executed. Specifically, FIG. 49 shows a diagrammatic representation of a machine in the example form of a computer system within which instructions (e.g., software or program code) for causing the machine to perform any one or more of the methodologies discussed herein may be executed. In alternative embodiments, the machine operates as a standalone device or may be connected (e.g., networked) to other machines. In a networked deployment, the machine may operate in the capacity of a server machine or a client machine in a server-client network environment, or as a peer machine in a peer-to-peer (or distributed) network environment.

[0358] The machine may be a server computer, a client computer, a personal computer (PC), a tablet PC, a set-top box (STB), a personal digital assistant (PDA), a cellular telephone, a smartphone, a web appliance, a network router, switch or bridge, or any machine capable of executing instructions (sequential or otherwise) that specify actions to be taken by that machine. Further, while only a single machine is illustrated, the term "machine" shall also be taken to include any collection of machines that individually or jointly execute instructions to perform any one or more of the methodologies discussed herein.

[0359] The example computer system includes a processor (e.g., a central processing unit (CPU), a graphics processing unit (GPU), a digital signal processor (DSP), one or more application specific integrated circuits (ASICs), one or more radio-frequency integrated circuits (RFICs), or any combination of these), a main memory, and a non-volatile memory, which are configured to communicate with each other via a bus. The computer system may further include graphics display unit (e.g., a plasma display panel (PDP), a liquid crystal display (LCD), a projector, or a cathode ray tube (CRT)). The computer system may also include alphanumeric input device (e.g., a keyboard), a cursor control device (e.g., a mouse, a trackball, a joystick, a motion sensor, a touch screen, or other pointing instrument), a storage unit, a signal generation device (e.g., a speaker), and a network interface device, which also are configured to communicate via the bus.

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[0360] The storage unit includes a non-transitory machine-readable medium on which is stored instructions embodying any one or more of the methodologies or functions described herein. The instructions may also reside, completely or at least partially, within the main memory or within the processor (e.g., within a processor's cache memory) during execution thereof by the computer system, the main memory and the processor also constituting machine-readable media. The instructions may be transmitted or received over a network via the network interface device.

[0361] While machine-readable medium is shown in an example embodiment to be a single medium, the term "machine-readable medium" should be taken to include a single medium or multiple media (e.g., a centralized or distributed database, or associated caches and servers) able to store instructions. The term "machine-readable medium" shall also be taken to include any medium that is capable of storing instructions for execution by the machine and that cause the machine to perform any one or more of the methodologies disclosed herein. The term "machine-readable medium" includes, but not be limited to, data repositories in the form of solid-state memories, optical media, magnetic media, or other non-transitory machine readable medium.

[0362] **X. Conclusion**

[0363] It should be clear that the WCD and TCD arrangements described according to various aspects of the disclosure provide a highly versatile and useful item of wearable electronics that is comfortable and convenient to wear, conveniently charged, and weatherproof for all-purpose and all-condition wearing. Various options for style and appearance can be implemented, as well as a variety of storage options. The functions and structure of the device lend themselves to both a ring version and a wrist-worn version. All versions are designed for long-life with minimal maintenance, and are adaptable to interoperate with a variety of networked devices including computers, smartphones, home controllers, security systems, and virtually any other device capable of communicating over a wireless link-including another WCD or TCD.

[0364] The foregoing has been a detailed description of illustrative embodiments of the invention. Various modifications and additions can be made without departing from the spirit and scope of this invention. Features of each of the various embodiments

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described above may be combined with features of other described embodiments as appropriate in order to provide a multiplicity of feature combinations in associated new embodiments. Furthermore, while the foregoing describes a number of separate embodiments of the apparatus and method of the present invention, what has been described herein is merely illustrative of the application of the principles of the present invention. For example, as used herein various directional and orientational terms such as "vertical", "horizontal", "up", "down", "bottom", "top", "side", "front", "rear", "left", "right", and the like, are used only as relative conventions and not as absolute orientations with respect to a fixed coordinate system, such as the acting direction of gravity. Note also, as used herein the terms "process" and/or "processor" should be taken broadly to include a variety of electronic hardware and/or software based functions and components. Moreover, a depicted process or processor can be combined with other processes and/or processors or divided into various sub-processes or processors. Such sub-processes and/or sub-processors can be variously combined according to embodiments herein. Likewise, it is expressly contemplated that any function, process, application, and/or processor here herein can be implemented using electronic hardware, software consisting of a non-transitory computer-readable medium of program instructions, or a combination of hardware and software. Also, while a variety of visible and near-visible radiation sources are described as LEDs, it is expressly contemplated that other types of sources can be employed according to aspects of the disclosure-for example plasma discharge sources and bioluminescent sources, as well as sources that are based upon developing technologies. Electronic circuits and RF components can similarly be based on alternate and/or developing technologies. Accordingly, this description is meant to be taken only by way of example, and not to otherwise limit the scope of this invention.

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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/323,385	**07/19/2023 03:19:02 PM ET**	**PM0002**

Title of Invention

WEARABLE COMPUTING DEVICE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7585	FILED BY	Jamie LaFleur
PATENT CENTER #	62469353	FILING DATE	05/24/2023
CUSTOMER #	179918	FIRST NAMED INVENTOR	Mr. Curt C. von Badinski
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Nathan Mutter

Documents

TOTAL DOCUMENTS: 3

DOCUMENT		PAGES	DESCRIPTION	SIZE (KB)
18323385_NTFCAP.pdf		138	-	591 KB
18323385_NTFCAP-PEFR.pdf	(1-2)	2	Applicant Response to Pre-Exam Formalities Notice	124 KB
18323385_NTFCAP-SPEC.pdf	(3-70)	68	Specification	344 KB
18323385_NTFCAP-SPEC.pdf	(71-138)	68	Specification	328 KB

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DOCUMENT	MESSAGE DIGEST(SHA-512)
18323385_NTFCAP.pdf	2CFD089D80CDD2EBFDBF899C9C50BB46E23C84A65CEEB503D0113D2407F61D2AF0BC33C8DEF7880C198CE12CE12312151E02C071DABCD4583455637CF35538A1
18323385_NTFCAP-PEFR.pdf	AD8FBEC11944AB8B28E88F5C1A261E05A21334895E3A7B38F6323AC4EA55357CF96776CBE0CDFCD60D54C441803FB70E3839723A7977399E6AA6AD569605BC5E
18323385_NTFCAP-SPEC.pdf	2261528A947985A4A7570188E4661BDABF1B2BF9D8E8539AC094F97F6F27B6B648E2360BA7E96068E316CDB755092858D36FF0342E6A130EE7FD394D09FE2F80
18323385_NTFCAP-SPEC.pdf	621CC199AED85EFA5C4AE3767E91F9D6624F4EE0820D2004827F7112EC68D94672A566347F60396FA5D664FF380CEDCF2BE36B1EB3DA98F8404995034D36DCED

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

(19) Bundesrepublik Deutschland
Deutsches Patent- und Markenamt

(10) **DE 20 2006 000 119 U1** 2006.05.04

(12) # Gebrauchsmusterschrift

(21) Aktenzeichen: **20 2006 000 119.0**
(22) Anmeldetag: **05.01.2006**
(47) Eintragungstag: **30.03.2006**
(43) Bekanntmachung im Patentblatt: **04.05.2006**

(51) Int Cl.[8]: ***A61B 5/02*** (2006.01)

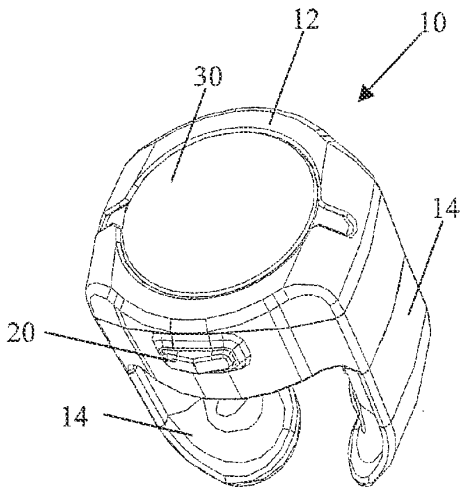
(73) Name und Wohnsitz des Inhabers:
TaiDoc Technology Corp., San-Chung, Taipeh, TW

(74) Name und Wohnsitz des Vertreters:
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Die folgenden Angaben sind den vom Anmelder eingereichten Unterlagen entnommen

(54) Bezeichnung: **Messgerät für physiologischen Zyklus**

(57) Hauptanspruch: Meßgerät, umfassend ein ringartiges Gehäuse (10), einen Meßdetektor (50) und einen Mikroprozessor (60), dadurch gekennzeichnet:
dass das Gehäuse (10) am Finger tragbar ist,
dass der Meßdetektor (50) in dem Gehäuse (10) angeordnet ist, wobei der Meßdetektor (50) zum Empfangen von Signalen vorgesehen ist,
dass der Mikroprozessor (60) die von dem Meßdetektor (50) empfangenen und weitergeleiteten Signale eines physiologischen Vorgangs bearbeiten kann, so dass das Meßgerät zum Ermitteln Daten des physiologischen Vorgang benutzt werden kann.



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Beschreibung

[0001] Die Erfindung betrifft ein Meßgerät für einen physiologischen Vorgang, und insbesondere ein Meßgerät, das ringartig ausgebildet ist, wobei das Meßgerät hauptsächlich aus einem in ein ringartiges Gehäuse eingebauten Meßdetektor und einem in ein ringartiges Gehäuse eingebauten Mikroprozessor besteht, so dass das Meßgerät gemäß der Erfindung zum Ermitteln von Daten eines physiologischen Vorgangs benutzt werden kann.

[0002] Herkömmliche Meßgeräte für einen physiologischen Vorgang, wie z. B. Pulsschlagdetektor oder Oxyhämoglobindetektor, sind relativ groß und nicht zum Mitnehmen geeignet. Heutzutage erkennen viele Leute, dass Fitness des Körpers wichtig ist. Um fit zu bleiben oder zu werden, treiben viele Menschen Sport. Aber es ist für herzkarnke Menschen sehr gefährlich Sport zu treiben, ohne auf bestimmte physiologische Vorgänge zu achten. Dazu werden Trainingsgeräte entwickelt, die mit einem Pulsschlagdetektor versehen sind, so dass die Benutzer der Trainingsgeräte zur Verbesserung ihrer Körperkondition ihren Pulsschlag überwachen können.

[0003] Herkömmliche Oxyhämoglobindetektoren bestehen grundsätzlich aus einem Fingermeßdetektor und einem Analysegerät, um die medizinischen Diagnostik durchzuführen, z. B. durch Messung der arteriellen Sauerstoff-Sättigung (SaO_2) im Blut zur schnellen Erkennung von Herzinfarkten u. a. Erkrankungen.

[0004] Gemäß dem Stand der Technik sind drei Arten von Pulsschlagdetektoren bekannt. Die erste Art vom Pulsschlagdetektor ist ein Infrarotsensor, der den Blutkreislauf am Finger oder Ohrläppchen messen kann. Die zweite Art von Pulsschlagdetektor ist ein Elektrokardiogramm (EKG), das den Blutkreislauf im Handbereich messen kann. Die dritte Art vom Pulsschlagdetektor ist ein Brustkorbelektrokardiogramm, das den Pulsschlag des Blutkreislaufs am Brustkorb messen kann.

[0005] Der Infrarotsensor ist der am meisten benutzte Pulsschlagdetektor. Derartige Pulsschlagdetektoren sind entweder in einer mit der Hand greifbaren Form oder in einer Armbanduhr ausgebildet. Beim Benutzen legt der Benutzer seinen Finger an das Glasfenster des Infrarotsensor, womit der Infrarotsensor die Gegenwirkung des Blutkreislaufs, welche leicht durch den Pulsschlag zu beeinflussen ist, anzeigen kann. Diese Art von Infrarotdetektor wird sehr leicht durch Bewegung beeinflusst, wodurch das Ergebnis nicht genau gemessen werden kann. Weil der Benutzer beim Messen seinen Finger ständig an das Glasfenster des Infrarotsensor legen muß, ist diese Art vom Infrarotsensor für den Benutzer sehr unpraktisch. Die andere Art vom Infrarotsensor weist einen am Ohrläppchen getragenen Meßdetektor und ein Analysegerät auf, wobei der Meßdetektor mittels eines Kabels an das in ein Trainingsgerät eingebaute Analysegerät angeschlossen ist. Bei Übungen am Trainingsgerät wird der Benutzer jedoch durch das Kabel gestört. Außerdem ist diese Art von Trainingsgerät mit Infrarotsensor nicht zum Mitnehmen geeignet.

[0006] Die zweite Art vom Pulsschlagdetektor ist ein Kardiograph, der das Elektrosignal vom Pulsschlag und den Blutkreislauf am Handbereich oder am besten am Brustkorb messen kann. Im Allgemeinen ist diese Art vom Pulsschlagdetektor in Fitnessklubs oder Turnhallen vorhanden. Beim Messen muß der Benutzer zwei Metallblätter mit beiden Händen anfassen oder an zwei Finger anlegen, damit der Pulsschlagdetektor die Daten des physiologischen Vorganges ablesen kann. Während der Messung muß der Benutzer still stehen und mindestens ein Paar Sekunden abwarten. Das ist sehr unpraktisch für den Benutzer.

[0007] Die dritte Art vom Pulsschlagdetektor ist ein Brustkorbelektrokardiogramm, das den Blutkreislauf am Brustkorb messen kann. In Fig. 7 sind ein Elektrodengurt **70** und eine Armbanduhr **72** dargestellt. Der Elektrodengurt **70** wird am Brustkorb des Benutzers getragen, wobei der Elektrodengurt **70** einen mit Elektroden versehenen Gurt und einen Signalsender aufweist. Die Armbanduhr **72** weist einen dem Signalsender entsprechenden Signalempfänger auf. Diese Art vom Brustkorbelektrokardiogrammsystem (Chest-electrode EKG system) weist eine gute Genauigkeit auf. Beim Messen muß der Benutzer den Elektrodengurt **70** und die Armbanduhr **72** gleichzeitig tragen. Weil der Elektrodengurt **70** direkt auf der Haut getragen werden muß, kann der Elektrodengurt **70** sehr leicht durch elektromagnetische Wellen, wie z. B. Mobiltelephone, Fernsehen, Computer u.a., gestört werden. Weil diese Art von Pulsschlagdetektoren meistens im gleichen Frequenzbereich wie Mobiltelephone arbeiten, könnten die Signale des Pulsschlagdetektors zu Störungen führen, falls ein oder mehrere Mobiltelephon-Benutzer in die Nähe (ca. 80 cm oder 2, 5 feet) kommen. Andereseits ist der Elektrodengurt **70** um den Brustkorb geschnallt, was für den Benutzer während der Übung sehr unbequem ist.

[0008] Die Aufgabe der Erfindung besteht darin, ein weiteres Meßgerät für einen physiologischen Vorgang zu schaffen, das die obengenannten Nachteile der herkömmlichen Meßgeräte beseitigt.

[0009] Diese Aufgabe wird durch das im Anspruch 1 angegebene Meßgerät gelöst; vorteilhafte Weiterbildungen und Ausgestaltungen der Erfindung sowie deren Anwendungen sind in den Unteransprüchen angegeben.

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[0010] Erfindungsgemäß wird also ein Meßgerät vorgeschlagen, das ein ringartig ausgebildetes Gehäuse, einen Meßdetektor und einen Mikroprozessor aufweist und das zum Ermitteln von Daten eines physiologischen Vorganges benutzt werden kann.

[0011] Insbesondere sind in das ringartig ausgebildete Gehäuse ein Meßdetektor und ein Mikroprozessor eingebaut, so dass das Meßgerät gemäß der Erfindung zum Ermitteln Daten vom physiologischen Vorgang benutzt werden kann. Das Meßgerät wird von dem(r) Benutzerin) am Finger getragen, damit ein physiologisches Signal von dem Meßdetektor empfangen und an den Mikroprozessor weiter geleitet werden kann. Somit können die Daten des physiologischen Vorganges nach der Bearbeitung durch den Mikroprozessor angezeigt werden.

[0012] Ausführungsbeispiele der Erfindung werden nachstehend anhand der Zeichnung näher erläutert. Es zeigen:

[0013] Fig. 1 eine perspektivische Ansicht eines erfindungsgemäßen Meßgeräts;

[0014] Fig. 2 eine Rückansicht des erfindungsgemäßen Meßgeräts aus Fig. 1;

[0015] Fig. 3 eine Seitensnsicht des erfindungsgemäßen Meßgeräts aus Fig. 1;

[0016] Fig. 4 eine perspektivische Seitenansicht des erfindungsgemäßen Meßgeräts aus Fig. 1, die zeigt, dass eine Lichtquelle an einem der beiden Seitenteile des Gehäuses angeordnet ist;

[0017] Fig. 5 eine perspektivische Seitenansicht des erfindungsgemäßen Meßgeräts aus Fig. 1, die zeigt, dass ein Lichtempfänger an dem anderen Seitenteil des Gehäuses angeordnet ist;

[0018] Fig. 6 ein schematisches Blockschaltdiagramm des erfindungsgemäßen Meßgeräts;

[0019] Fig. 7 eine Darstellung der dritten Art eines herkömmlichen Pulsschlagdetektors bei Benutzung.

[0020] Zunächst wird auf die Fig. 1 bis Fig. 5 Bezug genommen. Es ist eine Ausführungsform gemäß der Erfindung gezeigt. Wie es aus den Figuren zu ersehen ist, umfasst das erfindungsgemäße Meßgerät ein ringartiges Gehäuse **10**, einen Druckknopf **20**, eine Anzeigevorrichtung **30**, eine Energieversorgungseinheit **40**, einen Meßdetektor **50** und einen Mikroprozessor **60**.

[0021] Das Gehäuse **10** ist ringartig ausgebildet und weist ein rundes Oberteil **12** und zwei gebogene und gegenständig ausgebildete Seitenteile **14** auf, die einander gegenüberstehend am Oberteil **12** angeordnet sind. Die beiden Seitenteile **14** sind aus weichem Material, wie z. B. Gummi oder Kunststoff, hergestellt. Weil das Gehäuse **10** des erfindungsgemäßen Meßgeräts wie ein normaler Ring ausgebildet ist, kann das Meßgerät einfach von dem(r) Benutzerin) am Finger getragen werden.

[0022] Das Gehäuse **10** ist mindestens mit einem Druckknopf **20** versehen, der zum An- und Ausschalten, Starten, Stoppen oder Programmieren vorgesehen ist. Gemäß den Fig. 4 und Fig. 5 ist das erfindungsgemäße Meßgerät in dieser Ausführungsform mit zwei Druckknöpfe **20** versehen, die beiderseits der Seitenteile **14** und auf gegenüberliegenden Seiten am Oberteil **12** angeordnet sind.

[0023] Die Anzeigevorrichtung **30** ist an dem Gehäuse **10** angebracht. In dieser Ausführungsform ist die Anzeigevorrichtung **30** am Oberteil **12** angeordnet.

[0024] Die Energieversorgungseinheit **40** ist in das Gehäuse **10** eingebaut. In dieser Ausführungsform ist die Energieversorgungseinheit **40** in das Oberteil **12** eingebaut, wobei die Energieversorgungseinheit **40** einen Deckel **42** aufweist, der an dem Oberteil **12** des Gehäuses **10** der Anzeigevorrichtung **30** gegenüberliegend angebracht ist.

[0025] Der Meßdetektor **50** ist in das Gehäuse **10** eingebaut. In dieser Ausführungsform ist der Meßdetektor **50** in den Seitenteilen **14** des Gehäuses **10** angeordnet. Der Meßdetektor **50** ist ein Infrarotstrahlungsdetektor. In dieser Ausführungsform weist der Meßdetektor **50** eine Lichtquelle **51** und einen Lichtempfänger **53** auf, wobei die Lichtquelle **51** und der Lichtempfänger **53** einander gegenüberliegend an den beiden Seitenteilen **14** angebracht sind. Die Lichtquelle **51** kann ein LED (Light Emitting Diode, Leuchtdiode) sein. Der Lichtempfänger **53** kann beispielsweise Licht in Strom umwandeln. Die Lichtquelle **51** und der Lichtempfänger **53** sind z.B. ein Paar aus Leuchtdiode und Foto-Transistor (PN photo-transistor), wobei der Meßdetektor **50** ein Pulsschlagdetektor oder ein Oxyhämoglobindetektor sein kann.

[0026] Die Lichtquelle **51** des Pulsschlagdetektors kann eine Wellenlänge von 940 nm Infrarotstrahlung aussenden, während der Lichtempfänger **53** die Lichtsignale empfangen und in Elektrosignale umwandeln kann. Das Licht wird von einer LED ausgesendet, durchläuft den Finger und wird dann vom Lichtempfänger **53** empfangen. Wenn die Lichtstrahlung in das Gewebe gesendet wird und durch den Finger läuft, wird die Lichtstrahlung teilweise vom Knochen und Gewebe absorbiert und daran reflektiert sowie teilweise durchgelassen und vom Lichtempfänger **53** empfangen. Beim Pulsschlag wird die Blutmenge in der Pulsader abwechselnd geändert, wodurch sich auch die vom Lichtempfänger **53** emp-

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fangene Lichtmenge entsprechend dem Rhythmus des Pulses, der mit dem Herzschlagrhythmus übereinstimmt, ändert, so dass der Puls bzw. Herzschlag durch entsprechende Signale erfasst und angezeigt werden kann.

[0027] Die Lichtquelle **51** vom Oxyhämoglobindetektor kann eine Wellenlänge von 660 nm Rotstrahlung bzw. von 940 nm Infrarotstrahlung aussenden, wobei der Lichtempfänger **53** die Lichtsignale empfangen und in die Elektrosignale umwandeln kann. Das Blut setzt sich zusammen aus der Blutflüssigkeit (Plasma) und den Blutkörperchen (Korpuskeln), wobei 99% der Blutkörperchen Erythrozyten sind. Die Farbe des Bluts beruht auf dem Blutfarbstoff (Hämoglobin). Im Rahmen des Blutkreislaufs dient das Blut zum Transport von 97% Sauerstoff aus der Lunge in die Gewebe und führt Schlackenstoffe, wie Kohlendioxid und harnpflichtige Substanzen aus den Geweben in die Ausscheidungsorgane (Lunge bzw. Nieren). Bei hohem Sauerstoffdruck wird Sauerstoff angelagert, Hämoglobin wird zum hellroten Oxihämoglobin. Bei niederem Sauerstoffdruck gibt dieses seinen Sauerstoff ab und wird zu dunkelrotem reduzierten Hämoglobin. Hierbei wird die arterielle Sauerstoff-Sättigung (SaO_2) auf eine einfache Formel gebracht.

$$SaO_2 = CHbO_2/(CHbO_2 + CHb)$$

[0028] $CHbO_2$ ist die Dichte des Oxihämoglobins, wobei CHb Dichte des reduzierten Hämoglobins ist. Die arterielle Sauerstoff-Sättigung (SaO_2) wird aufgrund der unterschiedlichen Absorptionsspektren von $CHbO_2$ und CHb erkennbar gemessen. Zum Messen sendet der Oxyhämoglobindetektor des Meßdetektors **50** zwei Wellenlängen von Lichtstrahlungen in das Gewebe des Benutzers, so dass die unterschiedlicher Absorbtion unterliegenden Lichtstrahlungen teils zum Wechselstrom-Bestandteil (AC, alternating current) und teils zum Gleichstrom-Bestandteil (DC, direct current) beitragen. Aufgrund der unterschiedlichen Absorptionsspektren der Rotstrahlung und der Infrarotstrahlung können die Dichten von $CHbO_2$ und CHb im Blut erkannt und gemessen werden. Der Mikroprozessor **60** kann die aus dem durchgelassenen Licht der beiden Wellenlängen, das verschiedener Absorption und Reflektion unterliegt, erhaltenen Signale zu Daten der arteriellen Sauerstoff-Sättigung verarbeiten.

[0029] In der Fig. 6 ist ein Blockschaltdiagramm des erfindungsgemäßen Meßgerät dargestellt. Der Meßdetektor **50** weist eine Übermittlungseinheit **52**, eine Signalverarbeitungseinheit **54** und einen Analog-Digital-Umsetzer **56** auf, wobei die Übermittlungseinheit **52** die Informationen vom Meßdetektor **50** umwandeln und zu der Signalverarbeitungseinheit **54** weiterleiten kann. Die Signalverarbeitungseinheit **54** kann die bearbeiteten Daten zum Analog-Digital-Umsetzer **56** übermitteln, der die Daten elektronisch verarbeiten und weiter zum Mikroprozessor **60** weiterleiten kann.

[0030] Der Mikroprozessor **60** kann die vom Meßdetektor **50** empfangenen und weitergeleiteten Daten vom physiologischen Vorgang bearbeiten, so dass das Meßgerät zum Ermitteln von Daten des physiologischen Vorgangs benutzt werden kann. In dieser Ausführungsform umfasst der Mikroprozessor **60** eine Treibereinheit **62**, die zum Schalten der Anzeigevorrichtung **30** vorgesehen ist.

[0031] Beim Benutzen wird das erfindungsgemäße Meßgerät von dem(r) Benutzerin) am Finger getragen. Wird der Druckknopf **20** gedrückt, wird das Meßgerät eingeschaltet und die physiologischen Signale von dem Meßdetektor werden empfangen und weiter an den Mikroprozessor geleitet. Die Daten vom physiologischen Vorgang vom(von der) Benutzerin) werden durch die Bearbeitung des Mikroprozessors angezeigt. Die obere und untere Grenzen der Pulsfrequenz vom Meßgerät können vorher programmiert werden. Wenn die Pulsfrequenz die obere bzw. untere Grenze über- bzw. unterschreitet, zeigt die Anzeigevorrichtung 30 dem(er) Benutzerin) ein Warnsignal an. Außerdem weist das Meßgerät die Funktion einer Sportuhr auf. Es ist sehr praktisch für den(ie) Benutzerin) beim Sporttreiben.

[0032] Gemäß obenstehender Beschreibungen weist das erfindungsgemäße Meßgerät für einen physiologischen Vorgang folgende Vorteile auf

1. Das erfindungsgemäße Meßgerät ist relativ klein konstruiert und wird beim Benutzen von dem(r) Benutzerin) am Finger getragen, so dass das Meßgerät viel praktischer als herkömmliche Meßgeräte ist.
2. Das erfindungsgemäße Meßgerät ist ringartig ausgebildet und kann somit beim Benutzen von dem(r) Benutzerin) einfach am Finger getragen werden, so dass das Meßgerät viel praktischer zum Benutzen konstruiert ist.
3. Das erfindungsgemäße Meßgerät ist zimmlich klein konstruiert, so dass das Meßgerät zum Mitnehmen geeignet ist.
4. Das erfindungsgemäße Meßgerät ist ringartig ausgebildet. Der(ie) Benutzerin) kann das Meßgerät während der Übungen in die Tasche legen oder einfach am Finger tragen, ohne die Übungsfreiheit zu beeinträchtigen.
5. Das erfindungsgemäße Meßgerät wird beim Benutzen von dem(r) Benutzerin) am Finger getragen. Weil der Finger bei den Übungen nicht erschüttert wird, kann es die Daten vom physiologischen Vorgang besser als herkömmliche Meßgeräte ermitteln.
6. Das erfindungsgemäße Meßgerät ist relativ klein und sehr praktisch konstruiert, so dass das Meßgerät sehr bequem zu tragen ist.

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7. Die obere und untere Grenzen der Pulsfrequenz vom erfindungsgemäßen Meßgerät können vorher programmiert werden. Wenn die Pulsfrequenz die obere bzw. untere Grenze über- bzw. unterschritten wird, zeigt die Anzeigevorrichtung 30 dem(er) Benutzerin) ein Warnsignal an. Dadurch ist das Meßgerät sehr praktisch für den(ie) Benutzerin) zur Beobachtung von seiner(ihrer) Körperkondition.
8. Das erfindungsgemäße Meßgerät weist die Funktion einer Sportuhr auf. Es ist sehr praktisch für den(ie) Benutzerin) beim Sporttreiben.
9. Das erfindungsgemäße Meßgerät ist kompakt konstruiert und weist keine Anschlußleitung oder Kabel auf, so dass das Meßgerät viel praktischer und besser als herkömmliche Meßgeräte in der Handhabung ist.
10. Mehrere Leute können gleichzeitig jeweils ein erfindungsgemäßes Meßgerät tragen, ohne dass sich die Funktion der jeweiligen erfindungsgemäßen Meßgeräte untereinander beeinträchtigen.

[0033] Die Anwendung der Meßgerät für einen physiologischen Vorgang ist vielseitig und die erwähnten Bauweisen sind nur beispielhaft. Damit sind die Aufgaben der Erfindung gelöst.

[0034] Die Erfindung betrifft also ein Meßgerät für einen physiologischen Vorgang, und insbesondere ein Meßgerät, das ringartig ausgebildet ist, und einen in ein ringartiges Gehäuse eingebauten Meßdetektor und einen in ein ringartiges Gehäuse eingebauten Mikroprozessor umfasst, so dass das Meßgerät gemäß der Erfindung zum Ermitteln von Daten von einem physiologischen Vorgang benutzt werden kann. Das Meßgerät wird von dem(r) Benutzerin) am Finger getragen, womit ein physiologisches Signal von dem Meßdetektor empfangen und weiter an den Mikroprozessor geleitet wird. Dann werden die Daten des physiologischen Vorgangs der der Bearbeitung durch den Mikroprozessor von diesem angezeigt.

Schutzansprüche

1. Meßgerät, umfassend ein ringartiges Gehäuse (**10**), einen Meßdetektor (**50**) und einen Mikroprozessor (**60**), **dadurch gekennzeichnet**:
dass das Gehäuse (**10**) am Finger tragbar ist,
dass der Meßdetektor (**50**) in dem Gehäuse (**10**) angeordnet ist, wobei der Meßdetektor (**50**) zum Empfangen von Signalen vorgesehen ist,
dass der Mikroprozessor (**60**) die von dem Meßdetektor (**50**) empfangenen und weitergeleiteten Signale eines physiologischen Vorgangs bearbeiten kann, so dass das Meßgerät zum Ermitteln Daten des physiologischen Vorgang benutzt werden kann.

2. Meßgerät nach Anspruch 1, dadurch gekennzeichnet, dass der Meßdetektor (**50**) eine Lichtquelle (**51**) und einen Lichtempfänger (**53**) aufweist.

3. Meßgerät nach Anspruch 2, dadurch gekennzeichnet, dass die Lichtquelle (**51**) eine LED (Licht-Emittierende-Diode) und der Lichtempfänger (**53**) ein Foto-Transistor ist.

4. Meßgerät nach Anspruch 2, dadurch gekennzeichnet, dass der Meßdetektor (**50**) ein Infrarotstrahlungsdetektor ist.

5. Meßgerät nach Anspruch 2, dadurch gekennzeichnet, dass der Meßdetektor (**50**) ein Pulsschlagdetektor oder ein Oxyhämoglobindetektor ist.

6. Meßgerät nach Anspruch 5, dadurch gekennzeichnet, dass der Meßdetektor (**50**) ein Oxyhämoglobindetektor ist, der Licht zweier Wellenlängen aussenden kann, so dass der Mikroprozessor (**60**) die aus dem transmittierten Licht der beiden Wellenlängen erhaltenen Signale zu Daten der arteriellen Sauerstoff-Sättigung verarbeiten kann.

7. Meßgerät nach Anspruch 6, dadurch gekennzeichnet, dass eine der beiden vom Oxyhämoglobindetektor ausgesandten Wellenlängen eine 660 nm Rotstrahlung ist, während die andere Wellenlänge eine 940 nm Infrarotstrahlung ist.

8. Meßgerät nach Anspruch 5, dadurch gekennzeichnet, dass der Meßdetektor (**50**) ein Pulsschlagdetektor ist, der Licht einer Wellenlänge aussenden kann, und dass der Mikroprozessor (**60**) die aus dem transmittierten Licht der einen Wellenlänge erhaltenen Signale zu Daten der Frequenz des Pulses verarbeiten kann.

9. Meßgerät nach Anspruch 8, dadurch gekennzeichnet, dass die vom Pulsschlagdetektor ausgesandte Wellenlänge eine 940 nm Infrarotstrahlung ist.

10. Meßgerät nach Anspruch 8, dadurch gekennzeichnet, dass das Meßgerät die Funktion einer Sportuhr aufweist.

11. Meßgerät nach Anspruch 8, dadurch gekennzeichnet, dass die obere und untere Grenzen der Frequenz des Pulses am Meßgerät vorher programmiert werden können.

12. Meßgerät nach einem der Ansprüche von 1 bis 11, dadurch gekennzeichnet, dass das Gehäuse (**10**) des Meßgeräts ein Oberteil (**12**) und zwei Seitenteile (**14**) aufweist, wobei die Lichtquelle (**51**) und der Lichtempfänger (**53**) des Meßdetektors (**50**) in den Seitenteilen (**14**) eingebaut sind.

13. Meßgerät nach Anspruch 12, dadurch gekennzeichnet, dass das Oberteil (**12**) rund ausgebildet ist, wobei die beiden Seitenteile (**14**) gebogen ausgebildet sind und einander gegenüberstehend an dem Oberteil (**12**) angebracht sind.

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14. Meßgerät nach Anspruch 12, dadurch gekennzeichnet, dass das Gehäuse (**10**) des Meßgeräts mindestens einen Druckknopf (**20**) aufweist.

15. Meßgerät nach Anspruch 14, dadurch gekennzeichnet, dass das Gehäuse (**10**) des Meßgeräts zwei Druckknöpfe (**20**) aufweist, die entgegengesetzt zu einander an dem Oberteil (**12**) angebracht sind.

16. Meßgerät nach Anspruch 12, dadurch gekennzeichnet, dass das Meßgerät eine Anzeigevorrichtung (**30**) aufweist, die an dem Gehäuse (**10**) angebracht ist.

17. Meßgerät nach Anspruch 16, dadurch gekennzeichnet, dass die Anzeigevorrichtung (**30**) am Oberteil (**12**) des Gehäuses (**10**) angebracht ist, und dass der Mikroprozessor (**60**) eine zum Treiben der Anzeigevorrichtung (**30**) vorgesehene Treibereinheit (**62**) aufweist.

18. Meßgerät nach Anspruch 12, dadurch gekennzeichnet, dass das Meßgerät eine Energieversorgungseinheit (**40**) aufweist.

19. Meßgerät nach Anspruch 18, dadurch gekennzeichnet, dass die Energieversorgungseinheit (**40**) in das Oberteil (**12**) des Gehäuses (**10**) eingebaut ist, wobei die Energieversorgungseinheit (**40**) einen Deckel (**42**) aufweist, der an dem Oberteil (**12**) des Gehäuses (**10**) der Anzeigevorrichtung (**30**) gegenüberliegend angebracht ist.

20. Meßgerät nach Anspruch 1, dadurch gekennzeichnet, dass das Meßgerät eine Übermittlungseinheit (**52**), eine Signalverarbeitungseinheit (**54**) und einen Analog-Digital-Umsetzer (**56**) aufweist, wobei die Übermittlungseinheit (**52**) die Informationen vom Meßdetektor (**50**) umwandeln und zu der Signalverarbeitungseinheit (**54**) übertragen kann, dass die Signalverarbeitungseinheit (**54**) die bearbeiteten Daten zum Analog-Digital-Umsetzer (**56**) übermitteln kann, so dass der Analog-Digital-Umsetzer (**56**) die Daten elektronisch umsetzen und weiter zum Mikroprozessor (**60**) leiten kann.

Es folgen 4 Blatt Zeichnungen

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Anhängende Zeichnungen

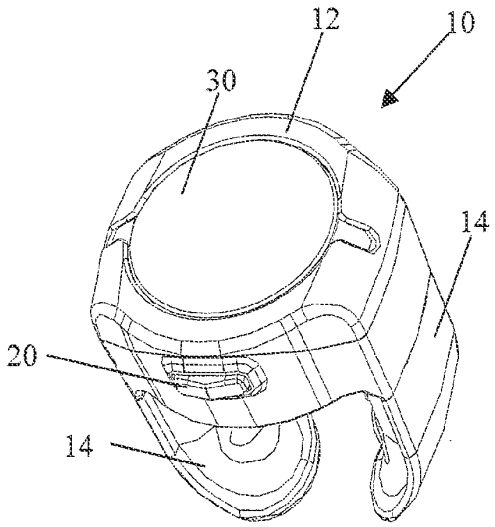


FIG.1

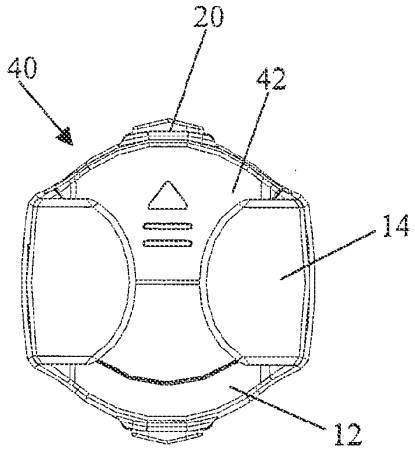


FIG.2

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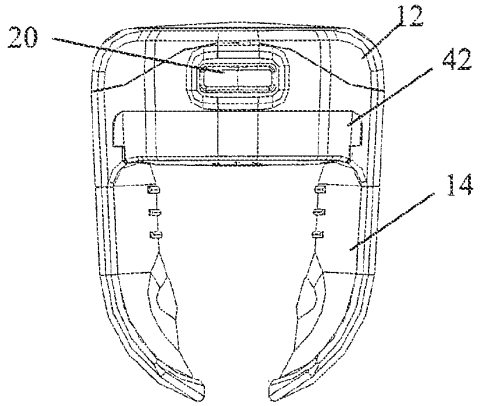


FIG.3

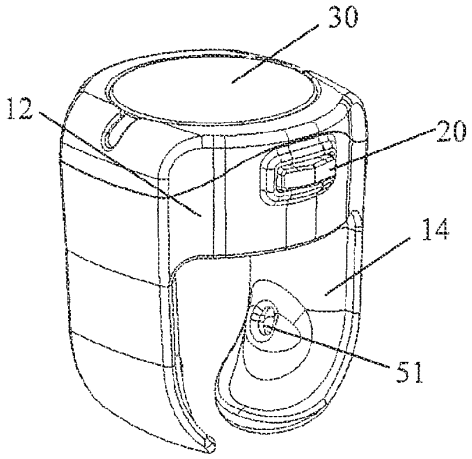


FIG.4

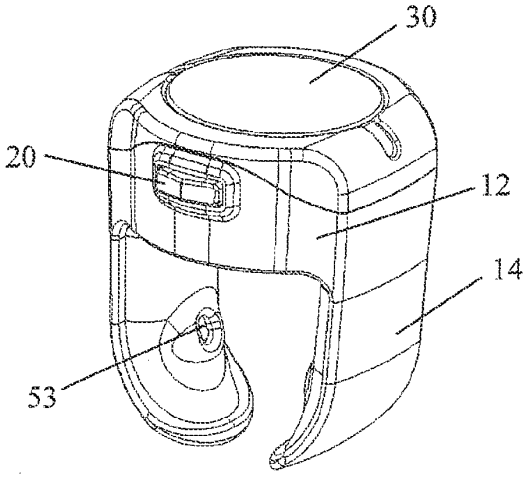


FIG.5

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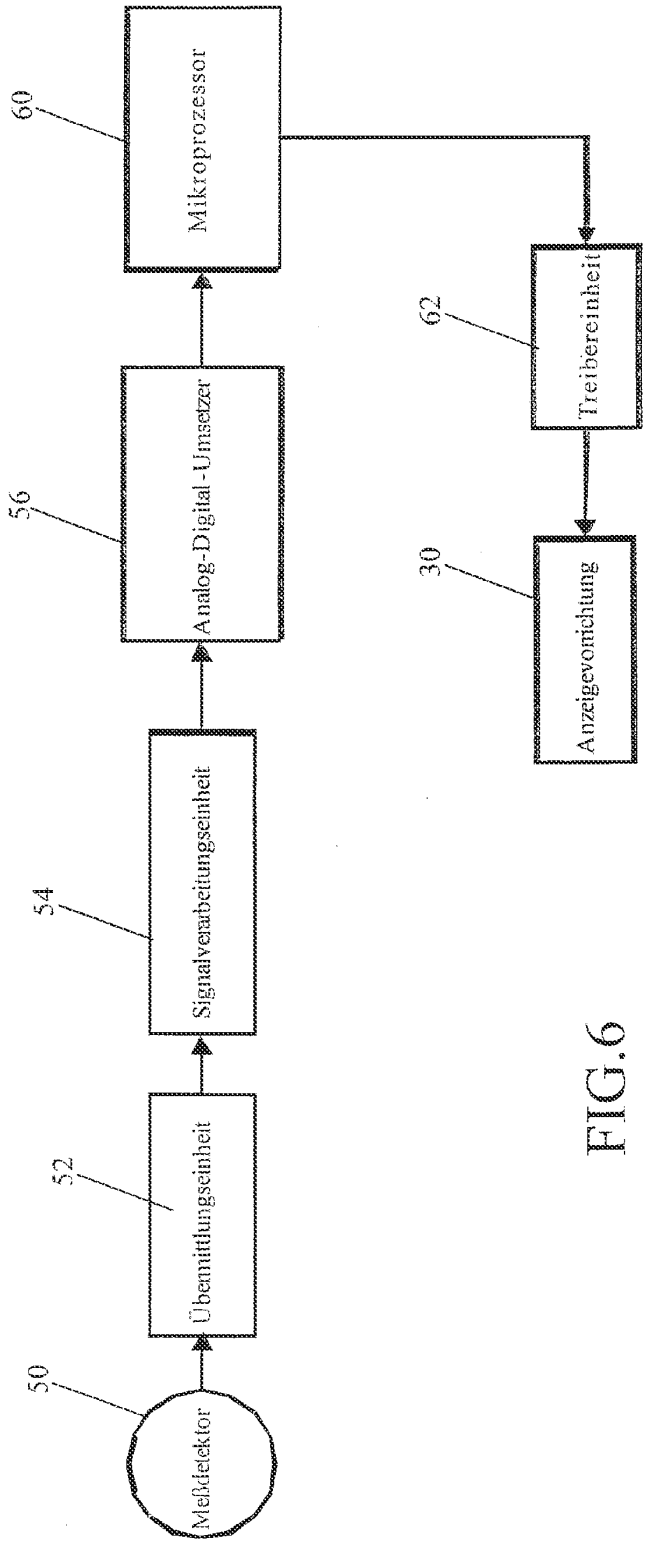


FIG.6

Petitioner Samsung Ex-1004, 0312

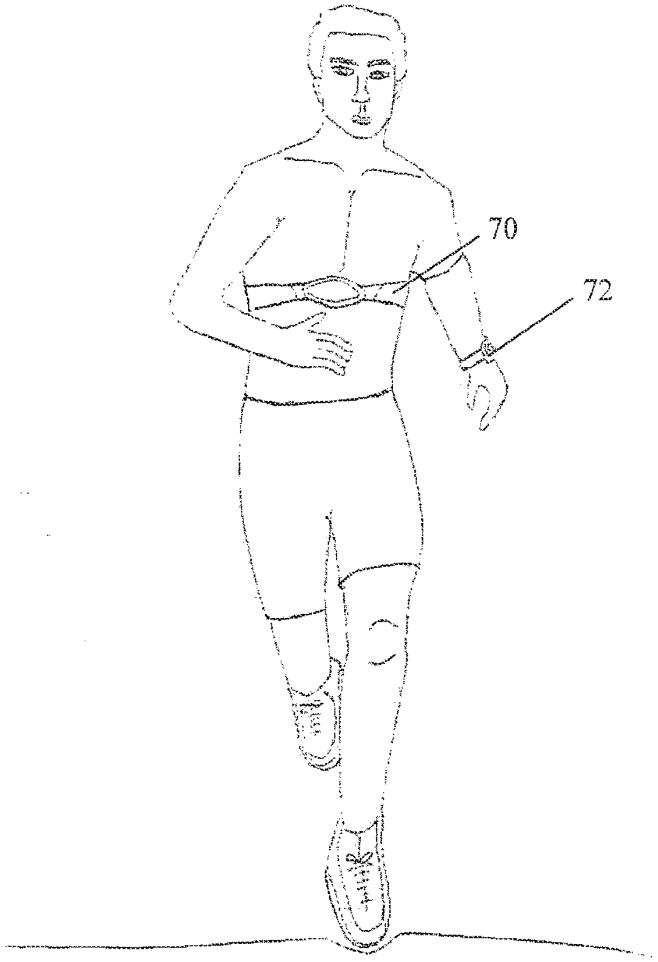


FIG.7

Petitioner Samsung Ex-1004, 0313

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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 June 2013 (27.06.2013)

W I P O I P C T

(10) International Publication Number
WO 2013/093638 A2

(51) International Patent Classification: Not classified

(21) International Application Number:
PCT/IB20 12/003048

(22) International Filing Date:
2 1 December 2012 (21 .12.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/578,837 2 1 December 201 1 (21. 12.201 1) US

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

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

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

(54) **Title:** GESTURE-BASED DEVICE

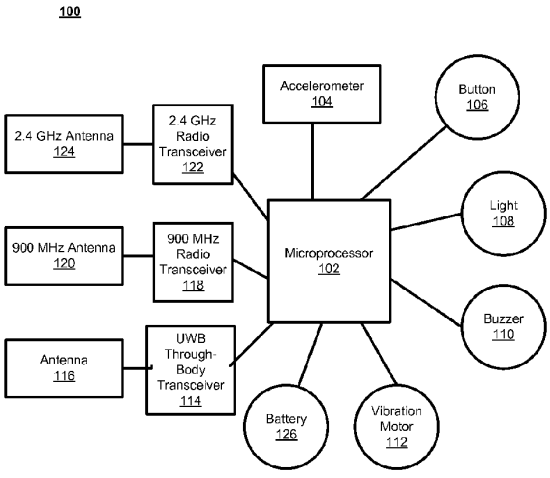


Fig. 1

(57) **Abstract:** The use of gestures on a user device to interact with and obtain functionality from remote communication hub devices is disclosed. A user device includes an accelerometer or other motion detection device and a wireless communications capability. The device is small enough to be placed conveniently about the person and communicates with a communication hub device to perform context-dependent actions. A user makes a gestural command to the device. The device interprets the gesture and undertakes activity. The gestural sensing device may be a motion switch, a multi-axis accelerometer, a video camera, a variable capacitance device, a magnetic field sensor, an electrical field sensor etc. When combined with business logic running on a remote computer system, the device can be used to implement a range of applications and services.

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GESTURE-BASED DEVICE

BACKGROUND

Field of the Invention

Described embodiments relate generally to a human-computer interaction device that detects a sequence of input gestures and selects actions based on a combination of the gestures, application, a current location, and the co-location of other users and objects.

Description of the Related Art

[0001] With the increasing importance of electronic modes of conducting personal and business affairs and increasing popularity of electronic entertainment, the instances of an individual needing to enter details into an electronic system in a structured way for transmission to another device or storage are increasing.

[0002] To use online shopping as an example, to use an online shopping service one typically must register with the website by providing identification, billing and delivery data for storage and later use by the merchant, or provide this data each time a transaction is performed. Even if the data is stored by the merchant, the user will need to go through a login process, entering her username and password, each time they access the site. This can be quite burdensome or boring for the person providing the data. Moreover with the popularity of portable computing devices, many of which do not have full-sized keyboards, this task requires some dexterity to perform. The result is that many users of online shopping services abandon their purchases, leading to lost sales by the merchant.

[0003] The online shopping paradigm also impacts how people conduct shopping in retail environments, and existing methods of payments centered around a single cash register may soon become outdated. Current payment methods using physical credit cards presented at point-of-sale (POS) terminals are not uniform and often not secure.

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SUMMARY

[0004] Disclosed embodiments include devices and methods for using gestures on a user device to interact with and obtain functionality from remote communication hub devices. In various embodiments a user device includes an accelerometer or other motion detection device and a wireless communications capability. The device is small enough to be placed conveniently about the person or unobtrusively attached to an object, and is configured to communicate with a communication hub device in order to perform context-dependent actions.

[0005] In operation the user makes a gestural command to the device (for example by tapping it twice in quick succession). The device using an internal processor (or an external processor connected by a wireless link) interprets the gesture and undertakes some activity on the user's behalf because of the gesture. The gestural sensing device may be a motion switch, a multi-axis accelerometer, a video camera, a variable capacitance device, a magnetic field sensor, an electrical field sensor or other sensing device. When combined with business logic running on a remote computer system, the device can be used to implement a range of applications and services including information services, security services including access control, stored value or credit card electronic payment systems, points or objects in a game, remote controls for consumer electronics, retail loyalty schemes, industrial equipment and so forth.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Fig. 1 is a schematic representation of a user device in accordance with one embodiment.

[0007] Fig. 2 illustrates communication between a communication hub device and a user device in accordance with one embodiment.

[0008] Fig. 3 illustrates communication between a communication hub device and a user device in accordance with one embodiment.

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[0009] Fig. 4 illustrates the sending of information from a user device to a communication hub device in accordance with one embodiment.

[0010] Fig. 5 illustrates the sending of a request message from a communication hub device to a user device in accordance with one embodiment.

[0011] Fig. 6 illustrates the sending of a request from a user device to a communication hub device in accordance with one embodiment.

[0012] Fig. 7 is a flowchart illustrating a method for gesture recognition by a user device in accordance with one embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] Fig. 1 illustrates an example of a user device 100 in accordance with one embodiment. The user device 100 includes a microprocessor 102; accelerometer 104; one or more buttons 106; a light 108; buzzer 110; vibrating motor 112; 2.4 GHz radio transceiver 122 and antenna 124; 900 MHz radio transceiver 118 and antenna 120; an ultra-wideband (UWB) through-body transceiver 114 and antenna 116; and a battery 126. In alternative embodiments, some of the illustrated components are not included— for example, in some embodiments, the user device includes a light but no buzzer or vibrator. The device may be, for example, a stand-alone device with a credit card form factor; a stand-alone device with a key-fob form factor; or a stand alone device with adhesive or screw mountings designed to be permanently attached to another object. The device can also be built into another device, for example a dog lead, mobile phone or mobile data tablet. The gesture recognition system and built-in sensors and actuators are configured to execute functionality based on inputs from the user or the sensors.

[0014] The user device 100 is configured to communicate with a communication hub device, as described below with respect to Figs. 2-6. Communication is initiated by either the user device 100 or the communication hub device 202 (Fig. 2), depending on context as described further below.

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[0015] The presence of multiple radio transceivers in the device (either physically or through software defined radio techniques) allows the device to adapt to the radio environment it finds itself in. A short range 2.4GHz radio can be used to indicate physical presence and interact within a small area while a longer range 900MHz radio can be used to indicate physical presence and interact within a larger area or through more obstructions.

[0016] Communication and interaction can be handed off from one radio system to another under control of the microprocessor to optimize system performance parameters including battery use, error rate and communications range.

[0017] The device forms part of a system of radio-enabled devices shown in the accompanying figures for 2.4GHz devices operating over existing wireless systems including WiFi, Bluetooth and DECT. Protocols for devices utilizing the 900MHz band are described in related United States patent application serial number 61/547,729, and PCT application PCT/ IB2012/002489, each of which is incorporated by reference herein in its entirety.

[0018] Fig. 2 is an interaction diagram illustrating communication between a communication hub device 202 and a user device 100. In various embodiments, the communication hub 202 has a higher capacity power source compared to the user device 100. A communication hub device 202 may be connected to or internal to, for example, a laptop computer used by the user to access online shopping through a browser application. Alternatively the communication hub device 202 may be a point of sale terminal, an advertising poster, a retail display rack or other relatively fixed infrastructure. In this embodiment the communication hub device 202 uses a larger power source (such as a bigger battery) or mains power enabling it to perform more power-intensive radio functions more frequently.

[0019] In another embodiment the communication hub 202 is mobile and enclosed in a smaller form factor. This could be a smart phone, an external device attached to a smartphone, a small self contained portable device or other portable device.

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[0020] In one embodiment, the communication hub 202 transmits a page message 204 at regular intervals, providing its device identification number, e.g., ID1. The page message 204 is transmitted to allow other devices 100 to identify the existence of the transmitting device at a particular location. A user device 100 can receive the page message 204 as a wireless communication through its radio system 114, 118, 122, and may wake up the user device microprocessor 102 and process or store the page message 204 and communication hub identification. The decision to process or store can be based, for example, on the application that is being implemented using the communication hub and user devices, such as a stored value card, a point collection system for a game, or the implementation of a consumer product information collection system. The communication hub device 202 may also store the responses from the user device 100, which may contain information about the user device 100.

[0021] In one embodiment the ID and associated information is automatically collected and stored as the device 100 moves into and then stays within proximity of the communication hub 202, for example when browsing at a retail location.

[0022] An input gesture from the user device 100 may flag the stored ID and associated information as important or particularly relevant to the user, for example when collecting product information from a product on display at a retailer.

[0023] In another embodiment the device 100 being within proximity of the communication hub device 202 authenticates the user to access the communication hub device 202 to access the user's account, for example on an online banking portal or an online shopping portal.

[0024] Alternatively, an input gesture from the user device 100 can provide a final level of authorization to an application being executed on the communication hub device 202 allowing the user to access the user's account on the communication hub device 202, or complete a transaction in an online shopping transaction on the communication hub device 202.

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[0025] Storage in various embodiments is to memory in the user device 100, typically implemented as EEPROM or flash memory. Upon receipt of the page message 204 the user device 100 knows that it is within range of the communication hub 202. In various embodiments, the user device 100 provides a signal to the user to indicate that the device 100 is in communication with the communication hub 202. This may include, for example, a flash of light from light 108, a buzz from buzzer 126 or a vibration from vibration motor 112.

[0026] Fig. 3 illustrates an embodiment in which the user device 100 responds to the page message 204 and sends an acknowledgment message 306 to the communication hub 202. The communication hub 202 responds with a session key and time to live message 308 to be used to disambiguate future communications. The session key is valid for the amount of time in the time to live field. The communication hub 202 may perform other actions based upon the receipt of the acknowledge message 306, such as initiating a transaction in a retail system, performing a database lookup, unlocking the user device 100, logging into the user's account being accessed by the browser running on the user device 100, and recording the presence of the user device 100 in proximity to the communication hub in a loyalty card application. The user device 100 has a number of sensors and actuators integrated with one or more radio transceivers 114, 118, 122. It can be used to provide user interaction to multiple applications where the application (business) logic is implemented on a computer system remote to the user device 100. In such embodiments, performing a gesture such as a double tap (tap-tap), pushing a button 106 or simply being in a particular place or combination of place and time can cause the business logic to implement a particular action which is dependent on the user, the location, the gesture performed, the date and time and the presence or absence of other co-located users. The business logic is responsible for determining and implementing the required action based on the collection of information including, for example, the location, the gesture performed, the date and time and the presence or absence of other co-located users, collectively called the users context.

[0027] Fig. 4 illustrates an embodiment in which the user device 100 explicitly sends information 410 to the communication hub 202. This may be in response to a user gesture

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command, for example. The communication hub 202 may then act on the information 410 in some way. In one embodiment, the communication hub 202 explicitly acknowledges receipt or the information with an acknowledge message 412.

[0028] This example illustrates the use of sequence numbers, which in one embodiment are monotonically increasing numbers generated by both sides of the communication starting with the user device 100 in the initial acknowledge message 306. Sequence numbers are used to detect lost messages. The user device 100 or the communication hub 202 maintains records of the last sequence number transmitted to and the last sequence number received from the other party. If the series of monotonically increasing sequence numbers is broken then the party identifying the break knows that a message has been transmitted but not received. This fact is revealed at the application layer on both devices and any corrective action is up to the application to implement. Possible corrective action could be to implement a reliable transport protocol like TCP or TP4 or to ignore the message.

[0029] Fig. 5 illustrates an embodiment in which, some time after the initial generation of a session key, the communication hub sends the user device 100 a request message 510. This could occur in a payment system where the request is a request for payment based on an out-of-band (human to human) communication. The user device 100 can choose to ignore the request if, for example, it is not addressed to it or if it is for a transaction that the user does not wish to complete; or reply to the request with an information message 512 providing the requested information. The structure of the content of the request 510 and the information messages are application dependent.

[0030] Fig. 6 illustrates a scenario where the user device 100 sends a request message 610 to the communication hub device 202. The message 610 could relate to the user device 100 approving a transaction being executed on the communication hub device. The user device 100 might continue to send this message until it received a message from the communication hub device 202 that the message had been received. Alternatively, the message could be related to a retail application and contain a request for a pre-defined order at a coffee shop. The communication hub 202 would send back a confirmation message 612 confirming the

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request and optionally providing additional information. Additional information could be cost, expected wait time, advertising material about the product, loyalty points earned, etc. In some situations the communication hub may send a request 614 to the user device 100 asking for payment. The user device 100 would send back an information message 616 containing the required payment information.

[0031] In various embodiments, communication between the user device and communication hub is initiated upon user input of a gesture. In various embodiments, and referring to Fig. 7, recognizing a gesture begins with sampling 702 the parameter that the sensor measures at intervals higher than the Nyquist rate of the gesture to be captured. Device 100 then uses a dynamic time warping algorithm (DTW) to correlate 704 the samples with templates for each gesture to be recognized and determine a correlation coefficient and error value. If 706 the correlation coefficient exceeds a pre-determined threshold and the error value is below a pre-determined threshold, then the gesture is classed 708 as recognized. If 706 none of the classification tests are satisfied then further samples are taken 710 from the sensor and the process repeated until a gesture is matched.

[0032] In a microprocessor implementation, in one embodiment a wake-on-change function is used to wake up the microprocessor 102 when the sensor value exceeds a predefined value, allowing power to be conserved.

[0033] The device 100 may detect a range of different gestures for different actions, e.g., tap-tap for retail shopping transactions, a wave to auto-fill web forms, a key-unlock gesture to approve online payments or get access to secure accounts. In each case it is advantage of this invention is that a gesture can be defined which relates to the action be actuated and hence is intuitive for the user, reducing user resistance and providing them with an increased sense of security.

[0034] The device may also include other sensors for the user to provide additional input to the device, for example biometric input sensors including but not limited to fingerprint scanner, microphone with voiceprint analysis, touchpad with signature recognition, retinal scanner, etc., to further authenticate the user; or push buttons, and actuators for the device

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to provide feedback to the user, for example indicator lights, auditory indicators (buzzers) and tactile indicators (vibrators).

[0035] Once a gesture has been recognized the device 100 executes its stored program logic to respond to the gesture. Operations in response to a recognized gesture may include one or more of making a noise; flashing a light or using other actuators built into the device; transmitting information through a wireless link built into the device to a person or another computer system to effect a change in the environment, for example open a door, make a payment, or to control the actuators on the device, for example flash a light, make a noise or vibrate.

[0036] The actuators can be used to provide feedback based on the use of the gesture recognition, the use of the buttons, or in response to a communication received from the wireless connection.

[0037] The device can use its radio transceiver 114, 118, 122 to send or listen for periodic beacon messages and may interact with a remote person or computer system without the need for a gesture-based trigger (the presence of the device in a particular location may be sufficient to initiate the interaction and can be considered a degenerate gesture 'do nothing').

[0038] A further aspect is the ability to disambiguate user responses in crowded environments. In retail or other environments ambiguity can arise when two or more devices are simultaneously within range of a payment terminal.

[0039] In one embodiment, when a device comes within range of a payment terminal it communicates with the terminal in response to a terminal broadcast message. The terminal responds to the device with a session key. Multiple session keys can be active for a vendor terminal and multiple devices at one time. When a payment is requested by the vendor, the vendor terminal broadcasts the request including the session key. Only the device holding that matching session key responds to authorize the payment (using an existing stored value card protocol). If a vendor cannot differentiate between several devices currently enrolled, the vendor terminal can use the instantaneous relative signal strength of the connections to

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each device to determine the device closest to the vendor terminal (using an algorithm based on the distribution of relative signal strengths of all the devices with active session keys) and send the payment request using that devices session key. If there is no clear closest device then, the vendor can ask the customer currently being served to tap-tap their device, thus clearly identifying to the vendor terminal the session key associated with the transaction. The payment request can then be sent to the device with the associated session key.

[0040] In an alternate disambiguation system the payment request is sent to all devices with active session keys and only the device that corresponds to the user being served at the front of the queue responds. If the vendor terminal received multiple responses within a time window from the payment request then it disregards all responses and re-issues the payment request and repeats the process until it receives only one response within the time window. This allows for human social protocols to provide disambiguation and also allows for 'someone else to pick up your tab'.

[0041] In the case of multiple vendor terminals, multiple payment requests can be received by a single device in a small time window. The disambiguation process takes place on the device where the device looks at the relative signal strength of the connection with each vendor terminal and only responds to the payment request with the highest relative signal strength. If the relative signal strengths are similar then the device responds to none of the request and waits for the vendor terminal to re-issue the payment request. A human social protocol can then be used to remove the ambiguity (for example in a crowded market situation the vendor could ask the customer to move closer to the vendor terminal to remove the payment ambiguity).

[0042] Alternate disambiguation technologies can be used. For example biometric facial identification data can be stored on the device and transferred to the vendor terminal when an enrollment occurs. The vendor terminal uses a low cost video camera to capture the facial image of the customer immediately in front of the terminal (the one being served). The biometric is used to match with the biometric supplied by the device and the payment

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request is sent with the matching session key. If no biometrics match then a potential fraud alert can be generated.

[0043] Examples of applications and services include:

[0044] Example 1

[0045] In one embodiment, a payment system includes the device 100 located in a credit card form factor with two user pushable buttons 106 on the card and an audio actuator (buzzer) 110. The first time a user goes to a retailer, she takes out the card. For the local gas station, she pushes the "Connect Pay" button 106. The cashier also pushes his Connect Pay button and completes the first time authorization. From then on, the user can use a tap-tap or other gesture on her wallet (still in her pocket or hand bag) to pay for transactions. Through-the-wallet tapping works by using an accelerometer 104 in the card stored in the wallet to detect the accelerations associated with the displacement of the wallet when tapped. The dynamic time warping algorithm is then used to match the accelerometer 104 output against a series of templates associated with different gestures (e.g. tap tap-tap, TAP-tap, tap-tap-tap, tap-tap .... tap, etc.) when a match is found a predefined (application dependent) action takes place.

[0046] In another embodiment, a user may log into their laptop and identify through a browser application certain goods that they would like to buy, at which point the application will request that they enter certain personal information such as name, address and credit card details. The user can then wave their wallet in which is held the user device 100 in a swiping gesture in order to "autofill" the personal data. The browser application will then ask the user to approve the purchase as a final check before processing payment and executing an order.

[0047] The user can then twist the hand holding the wallet in a "key-unlock" gesture as a means of approval.

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[0048] In another embodiment, the user can wave the device 100 over a tablet or smartphone to provide personal information such as medical records or a history of recent personal activity such as exercise routine.

[0049] In another embodiment, the user can twist the hand holding the wallet in a "key-unlock" gesture over a laptop, smartphone or tablet as a means to further provide security information to the bank for a secure log-on or approval of a transaction. Security information may include username and password, a secure verifiable code such as a one time key, or other personal information.

[0050] In another embodiment, a user visits a cafe, and the first time she pushes the share button 106, a message is communicated from the user device 110 to the communication hub 202 giving the cafe permission to track the user's shopping while at their store, signing them up to their loyalty program. The user also has to push the Connect Pay button 106 on his device to complete the authorization process. The user can then tap-tap his wallet to pay for small transactions, plus he shares his spending and coffee preferences with the cafe, or any one of the shops in the chain. In one embodiment the user can also pre-order while waiting in the line.

[0051] Example 2: Exchanging simple information between two friendly devices.

[0052] In this example a user bumps into a colleague while out for a walk in the park and is introduced to her friend.

[0053] To share user configurable contact information the user makes a tap-tapped gesture on her purse while it is still in her bag, as does the other party. The two wireless devices in their wallets or purses discover each other and share contact information, such as social network identities, across the wireless link.

[0054] When the user arrives home, the device 100 communicates with her home computer system (the communication hub) 202 and records the contact information for later use. Her new friend does not have a home computer system—her device uses her mobile

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phone to save the contact information for later use. The information is stamped with the date of the encounter and if available the location of the encounter.

[0055] Location specific information exchange

[0056] Embodiments also include the option of modifying the environment to alert users that the device 100 can be used at a particular location. Modifications include a variable message display triggered by the reception of a radio message from the device or a graphic symbol and/ or words in a sign or logo.

[0057] For example, a "Tap-Tap" symbol sign in a store window or near merchandise can indicate that a gesture to the device 100 (a tap-tap) could initiate a wireless connection to a computer or person associated with the location or merchandise.

[0058] The activity associated with the gesture is dependent on the context the gesture is performed in and on pre-stored user preferences. For example a tap-tap gesture when standing near a product displaying a Tap-Tap symbol could be configured in user preferences to e-mail information about the associated product to the user for one user; for another user it could be configured to load product information immediately into the user's smart phone; for another user it could be configured to request a sales call between 3:00 PM and 5:00 PM on the following day. What it does is dependent on the business logic and on the user's preferences.

[0059] In one example a gesture may gather information from the environment about the product in close proximity to the user (using short range radio location by adjacency, GPS or some other location technology) to establish his location.

[0060] In another example a gesture may request a staff member assist a customer at a location in a busy store, queuing in the system for the next available shop assistant.

[0061] In another example the gesture may provide information to the merchant along with a request to be contacted later about the product or service. These scenarios can be generalized to the provision and/ or collection of information associated with a location and

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with potential additional context such as user preferences and merchant/ provider preferences based on a gesture performed by the user using the device.

[0062] In another example the gesture may provide customer information to a merchant for use in a loyalty program.

[0063] Feedback

[0064] A further aspect involves using the device to provide feedback to the user based on context, user preferences and other externalities.

[0065] Example 3

[0066] When the device is used to make a payment in response to a user gesture, an audio response is provided to indicate that the payment has been successful or not successful. If successful the tone and cadence of the feedback response can be altered to indicate a low balance in the users account.

[0067] Example 4

[0068] In an industrial setting the device can be used to warn of the presence of hazardous areas by vibrating or beeping to alert the user when the user moves within a pre-determined range of a transceiver located in the environment. A gesture to the device can be used to acknowledge the receipt of the warning.

[0069] Other variations of feedback can be constructed for other applications and other feedback actuators.

[0070] The present invention has been described in particular detail with respect to a limited number of embodiments. Those of skill in the art will appreciate that the invention may additionally be practiced in other embodiments.

[0071] Within this written description, the particular naming of the components, capitalization of terms, the attributes, data structures, or any other programming or structural aspect is not mandatory or significant, and the mechanisms that implement the invention or its features may have different names, formats, or protocols. Further, the

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system may be implemented via a combination of hardware and software, as described, or entirely in hardware elements. Also, the particular division of functionality between the various system components described herein is merely exemplary, and not mandatory; functions performed by a single system component may instead be performed by multiple components, and functions performed by multiple components may instead be performed by a single component.

[0072] Some portions of the above description present the feature of the present invention in terms of algorithms and symbolic representations of operations on information. These algorithmic descriptions and representations are the means used by those skilled in the art to most effectively convey the substance of their work to others skilled in the art. These operations, while described functionally or logically, are understood to be implemented by computer programs. Furthermore, it has also proven convenient at times, to refer to these arrangements of operations as modules or code devices, without loss of generality.

[0073] It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise as apparent from the present discussion, it is appreciated that throughout the description, discussions utilizing terms such as "selecting" or "computing" or "determining" or the like, refer to the action and processes of a computer system, or similar electronic computing device, that manipulates and transforms data represented as physical (electronic) quantities within the computer system memories or registers or other such information storage, transmission or display devices.

[0074] Certain aspects of the present invention include process steps and instructions described herein in the form of an algorithm. It should be noted that the process steps and instructions of the present invention could be embodied in software, firmware or hardware, and when embodied in software, could be downloaded to reside on and be operated from different platforms used by real time network operating systems.

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[0075] The present invention also relates to an apparatus for performing the operations herein. This apparatus may be specially constructed for the required purposes, or it may comprise a general-purpose computer selectively activated or reconfigured by a computer program stored in the computer. Such a computer program may be stored in a computer readable storage medium, such as, but is not limited to, any type of disk including floppy disks, optical disks, DVDs, CD-ROMs, magnetic-optical disks, read-only memories (ROMs), random access memories (RAMs), EPROMs, EEPROMs, magnetic or optical cards, application specific integrated circuits (ASICs), or any type of media suitable for storing electronic instructions, and each coupled to a computer system bus. Furthermore, the computers referred to in the specification may include a single processor or may be architectures employing multiple processor designs for increased computing capability.

[0076] The algorithms and displays presented herein are not inherently related to any particular computer or other apparatus. Various general-purpose systems may also be used with programs in accordance with the teachings herein, or it may prove convenient to construct more specialized apparatus to perform the required method steps. The required structure for a variety of these systems will appear from the description above. In addition, the present invention is not described with reference to any particular programming language. It is appreciated that a variety of programming languages may be used to implement the teachings of the present invention as described herein, and any references to specific languages are provided for disclosure of enablement and best mode of the present invention.

[0077] Finally, it should be noted that the language used in the specification has been principally selected for readability and instructional purposes, and may not have been selected to delineate or circumscribe the inventive subject matter. Accordingly, the disclosure of the present invention is intended to be illustrative, but not limiting, of the scope of the invention.

[0078] We claim:

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CLAIMS

1. A device comprising:

an accelerometer;

a microprocessor, coupled to the accelerometer, configured to identify one of a plurality of possible gestures according to data received from the accelerometer;

a button, coupled to the microprocessor, for receiving user input; and

a radio transceiver, coupled to the microprocessor, configured to communicate with a communication hub;

wherein the microprocessor is further configured to transmit an instruction via the radio transceiver to the communication hub, the instruction selected according to an identity of the communication hub and the identified gesture.

2. The device of claim 1 further comprising a light coupled to the microprocessor, and wherein the microprocessor is further configured to illuminate the light in conjunction with transmitting the instruction.

3. The device of claim 1 further comprising a buzzer coupled to the microprocessor, and wherein the microprocessor is further configured to sound the buzzer in conjunction with transmitting the instruction.

4. The device of claim 1 further comprising a vibration motor coupled to the microprocessor, and wherein the microprocessor is further configured to cause the vibration motor to vibrate in conjunction with transmitting the instruction.

5. The device of claim 1 wherein the radio transceiver is an ultra-wideband through-body transceiver.

6. The device of claim 1 wherein the radio transceiver is a 2.4 GHz radio transceiver.

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7. The device of claim 1 wherein the identified gesture includes movement of the device according to a predefined pattern.

8. The device of claim 1 wherein the identified gesture includes a tapping of the device according to a predefined pattern.

9. A method for providing a service to a device, the method comprising:

receiving at a communication hub an instruction from the device of claim 1, the instruction including a request for authorization; and

responsive to the request, transmitting a response to the device authorizing the device to engage in a financial transaction using the communication hub.

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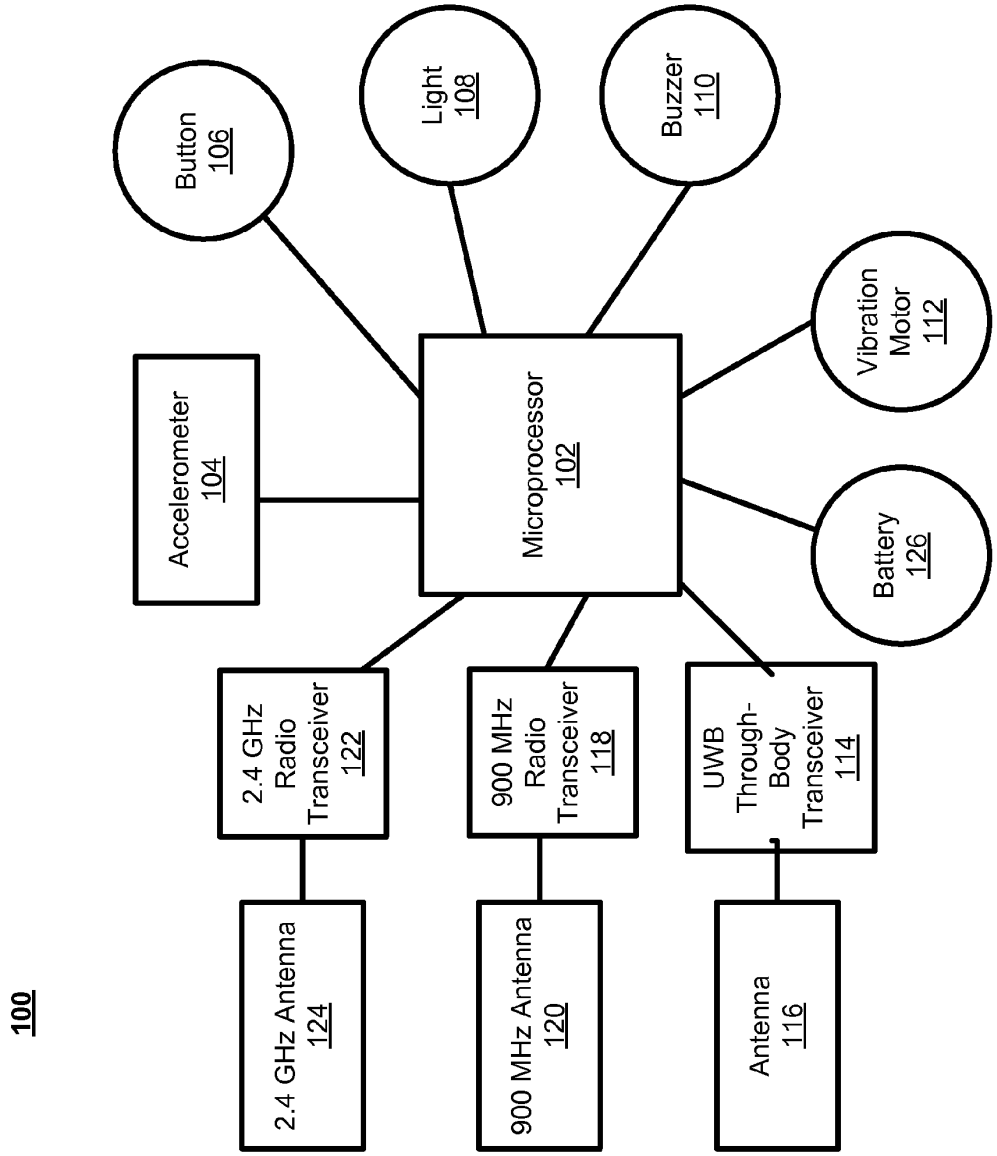


Fig. 1

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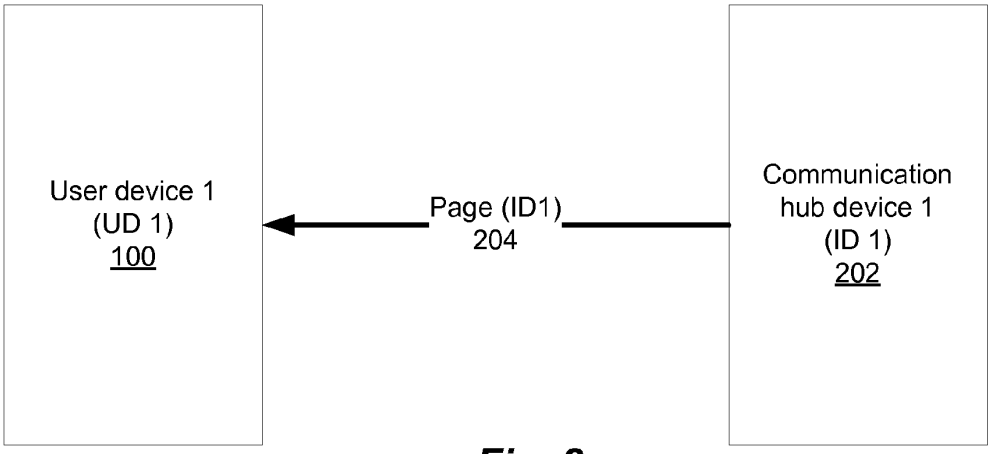


Fig. 2

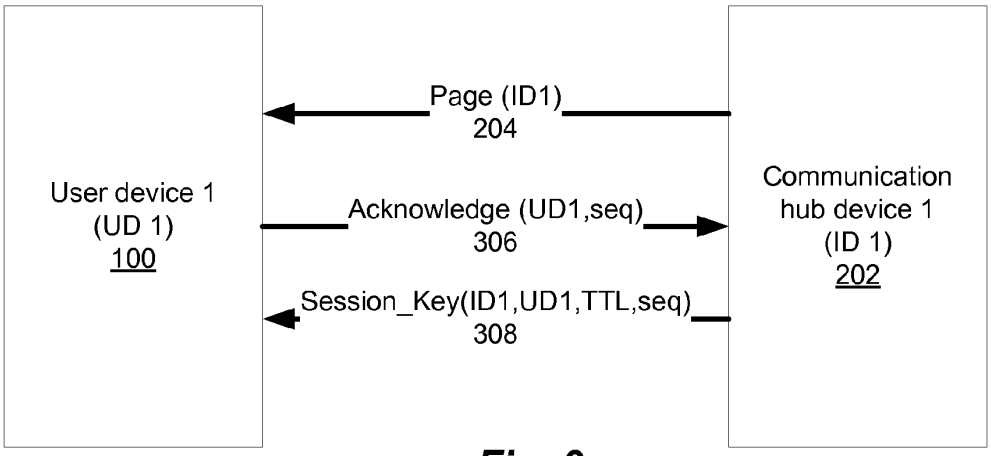


Fig. 3

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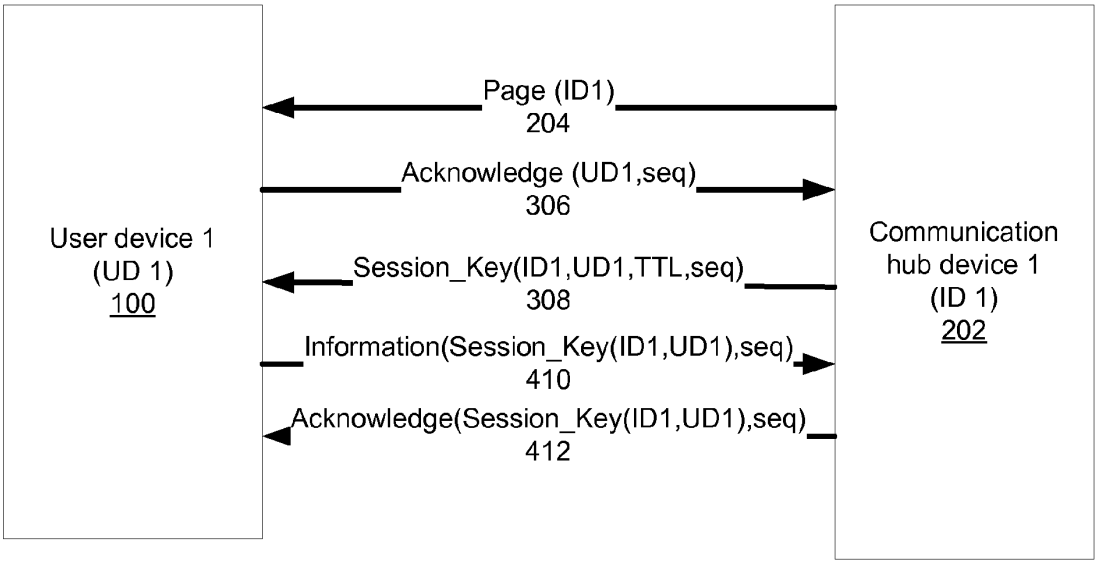


Fig. 4

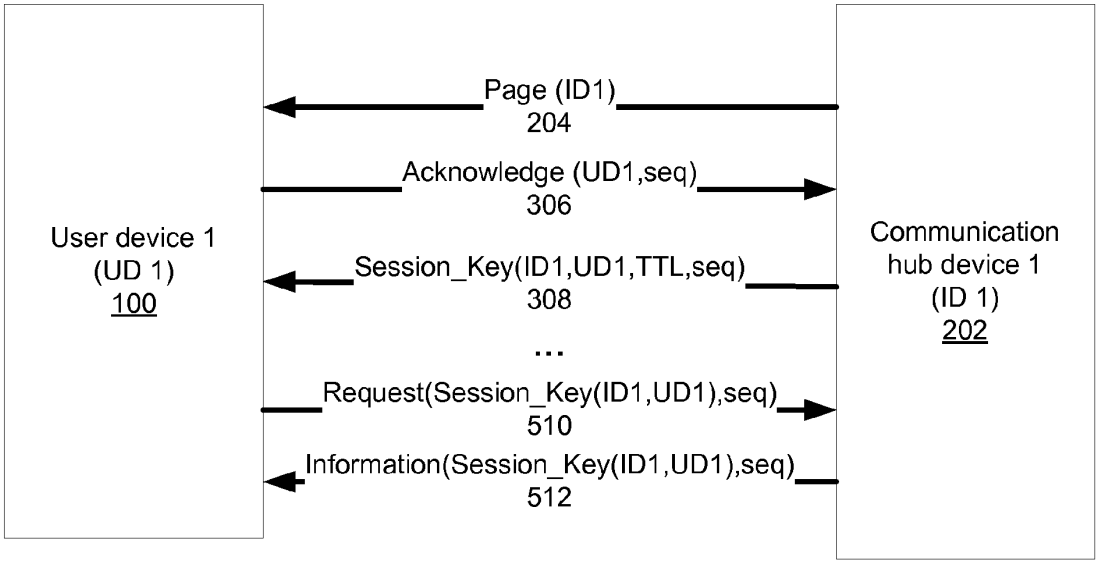


Fig. 5

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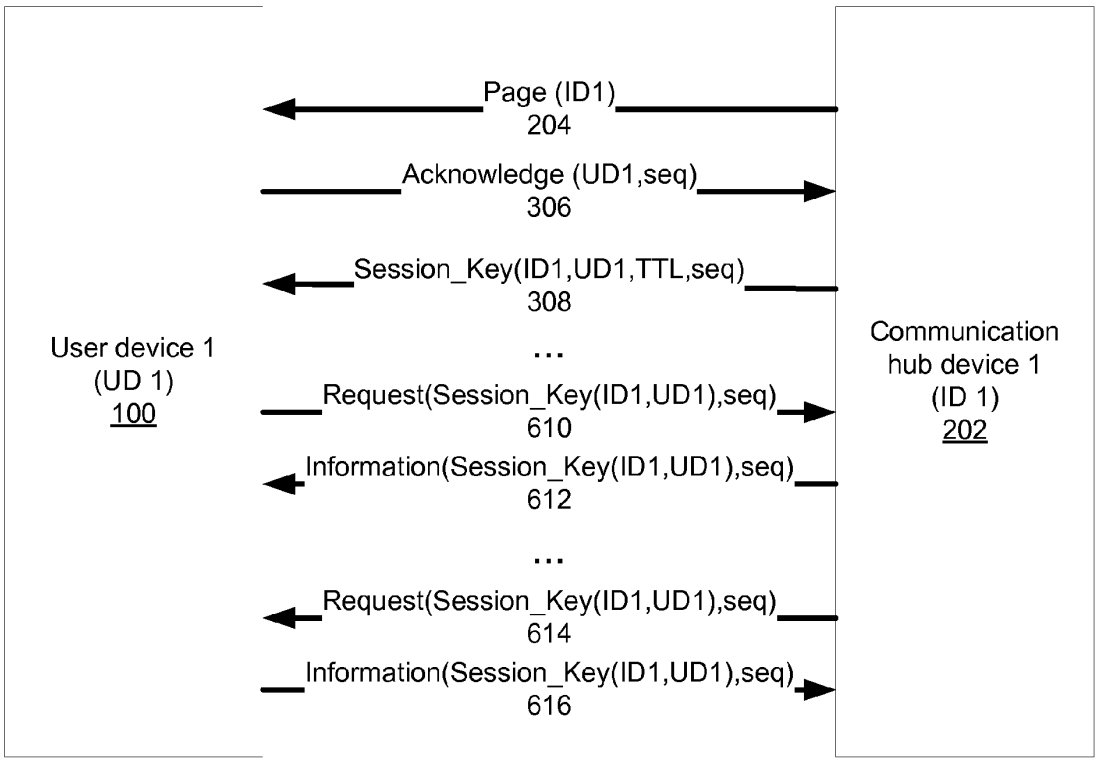


Fig. 6

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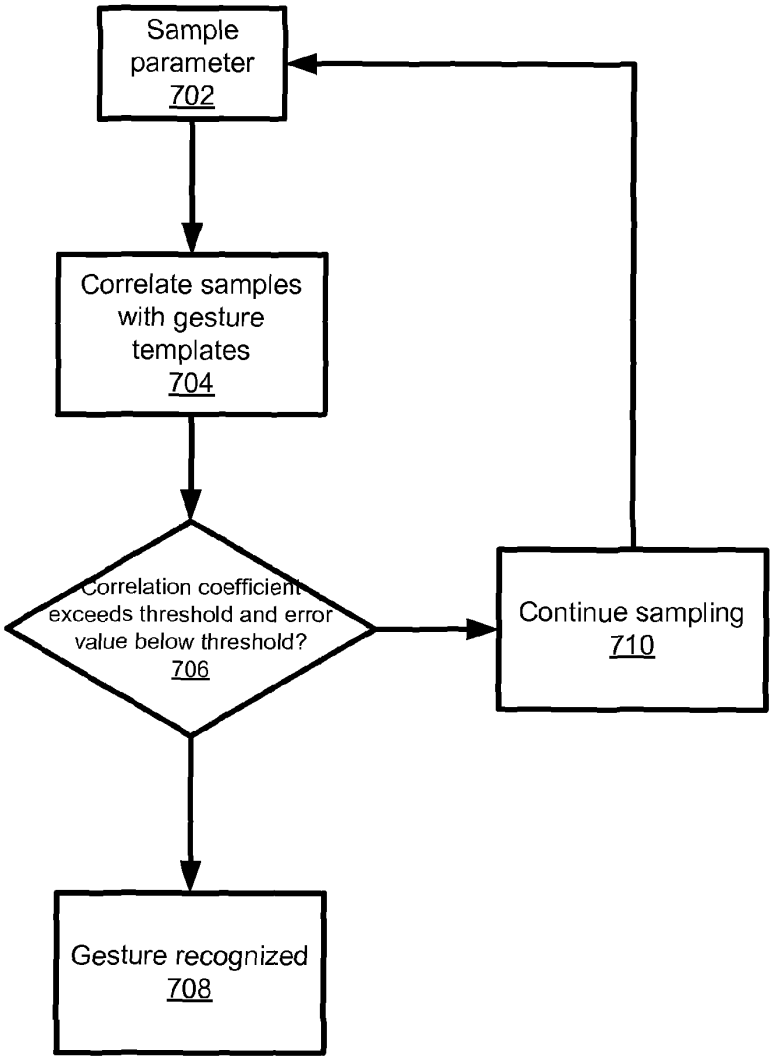


Fig. 7

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Finger ring physiological measuring assembly for e.g. heartbeat or oxyhaemaglobin has a housing around a detector and microprocessor

List of publications

Publication date

- Application number 2006DE-20000119 Date 2006-01-05 Register
  - DE202006000119 U1 Utility model 2006-03-30

English Title

Finger ring physiological measuring assembly for e.g. heartbeat or oxyhaemaglobin has a housing around a detector and microprocessor

German Title

Messgerät für physiologischen zyklus

Abstract - German

Hauptanspruch :
Messgerät, umfassend ein ringartiges Gehäuse (10), einen Messdetektor (50) und einen Mikroprozessor (60), dadurch gekennzeichnet: dass das Gehäuse (10) am Finger tragbar ist, dass der Messdetektor (50) in dem Gehäuse (10) angeordnet ist, wobei der Messdetektor (50) zum Empfangen von Signalen vorgesehen ist, dass der Mikroprozessor (60) die von dem Messdetektor (50) empfangenen und weitergeleiteten Signale eines physiologischen Vorgangs bearbeiten kann, so dass das Messgerät zum Ermitteln Daten des physiologischen Vorgang benutzt werden kann.

English Abstract (Native or MT)

Measuring device, comprising an annular housing (10), and a microprocessor (60), a measuring detector (50) wherein: the housing (10) can be worn on the Finger, the housing (10) of the measuring detector (50), the detector (50) is provided to receive signals from the measurement, the microprocessor (60) signals received and forwarded by the measuring detector (50) a surgical procedure can handle, so that the measurement data may be used to determine the physiological action device.

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Application Numbers & Dates	DE202006000119U 2006-01-05 [2006DE-20000119]
Priority Numbers & Dates	DE202006000119U 2006-01-05 [2006DE-20000119]

Technology domain Medical technology

US codes history

IPC codes A61B-005/02*
IPC codes history A61B-005/02*
CPC codes A61B-005/024/16* A61B-005/6826 A61B-005/6838
CPC codes history A61B-005/024/16* A61B-005/6826 A61B-005/6838

[0001] The invention relates to a measuring device for a physiological event, and in particular a measuring device, which is designed as a ring, wherein the measuring device in a ring-like body composed mainly of a measurement detector installed on-board microprocessor is znd annular housing, so that the measurement device according to the invention can be used to determine data of a surgical procedure.

[0002] Conventional instruments for a physiological action, such as for example pulse detector or oxygenized hemoglobin detector, relatively large and not suitable for driving. Many people today recognize, that Fitness of the body is important. In order to remain or to be fit, many people exercise. It will be very dangerous for human sports herzkarnke drive, with no regard to certain physiological processes. Exercisers to be developed, which are provided with a pulsation detector, so that the user may change the training devices to improve their body condition monitor pulse.

[0003] Conventional oxyhemoglobin detectors basically consist of a finger measurement detector and an analyzer, the medical diagnostics, e.g. by measuring the arterial oxygen saturation (sao2) in the blood for rapid detection of myocardial infarctions include diseases.

[0004] According to the prior art three kinds of pulse detectors are known. The first kind of pulse detector is an infrared sensor, which can measure the blood circulation to the Finger or ear lobe. The second type of pulse detector is an electrocardiogram (EKG), can measure the blood circulation in the handle section. The third type of pulse detector is a thoracic electrocardiogram, which can measure the pulse to the chest of the circulatory system.

[0005] The infrared sensor is the most commonly used pulse detector. Such pulse detectors are formed either in a Hand-grippable Form or in a wristwatch. When using the user places his Finger to the glass window of the infrared sensor, whereby the infrared sensor can indicate the reaction of the circulatory system, which is easy to influence by pulsation. This kind of infrared detector is easily affected by movement, whereby the result cannot be accurately measured. Because the user must place his or her Finger to the glass window of the infrared sensor to measure continuously, this mode is very

inconvenient for the user of the infrared sensor. The other type of the infrared sensor includes a measurement detector and an analyzer carried the ear lobe, wherein the measurement detector is coupled through a cable to the analyzer incorporated into a training apparatus. During exercises on the exercise machine of the user is disturbed by the cable is also suitable. this type of training device with infrared sensor not to be taken.

[0006] The second type from the pulse detector is a cardiograph, which can measure the electrical signal from the pulse and blood circulation in the best hand region or to the chest. Generally this type of fitness clubs or gymnasiums pulse detector present. In measuring the user must grip with both hands or two sheets of metal deposited on two fingers, so that the pulse detector can read the data of the physiological cycle. The user must remain stationary during the measurement and wait for at least a few seconds. Which is very inconvenient to the user.

[0007] The third type of pulse detector is a thoracic electrocardiogram, which can measure the blood circulation to the chest. In 7 are an electrode belt 70 and a wrist watch 72 shown. The electrode belt 70 is carried to the chest of the user, the electrode belt 70 an electroded belt has a signal transmitter. The wristwatch 72 has a corresponding receiver on the signal transmitter. This type of the thoracic electrocardiogram system (Chest-electrode ecg system) has good accuracy. In measuring the user must electrodes belt 70 and the wristwatch 72 simultaneously carry. Because the electrode belt 70 must be carried directly on the skin, the electrodes may belt 70 very easily by electromagnetic waves, such as for example mobile phones, television, Computer include, to be damaged. Because this kind of pulse detectors operate as mobile phones are usually in the same frequency range, the signals could lead to problems of pulse detector, if one or more mobile phone users in the vicinity (about 80 cm or 2, 5 cubic feet) are. Other side is the electrode belt 70 strapped around the chest, which is very inconvenient for the user during the exercise.

[0008] The object of the invention is, to create an additional measurement device for a physiological event, which eliminates the above-mentioned disadvantages of the conventional meters.

[0009] This object is solved by the measuring device as in claim 1; advantageous developments and embodiments of the invention and the use thereof are also disclosed herein.

[0010] A meter is thus provided in accordance with invention, the housing having an annular design, and a microprocessor and a measuring detector can be used to determine the data of the physiological cycle.

[0011] In particular a measuring detector are incorporated into the annular shaped housing and a microprocessor, so that the measurement apparatus may be used according to the invention for

detecting data from the physiological event. The meter by the (r) user) supported on the Finger, thereby measuring a physiological Signal from the detector can be received and forwarded to the microprocessor. Thus the data can be displayed in the physiological after processing by the microprocessor operation.

[0012] Embodiments of the invention will be described with reference to the attached drawings. It shows:

[0013] 1 a perspective view of measuring device according to this invention;

[0014] 2 meter from a rear view of the inventive 1;

[0015] 3 Seitensnsicht from a measuring device of the inventive 1;

[0016] 4 from a side perspective view of the inventive meter 1, showing, a light source to one of the two lateral parts of the housing;

[0017] 5 meter from a side perspective view of the inventive 1, which shows, on the other side part of a receiver's body;

[0018] 6 a schematic block diagram of the inventive measuring device;

[0019] 7 a representation of the third type of conventional pulse detector in use.

[0020] Are first1 to 5 reference. One embodiment of the invention is shown. As can be seen from the figures, measuring device according to the invention comprises an annular housing 10, a pushbutton 20, a display device 30, a power supply unit 40, a measuring detector 50 and a microprocessor 60.

[0021] The housing 10is ring-shaped and has a round top 12 and two arcuate parts formed and oppositely 14 to, face each other at the top 12 are arranged. The two side 14 are made of soft Material, such as rubber or plastic, prepared. Because the housing 10of the inventive measuring device is configured as a normal Ring, the meter can easily from the (r) user) carried on the Finger.

[0022] The housing 10connected to at least one button 20provided, for on-and off, start, stop or programming is provided. According to the4 and 5 meter according to the invention is in this embodiment having two buttons 20provided, on either side of the side members 14 and on opposite sides at the top 12 are arranged.

[0023] The display device 30in the housing 10attached. In this embodiment is the display 30at the top 12 arranged.

[0024] The power supply unit 40into a housing 10installed. In this embodiment is the power supply unit 40into the top 12 installed, wherein the power supply 40a lid 42 has, at the top 12 housing 10display 30mounted opposite.

[0025] The measurement detector 50 into a housing 10installed. In this embodiment the measurement detector 50 side plates 14 housing 10arranged. The measurement detector 50 is an infrared radiation detector. In this embodiment has the measurement detector 50 a light source 51 and a light receiver 53 on, wherein the light source 51 and the light receiver 53 opposite one another on the two lateral parts 14 are attached. The Light source 51 may an LED (Light Emitting Diode, LED) be. The light receiver 53 can convert light to electrical current. The light source 51 and the light receiver 53 and photo-Transistor are e.g. a pair of light-emitting diode (PN photo-Transistor), wherein the measurement detector 50 type or may be a pulse detector oxyhemoglobin.

[0026] The light source 51 of pulse detector can emit a wavelength of 940 nm infrared radiation, while light receiver 53 can convert the light signals to electrical signals received. The light is emitted by an LED, and then passes through the Finger by the light receiver 53 received. If the light beam passes through the Finger is transmitted into the tissue, the light radiation is absorbed and partly by the bone and tissue as well as partially reflected therefrom and transmitted by the light receiver 53 received. When the amount of blood in the radial artery pulse is alternately changed, thereby also increasing the light receiver 53 accordance with the rhythm of the pulse of light received, the rhythm with the heart beat, changes, so that the pulse or heartbeat can be detected and displayed by corresponding signals.

[0027] The light source 51 red radiation detector is a wavelength of 660 nm from the oxyhemoglobin and from 940 nm to emit infrared radiation, wherein the light receiver 53 can convert the light signals into the electrical signals received. The blood is composed of the blood fluid (Plasma) and cells (pellet), and 99% of said cells are red blood cells. The color of blood is based on the blood dye (hemoglobin). In the context of the blood circulation is to Transport oxygen from the lungs into the tissues and 97% lead slag materials, such as carbon dioxide and urophanic substances from the tissues to the excretion organs (lung and kidney). Oxygen is annealed at high oxygen pressure, the hemoglobin is bright red oxyhemoglobin. This gives up its oxygen at low oxygen tension and reduced hemoglobin to be dark red.

In this case the arterial oxygen saturation (sao2) brought to a simple formula. Sao2 =CHbO2 /(CHbO2 + cm)

[0028] CHbO2 is the density of the Oxihaemoglobins, wherein the reduced hemoglobin is density cd. Arterial oxygen saturation (sao2) is due to the different absorption spectra of CHbO2 and cm measured apparent. Measuring detector for measuring hemoglobin detector sends 50 two wavelengths of light rays into the tissue of the user, so that the light radiations some for AC component subjected to different absorption (AC, alternating current) and some for DC component (DC, direct current) contribute. Due to the different densities of infrared absorption spectra of the red radiation and can CHbO2 and cd and measuring detected in the blood. The microprocessor 60from the transmitted light of two wavelengths can, subject to the differential Absorption and reflection, the arterial oxygen saturation signals received at data processing.

[0029] In the6 is a block diagram of the inventive measuring device is illustrated. The measurement detector 50 has a transmitting unit 52, a signal processing unit 54 and an Analog to Digital converter 56 on, wherein the transmission unit 52the information from the measurement detector 50 and to convert the signal processing unit 54 forward. The signal processing unit 54 processed data to the Analog-Digital converter may 56 transmit, the data to the microprocessor and further processed electronically 60forward.

[0030] The microprocessor 60may influence the measurement detector 50 received and forwarded from the physiological data processing operation, so that the measuring device can be used to determine data of the physiological event. In this embodiment the microprocessor 60a driver unit 62, to switch the display 30is provided.

[0031] When using the measuring device according to the invention by the (r) user) supported on the Finger. The push button 20pressed, the meter is turned on and the physiological signals received from the measurement and further directed to the microprocessor detector. The data from the physiological operation from (the) user) indicated by the processing of the microprocessor. The upper and lower limits may be pre-programmed by the pulse rate meter. When the pulse rate falls below the upper and lower limit over-or ., the display device 30 the user) a warning signal to. The meter also has the function of a sport watch intended. It is very convenient for the (ie) user) during exercise.

[0032] According to the above descriptions the invention according to the existing measuring device has the following advantages for a physiological event

1. the invention according to the measuring device is constructed and is relatively small when using the (r) user) supported on the Finger, so that the measuring device is much more convenient than conventional devices.

2. the invention according to the measuring device is ring-shaped and can thus when using the (r) user) simply supported on the Finger, so that the measuring device is designed to use more practical.

3. the invention according to the zimm light meter is designed to be small, so that the measuring device is suitable for carrying.

4. The invention according to the measuring device is ring-shaped design. The (ie) user) may place the meter during exercise on the Finger into the pocket or simply carry, without affecting the exercise freedom.

5. the invention according to the invention when using the measuring device (r) user) supported on the Finger. Because the Finger is not jarred during exercise, from the physiological data may determine the operation more than conventional devices.

6. The invention according to the measuring device is relatively small and very convenient construction, so that the meter is very convenient to carry.

7. The upper and lower limits of the pulse rate can be pre-programmed by the measurement device according to this invention. The upper and lower limit when the pulse rate over or below ., the display device 30 the user) a warning signal to. Thus it is very convenient for the meter (ie) user) to observe his (her) body condition.

8. The invention according to the measuring device has the function of a sport watch intended. It is very convenient for the (ie) user) during exercise.

9. the invention according to the measuring device is constructed compact and has no lead wire or cable, so that the measuring device is much more convenient and better than conventional meters to handle.

10. a plurality of people can carry a gene are simultaneously measuring device, according to this invention without interfering with the function of these devices each other.

[0033] The use of the measuring device is versatile and the aforementioned designs for a physiologic are exemplary only operation. Thus the problems are solved.

[0034] The invention thus relates to a measuring device for a physiological event, and in particular a measuring device, which is designed as a ring, and an annular housing mounted in an annular housing in measuring detector and a built-in microprocessor includes, so that the measuring device to determine data according to the invention can be used by a physiological event. The meter by the (r) user) supported on the Finger, whereby a physiological Signal received from the measurement is conducted to the microprocessor and further detector. The data of the physiological event processing by the microprocessor thereof are displayed.

(19) RÉPUBLIQUE FRANÇAISE

INSTITUT NATIONAL
DE LA PROPRIÉTÉ INDUSTRIELLE

PARIS

(11) N° de publication : **2 767 384**
(à n'utiliser que pour les commandes de reproduction)

(21) N° d'enregistrement national : **97 10366**

(51) Int Cl[6] : **G 01 K 1/14**

(12) **CERTIFICAT D'UTILITÉ** **B3**

(54) BAGUE D'INDICATION DE TEMPERATURE DE DOIGT A DES FINS PRINCIPALEMENT MEDICALES.

(22) **Date de dépôt :** 14.08.97.

(30) **Priorité :**

(43) **Date de mise à la disposition du public de la demande :** 19.02.99 Bulletin 99/07.

(45) **Date de la mise à disposition du public du certificat d'utilité :** 16.07.99 Bulletin 99/28.

(56) **Les certificats d'utilité ne font pas l'objet d'un rapport de recherche.**

(60) **Références à d'autres documents nationaux apparentés :**

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Bague d'indication de température de doigt à des fins principalement médicales.

En raison de la modernisation et du développement économique rapides, les gens ont à faire face à un stress de plus en plus grand au cours de leur vie quotidienne. Il en résulte que des problèmes psychiatriques, tels que des insomnies, des névroses, des psychoses, et des désordres psychosomatiques (y compris des migraines, des ulcères gastroduodénaux, des maux de tête dûs à la tension, etc.) deviennent de plus en plus courants parmi les gens. Selon des données statistiques, environ 5 à 15 pour cent d'adultes souffrent de tels problèmes.

Il existe une interaction entre notre corps physique et notre esprit. Des maladies physiques peuvent entraîner des désordres mentaux et une gêne mentale peut avoir une influence néfaste sur la santé physique. Quand une personne est sujette à un stress au-delà de ce qu'elle peut supporter, des désordres physiques ou mentaux peuvent donc se produire. Le mécanisme réside dans le fait que le stress, quand notre cerveau le ressent, peut entraîner un dysfonctionnement ou trouble de notre système nerveux autonome, de notre système endocrinien et de notre système immunitaire par l'effet de voies neurologiques.

Les symptomes d'anxiété provoqués par un trouble du système nerveux autonome peuvent se manifester par : des palpitations, de la dyspnée, une oppression thoracique, des étourdissements, des maux de tête, une bouche sèche, un déréglement du tractus gastro-intestinal, de la diarrhée, de la constipation, une fréquence exagérée des mictions, des tremblements, de la transpiration et un refroidissement des membres, etc. Le refroidissement des membres est dû à une

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vasoconstriction des vaisseaux. On a utilisé en clinique la température de l'extrémité des doigts comme indice général et sensible pour surveiller si quelqu'un est ou n'est pas dans un état détendu. En bref, quand nous sommes dans un état détendu, nos vaisseaux se dilatent et l'extrémité de nos doigts et plus chaude. Si nous sommes anxieux et tendus, nos vaisseaux se contractent et l'extrémité de nos doigts est plus froide.

Dans la pratique clinique, les docteurs en médecine peuvent donner aux patients des conseils sur la façon de détendre leurs muscles et, avec l'aide d'une machine de rétroaction biologique, ils surveillent les patients pour se rendre compte si ceux-ci effectuent une relaxation musculaire d'une façon correcte. Bien entendu, ce qui est le plus important est de trouver une façon de détecter une tension d'origine émotionnelle provoquée par le stress afin que cette tension puisse être éliminée et qu'il y soit remédié à temps.

Dans le procédé classique de mesure de la température de l'extrémité des doigts auquel on a recours en clinique, la machine de rétroaction est encombrante et coûteuse. Elle comporte un détecteur destiné à venir en contact avec la peau du patient pour détecter la température de l'extrémité de ses doigts. La valeur mesurée de la température est convertie en un signal électronique qui apparaît sur un écran de moniteur pour dire au patient s'il est dans un état détendu. Du fait qu'il est impossible que le personnel médical ou une machine volumineuse soit en permanence à la disposition des patients, il est souhaitable de mettre au point un instrument médical auxiliaire pouvant être porté commodément par des personnes et pouvant aider celles qui le portent à se détendre ou à prendre des mesures en ce sens à tout moment.

C'est pourquoi un objet principal de la présente invention est de fournir une bague qui indique la température d'un doigt et qui peut être disposée sur un doigt d'un utilisateur à tout moment pour servir d'instrument médical auxiliaire permettant de détecter et d'indiquer efficacement la température du doigt, laquelle traduit l'état de relaxation physique et/ou mental du porteur de manière à aider celui-ci, qui peut être un malade mental ou un utilisateur ordinaire, à contrôler ou

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maîtriser à temps son état émotionnel.

D'une façon générale, la bague selon la présente invention comprend: un corps de bague comprenant une partie formant bande comportant une ouverture inférieure formant deux extrémités dudit corps de bague, et deux canaux symétriques formés dans deux côtés opposés de ladite partie formant bande pour recevoir respectivement une tige arquée conductrice de la chaleur et une tige arquée de décharge de courant électrique, ladite tige conductrice de la chaleur et ladite tige de décharge de courant électrique comportant des extrémités inférieures qui font saillie respectivement du côté intérieur des deux extrémités inférieures dudit corps de bague, en formant deux extrémités découvertes destinées à toucher la périphérie extérieure du doigt du porteur de la bague quand celui-ci porte ladite bague d'indication de température de doigt autour d'un de ses doigts et ladite partie formant bande comportant un évidement supérieur peu profond pour loger des éléments électroniques de cette bague; un couvercle supérieur ayant un contour correspondant au contour dudit évidement supérieur formé dans ledit corps de bague pour recouvrir de façon ajustée ledit corps de bague et s'emboîter dans ledit évidement supérieur, et ledit couvercle supérieur comportant dans sa surface supérieure plusieurs ouvertures; un plaquette supérieure étant disposée dans un espace défini entre ledit couvercle supérieur et ledit évidement supérieur dudit corps de bague, ladite plaquette étant pourvue dans sa surface supérieure d'un bouton de commutation, d'un bouton ouvert/fermé, d'un afficheur à cristaux liquides, et d'une diode électroluminescente LED qui font saillie, respectivement, desdites ouvertures formées dans ledit couvercle supérieur; et une carte de circuits comprenant une thermistance, un élément indicateur, et d'autres éléments électroniques appropriés, ladite thermistance étant connectée à une extrémité supérieure de ladite tige conductrice de la chaleur et pouvant, par conséquent, détecter, par l'intermédiaire de ladite extrémité découverte de ladite tige conductrice, la température du doigt de la personne portant la bague et déclencher une opération dans ladite carte de circuits pour convertir en un signal ladite température détectée par ladite thermistance, ledit signal étant envoyé audit élément indicateur pour être porté à la

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connaissance de l'utilisateur de la bague d'une ou de plusieurs façons sélectionnées par l'intermédiaire du bouton de commutation se trouvant sur la plaquette supérieure, à savoir : a) en amenant la tige de décharge à décharger une petite quantité de courant électrique dans une mesure suffisante pour que le porteur de la bague la perçoive; b) en amenant l'afficheur à cristaux liquides à afficher la valeur détectée de la température du doigt; 3) en amenant la diode LED à émettre de la lumière; ou 4) en donnant un avertissement au porteur de la bague à l'aide d'un autre élément équivalent.

Cet autre élément équivalent servant à avertir la personne portant la bague peut comprendre un ronfleur et/ou un vibreur.

On va maintenant décrire de façon détaillée un mode de réalisation de la présente invention en se référant aux dessins annexés, sur lesquels:

la figure 1 est une vue en perspective éclatée de la bague selon la présente invention;

la figure 2 est une vue en coupe montrant la bague selon la présente invention dans un état assemblé; et

la figure 3 montre une bague d'indication de température de doigt selon la présente invention placée autour d'un doigt d'un utilisateur.

On va se référer simultanément aux figures 1 et 2. La présente invention concerne une bague d'indication de température de doigt qui peut détecter et mesurer la température d'un doigt d'une personne portant cette bague afin d'indiquer un état mental tendu ou stresséindésirable de manière que cette personne puisse se détendre elle-même à temps et de façon appropriée. Cette bague d'indication de température de doigt comprend principalement un corps 1 de bague, un couvercle supérieur 2 monté de façon ajustée sur la face de dessus du corps de bague 1, une plaquette supérieure 3 disposée entre le corps de bague 1 et le couvercle supérieur 2, et une carte 4 de circuits, connectée électriquement à la face de dessous de la plaquette supérieure 3.

Le corps 1 de bague comprend une partie formant bande 11 comportant une ouverture dirigée vers le bas et formant deux extrémités inférieures du corps de bague. Deux canaux symétriques 16, 17

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sont formés de façon circonférencielle à l'intérieur les deux côtés opposés de la partie formant bande 11. Les canaux 16, 17 reçoivent, respectivement, une tige arquée 14 conductrice de la chaleur et une tige arquée 15 de décharge de courant. La tige 14 conductrice de la chaleur et la tige 15 de décharge de courant comportent des extrémités inférieures qui font saillie respectivement du côté intérieur des deux extrémités inférieures du corps de bague 1, en formant deux extrémités découvertes 141 et 151, respectivement. Les extrémités découvertes 141 et 151 font saillie du côté intérieur de la partie formant bande 11 dans une mesure telle qu'elles peuvent juste toucher la périphérie extérieure du doigt de la personne quand celle-ci porte la bague de la présente invention autour d'un de ses doigts. La partie supérieure de la partie formant bande 11 comporte un évidement 12 peu profond dans lequel sont placés une pile 13 ou d'autres éléments électroniques.

Le couvercle supérieur 2 a un contour correspondant à celui de l'évidement 12 ménagé dans la partie supérieure du corps de bague 1 et peut, par conséquent, recouvrir le corps de bague 1 en s'emboîtant de façon ajustée dans l'évidement 12. Le couvercle supérieur 2 comporte dans sa surface supérieure plusieurs ouvertures 21, 22, 23 et 24.

La plaquette supérieure 3 est disposée dans un espace défini entre le couvercle supérieur 2 et l'évidement supérieur 12 du corps de bague 1 quand le couvercle est emboîté dans ce dernier. Un bouton de commutation 31, un bouton ouvert/fermé 32, un afficheur 33 à cristaux liquides, et une diode électroluminescente LED 34 sont présents sur la surface supérieure de la plaquette supérieure 2 et font saillie respectivement à travers les ouvertures 21, 22, 23 et 24 formées dans le couvercle supérieur 2.

La carte 4 de circuits comprend principalement une thermistance 41, un élément indicateur 42, et d'autres éléments électroniques courants appropriés. La thermistance 41 est connectée à une extrémité supérieure de la tige 14 conductrice de la chaleur. Du fait que la tige 14 conductrice de la chaleur a une extrémité découverte 141 qui est en contact avec la peau du doigt, la température du doigt peut être détectée par la thermistance 41 par l'intermédiaire de la tige 14 conductrice

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de la chaleur. La température du doigt détectée par la thermistance 41 déclenche une opération dans la carte 4 de circuits et est convertie en un signal qui est envoyé à l'élément indicateur 42. En utilisant le bouton de commutation 31, on peut sélectionner une ou plusieurs des façons suivantes pour porter à la connaissance de l'utilisateur le signal envoyé à l'élément indicateur 42, à savoir :

1) amener la tige de décharge 15 à décharger une petite quantité de courant électrique dans une mesure suffisante pour que le porteur de la bague la perçoive;

2) amener l'afficheur 33 à cristaux liquides à afficher la valeur détectée de la température du doigt;

3) amener la diode LED 34 à émettre de la lumière; ou

4) donner un avertissement au porteur de la bague à l'aide d'un autre élément équivalent, tel qu'un vibreur ou un ronfleur.

On va se référer maintenant à la figure 3. Pour utiliser la bague d'indication de température de doigt selon la présente invention, il suffit d'enfiler le doigt à travers la partie formant bande 11 du corps de bague 1 de manière que la bague soit portée autour du doigt. A ce stade, l'extrémité découverte 141 de la tige arquée 14 conductrice de la chaleur située près du côté intérieur inférieur de la partie formant bande 11 se trouve légèrement en contact avec le doigt de l'utilisateur. La tige 14 conductrice de la chaleur peut être en un matériau présentant une bonne conductibilité, tel que le platine, pour transmettre de façon précise et instantanée l'excès ou l'insuffisance de chaleur du doigt à la thermistance 41. Dans la carte 4 de circuits qui n'est pas l'objet de la présente invention, une opération peut être déclenchée par la température détectée du doigt en vue de convertir la valeur de la température en un signal. Le signal est envoyé à l'élément indicateur 42 et est présenté au porteur de la bague d'une manière sélectionnée. Il existe différentes manières de présenter le signal, à savoir la visualisation de chiffres par l'intermédiaire de l'afficheur 33 à cristaux liquides, l'émission de lumière par la diode LED 34, une décharge d'une petite quantité de courant électrique par la tige arquée 15 de décharge de courant, ou l'utilisation de tout autre moyen équivalent, tel qu'un vibreur, un ronfleur, etc. Grâce à ce signal, le porteur de la bague peut

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être informé d'une façon objective de la température actuelle de son doigt. Toutefois, il faut souligner que la présente invention n'est pas conçue pour avertir de façon négative le porteur de la bague mais pour encourager positivement ce dernier. Ainsi, quand la température diminue (ce qui signifie que le porteur de la bague est plus anxieux et tendu), la bague est silencieuse. Mais quand la température augmente, un signal est émis pour dire au porteur de la bague qu'il se trouve dans un état plus détendu.

On voit clairement, d'après la description qui précède que la présente invention apporte une solution simple et avantageuse aux appareils encombrants et compliqués utilisés en thérapie clinique pour mesurer la température d'un doigt d'un patient. La bague selon la présente invention convient pour être portée par un malade ou un utilisateur ordinaire à tout moment dans le but de rappeler à ce dernier qu'il doit se détendre afin d'éviter toute gêne provoquée par une tension physique ou mentale. Le porteur de la bague peut donc conserver en permanence un état détendu et stable. Pour un patient qui souffre d'une maladie psychiatrique et qui, par conséquent, à besoin de se relaxer lui-même fréquemment, la bague selon la présente invention apporte un aide à ce patient au moment opportun.

Il est bien entendu que la description qui précède n'a été donné qu'à titre illustratif et non limitatif et que des variantes et des modifications peuvent y être apportées dans le cadre de la présente invention.

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REVENDICATIONS

1. Bague d'indication de température de doigt destinée à indiquer l'état physiquement et/ou mentalement détendu d'une personne portant cette bague, caractérisée en ce qu'elle comprend:

un corps de bague (1) comprenant une partie formant bande (11) comportant une ouverture inférieure formant deux extrémités dudit corps de bague, et deux canaux symétriques (16, 17) formés dans deux côtés opposés de ladite partie formant bande pour recevoir respectivement une tige arquée (14) conductrice de la chaleur et une tige arquée (15) de décharge de courant électrique, ladite tige conductrice de la chaleur et ladite tige de décharge de courant électrique comportant des extrémités inférieures qui font saillie respectivement du côté intérieur des deux extrémités inférieures dudit corps de bague, en formant deux extrémités découvertes (141, 151) destinées à toucher la périphérie extérieure du doigt du porteur de la bague quand celui-ci porte ladite bague d'indication de température de doigt autour d'un de ses doigts et ladite partie formant bande comportant un évidement supérieur peu profond (12) pour loger des éléments électroniques de cette bague;

un couvercle supérieur (2) ayant un contour correspondant au contour dudit évidement supérieur formé dans ledit corps de bague pour recouvrir de façon ajustée ledit corps de bague et s'emboîter dans ledit évidement supérieur, et ledit couvercle supérieur comportant dans sa surface supérieure plusieurs ouvertures;

un plaquette supérieure (3) étant disposée dans un espace défini entre ledit couvercle supérieur et ledit évidement supérieur dudit corps de bague, ladite plaquette étant pourvue dans sa surface supérieure d'un bouton de commutation (31), d'un bouton ouvert/fermé (32), d'un afficheur (33) à cristaux liquides, et d'une diode électroluminescente LED qui font saillie, respectivement, desdites ouvertures formées dans ledit couvercle supérieur; et

une carte (4) de circuits comprenant une thermistance (41), un élément indicateur (42), et d'autres éléments électroniques appropriés, ladite thermistance étant connectée à une extrémité supérieure

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de ladite tige conductrice de la chaleur et pouvant, par conséquent, détecter, par l'intermédiaire de ladite extrémité découverte de ladite tige conductrice, la température du doigt de la personne portant la bague et déclencher une opération dans ladite carte de circuits pour convertir en un signal ladite température détectée par ladite thermistance, ledit signal étant envoyé audit élément indicateur pour être porté à la connaissance de l'utilisateur de la bague d'une ou de plusieurs façons sélectionnées par l'intermédiaire du bouton de commutation se trouvant sur la plaquette supérieure, à savoir :

a) en amenant la tige de décharge (15) à décharger une petite quantité de courant électrique dans une mesure suffisante pour que le porteur de la bague la perçoive;

b) en amenant l'afficheur (33) à cristaux liquides à afficher la va leur détectée de la température du doigt;

3) en amenant la diode LED (34) à émettre de la lumière; ou

4) en donnant un avertissement au porteur de la bague à l'aide d'un autre élément équivalent.

2. Bague d'indication de température de doigt selon la revendication 1, caractérisée en que ledit autre élément équivalent servant à avertir la personne portant la bague peut comprendre un ronfleur et/ou un vibreur.

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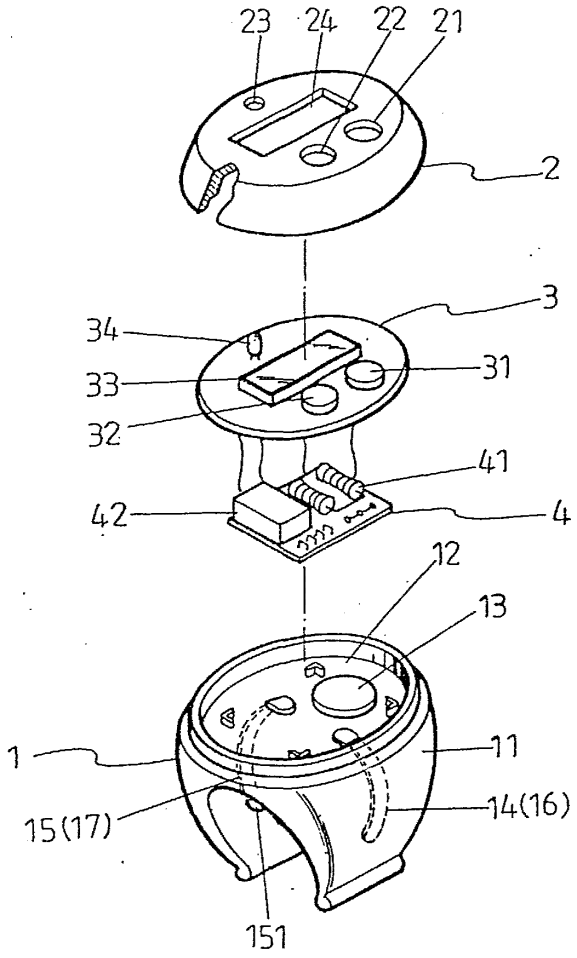

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151

FIG.1

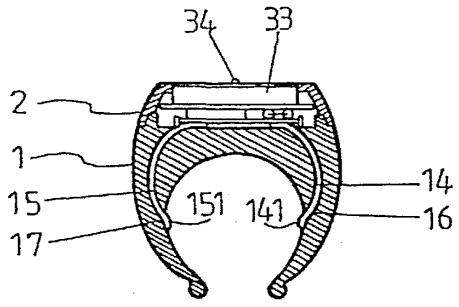

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FIG.2

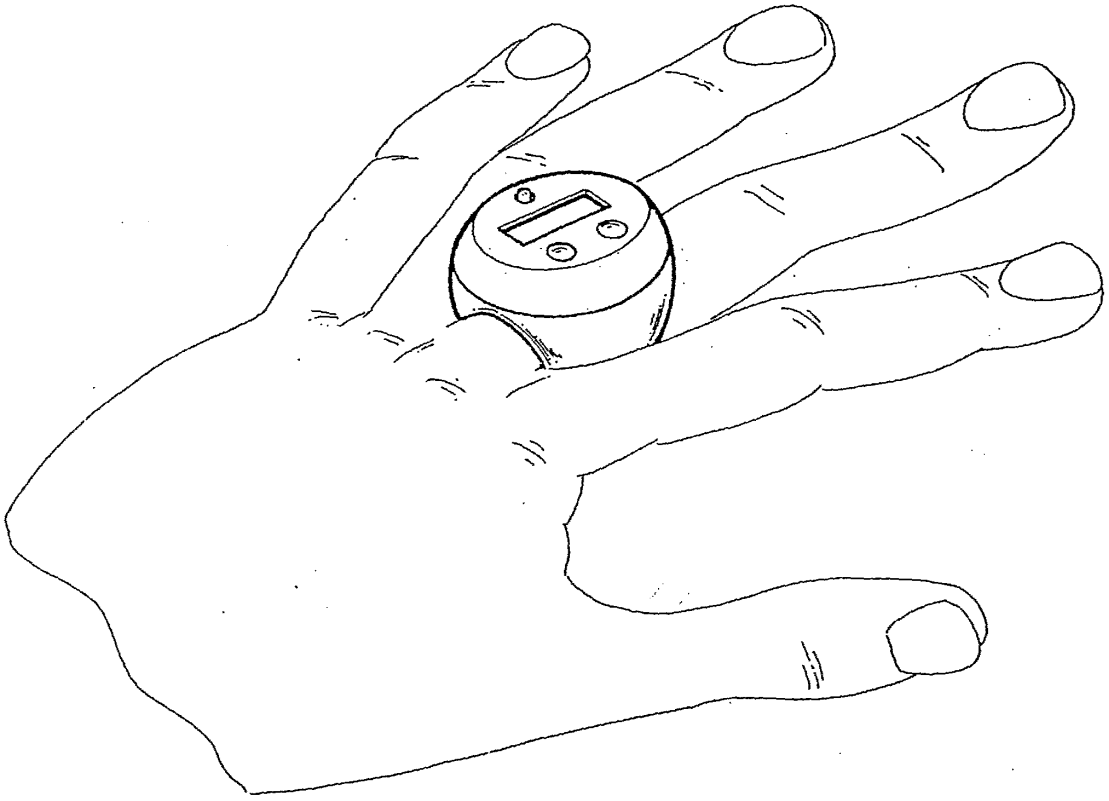


FIG.3

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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 June 2009 (25.06.2009)

PCT

(10) International Publication Number
WO 2009/079461 A1

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

(21) International Application Number:
PCT/US2008/086846

(22) International Filing Date:
15 December 2008 (15.12.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/013,850 14 December 2007 (14.12.2007) US

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

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

Declaration under Rule 4.17:

— *as to the identity of the inventor (Rule 4.17(i))*

[Continued on next page]

(54) Title: MEDICAL SENSOR AND TECHNIQUE FOR USING THE SAME

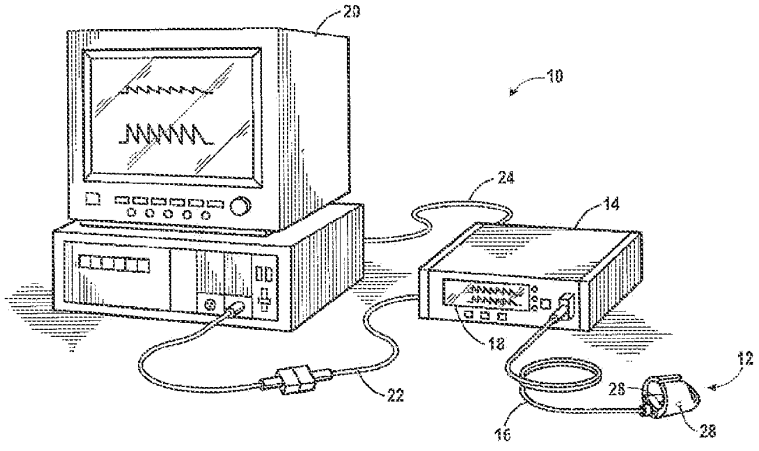


FIG. 1

(57) Abstract: Embodiments disclosed herein may include a sensor which is capable of enabling a generally more comfortable fit for a patient while reducing artifacts due to patient motion. In an embodiment, the sensor includes a generally tubular sensor body with a lengthwise opening to enable expansion of the sensor body to accommodate a patient's digit. In an embodiment, an opening may be provided to enable the patient's nail to protrude from an end of the sensor. The sensor body may be generally flexible and semi-rigid, such that the body may be expandable, yet is capable of maintaining a generally digit-conforming shape when not applied to the patient's digit. In an embodiment, a rigid or semi-rigid sensing component assembly may be integrated into the sensor. The sensor may be coupled to a monitor to measure the patient's physiological parameters, including but not limited to pulse rate, blood oxygen saturation, body water percentage, etc.

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Published:
— *with international search report*

MEDICAL SENSOR AND TECHNIQUE FOR USING THE SAME

Technical Field

[0001] The present disclosure relates generally to medical devices and, more particularly, to sensors used for sensing physiological parameters of a patient.

Background

[0002] This section is intended to introduce the reader to various aspects of art that may be related to various aspects of disclosed embodiments, which are described and/or claimed below. This discussion is believed to be helpful in providing the reader with background information to facilitate a better understanding of the various aspects of the present disclosure. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

[0003] In the field of medicine, doctors often desire to monitor certain physiological characteristics of their patients. Accordingly, a wide variety of devices have been developed for monitoring physiological characteristics. Such devices provide doctors and other healthcare personnel with the information they need to provide the best possible healthcare for their patients. As a result, such monitoring devices have become an indispensable part of modern medicine.

[0004] One such monitoring technique is commonly referred to as pulse oximetry, and the devices built based upon pulse oximetry techniques are commonly referred to as pulse oximeters. Pulse oximetry may be used to measure various blood flow characteristics, such as the blood-oxygen saturation of hemoglobin in arterial blood, the volume of individual blood pulsations supplying the tissue, and/or the rate of blood pulsations corresponding to each heartbeat of a patient.

[0005] Pulse oximeters typically utilize a non-invasive sensor that is placed on, adjacent, and/or against a patient's tissue that is well perfused with blood, such as a patient's finger, toe, forehead or earlobe, and/or other location. The pulse oximeter sensor may emit light, and

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photoelectrically sense the absorption and/or scattering of the light after passage through the perfused tissue. The data collected by the sensor may then be used to calculate one or more of the above physiological characteristics based upon the absorption or scattering of the light.

[0006] Interferences in the light path may distort the emitted and sensed light utilized in calculating the physiological characteristics. In particular, pulse oximetry may be sensitive to movement, such as moving the sensor in relation to the tissue, increasing or decreasing the physical distance between the emitter and detector in the sensor, changing the orientation of the emitter or detector with respect to the tissue or each other, changing the angles of incidence and interfaces probed by the light, directing the optical path through different amounts or types of tissue, and expanding, compressing, or otherwise altering the tissue near the sensor.

SUMMARY

[0007] Certain aspects commensurate in scope with this disclosure are set forth below. It should be understood that these aspects are presented merely to provide the reader with a brief summary of certain forms the invention might take and that these aspects are not intended to limit the scope of the invention. Indeed, the invention may encompass a variety of aspects that may not be set forth below.

[0008] According to an embodiment, there may be provided a sensor, including an emitter and a detector at a substantially fixed optical distance relative to one another, and an expandable molded body for securing secure the emitter and the detector to a digit.

[0009] According to an embodiment, there may also be provided a sensor body, including a semi-rigid molded structure having a generally tubular interior and a lengthwise opening to enable expansion of the generally tubular interior to accommodate a digit.

[0010] According to an embodiment, there may be still further provided a sensor body, including a flexible semi-rigid structure configured to be affixed to sensing components and to secure the sensing components to a digit.

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[0011] According to an embodiment, there may be yet further provided a method of manufacturing a sensor, including overmolding a flexible semi-rigid sensor body around an emitter and a detector.

[0012] Finally, according to an embodiment, there may be provided a method of manufacturing a sensor, including enclosing an emitter and a detector in a substantially rigid casing, molding a flexible sensor body, and coupling the substantially rigid casing to the flexible sensor body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Advantages of this disclosure may become apparent upon reading the following detailed description and upon reference to the drawings in which:

[0014] FIG. 1 is a perspective view of an exemplary patient monitoring system, in accordance with aspects of an embodiment;

[0015] FIG. 2 is a perspective view of an exemplary sensor for use with the patient monitoring system of FIG. 1, in accordance with aspects of an embodiment;

[0016] FIG. 3 is a perspective view of the exemplary sensor of FIG. 2 applied to a patient's digit, in accordance with aspects of an embodiment;

[0017] FIG. 4 is an exploded view of the exemplary sensor of FIG. 2, in accordance with aspects of an embodiment;

[0018] FIG. 5 is a perspective view of another exemplary sensor for use with the patient monitoring system of FIG. 1, in accordance with aspects of an embodiment;

[0019] FIG. 6 is a perspective view of a further exemplary sensor for use with the patient monitoring system of FIG. 1, in accordance with aspects of an embodiment; and

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[0020] FIG. 7 is a perspective view of another exemplary sensor for use with the patient monitoring system of FIG. 1, in accordance with aspects of an embodiment.

DETAILED DESCRIPTION

[0021] One or more specific embodiments will be described below. In an effort to provide a concise description of these embodiments, not all features of an actual implementation are described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

[0022] In accordance with the present disclosure, sensors for pulse oximetry or other applications utilizing spectrophotometry may be provided that reduce signal artifacts by reducing the occurrence of tissue deformation, such as compression or discoloration, associated with the movement of a patient's tissue relative to the sensor or the movement of the sensor elements relative to one another. For example, sensors are provided herein that include a flexible elastomeric body that may accommodate patient movement.

[0023] Prior to discussing such exemplary sensors in detail, it should be appreciated that such sensors may be designed for use with a typical patient monitoring system 10. For example, referring now to FIG. 1, a sensor 12 according to an embodiment may be used in conjunction with a monitor 14. In the depicted embodiment, a cable 16 connects the sensor 12 to the monitor 14. It should be appreciated that the sensor 12 and/or the cable 16 may include or incorporate one or more integrated circuit devices or electrical devices, such as a memory, processor chip, or resistor, that may facilitate or enhance communication between the sensor 12 and the monitor 14. Likewise the cable 16 may be an adaptor cable, with or without an integrated circuit or electrical device, for facilitating communication between the sensor 12 and various types of monitors, including older or newer versions of the monitor 14

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or other physiological monitors. In other embodiments, the sensor 12 and the monitor 14 may communicate via wireless means, such as using radio, infrared, or optical signals. In such embodiments, a transmission device (not shown) may be connected to the sensor 12 to facilitate wireless transmission between the sensor 12 and the monitor 14. It should be appreciated that the cable 16 (or corresponding wireless transmissions) may be used to transmit control or timing signals from the monitor 14 to the sensor 12 and/or to transmit acquired data from the sensor 12 to the monitor 14. In another embodiment, the cable 16 may be an optical fiber that enables optical signals to be conducted between the monitor 14 and the sensor 12.

[0024] The monitor 14 may be a pulse oximeter, such as those available from Nellcor Puritan Bennett LLC, and/or Covidien, or may be a monitor for measuring other body related metrics using spectrophotometric and/or other techniques. Additionally, the monitor 14 may be a multi-purpose monitor suitable for performing pulse oximetry and measurement of tissue water fraction, or other combinations of physiological and/or biochemical monitoring processes, using data acquired via the sensor 12. Measured physiological parameters may be displayed on a display 18. Furthermore, the monitor 14 may be coupled to a multi-parameter monitor 20 via a cable 22 connected to a sensor input port and/or via a cable 24 connected to a digital communication port and/or other methods or configurations.

[0025] In an embodiment, the sensor 12 includes an emitter 26 and a detector 28 which may be of any suitable type. For example, the emitter 26 may be one or more light emitting diodes adapted to transmit one or more wavelengths of light, such as in the red to infrared range, and the detector 28 may be a photodetector, such as a silicon photodiode package, selected to receive light in the range emitted from the emitter 26. The sensor 12 may transmit electrical and/or optical signals to and from the monitor 14 via the cable 16. The cable 16 may be permanently or removably coupled to the sensor 12, the latter alternative may be more useful and cost efficient in situations where the sensor 12 is disposable.

[0026] Pulse oximetry and other spectrophotometric sensors may be typically placed on a patient in a location conducive to measurement of the desired physiological parameters. For example, pulse oximetry sensors may be typically placed on a patient in a location that is normally perfused with arterial blood to facilitate measurement of the desired blood

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characteristics, such as blood oxygen saturation (SpO_2). Common pulse oximetry sensor sites may include, but is not limited to, a patient's fingertips, toes, forehead, or earlobes. Regardless of the placement of the sensor 12, the reliability of the pulse oximetry measurement may be related to the accurate detection of transmitted light that has passed through the perfused tissue and has not been inappropriately supplemented by outside light sources or modulated by subdermal anatomic structures. Such inappropriate supplementation and/or modulation of the light transmitted by the sensor may cause variability in the resulting pulse oximetry measurements.

[0027] The sensor 12 described above may be generally configured for use as a "reflectance type" sensor for use in spectrophotometric applications. Reflectance type sensors include an emitter and detector that are typically placed on the same side of the sensor site. If the sensor site is a fingertip, for example, the sensor 12 may be placed on a patient's fingertip such that the emitter and detector are positioned on the same side of the finger. Reflectance type sensors detect light photons that are scattered back to the detector. During operation, the emitter emits one or more wavelengths of light into the patient's fingertip, or other tissue, and the light received by the detector is processed to determine various physiological characteristics of the patient.

[0028] Referring now to FIG. 2, an exemplary embodiment of the sensor 12 may include a sensing component assembly 66 and a sensor body 68. The sensing component assembly 66 may include a rigid or semi-rigid casing configured to hold the emitter 26 and the detector 28 at a substantially fixed optical distance in relation to one another when the sensor 12 is applied to a patient. The emitter 26 and the detector 28 may be connected to the cable 14 by one or more wires 70. The wires 70 may be coupled to the cable 16 to enable transmission of data to and from the monitor 12 (FIG. 1).

[0029] In one embodiment, the sensor body 68 is a flexible, semi-rigid material capable of elastic deformation, or expansion. The sensor body 68 has a generally tubular shape which may be capable of conforming to a patient's digit 72, as illustrated in FIG. 3. One or more wings 74, may be separated by a lengthwise opening 75, and may be capable of securing the sensor 12 to the patient's digit 72. The wings 74 may be configured to expand laterally, indicated by arrows 76, to accommodate larger digits, swelling or edema, while remaining

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sufficiently positioned around the patient's digit 72 to ensure the sensing component assembly 66 remains generally flush with the patient's digit 72. In order to ensure that the wings 74 fit securely but comfortably around the patient's digit 72, multiple sizes of the sensor 12 may be manufactured. Additionally, to improve patient comfort, the cable 16 may have a relatively flat profile, such as a ribbon cable, and be disposed under the patient's digit 72.

[0030] The sensor body 68 may be composed of any suitable material such that the wings 74 are flexible enough to expand, yet rigid enough to secure the sensor 12 to the patient's digit 72. Additionally, the material used in the sensor body 68 may be considered semi-rigid in that, unlike a bandage sensor, the sensor body 68 may generally maintain its digit-conforming shape even when not secured to the patient's digit 72. In an embodiment, the sensor body 68 may be composed of an elastomer with a durometer of about 15-30 Shore A. In an embodiment, the sensor body 68 may be composed of a material that may be flexible and easily cleanable, such as polyurethane, santoprene, silicone thermoset, or any other medical grade elastomer, which may allow the sensor 12 to be reused. Alternatively, the sensor 12 and/or the sensor body 68 may be configured to be disposable, and the sensor body 68 may be composed of a closed cell foam elastomer or other suitable material. In addition, the sensor body 68 may be composed of a tacky material or coated with an adhesive layer, either partially or fully, to aid in securing the sensor 12 to the patient's digit 72. Furthermore, one or more adhesive layers may be included, such that when one adhesive layer is reduced in its bonding abilities, it may be removed to expose another adhesive layer with relatively greater bonding characteristics.

[0031] Environmental light may contribute to errors in physiological measurements. Therefore, it may be desirable to prevent light from the environment from reaching the detector. This environmental light may enter the sensor through gaps between the sensor body and the patient's tissue. For example, in many clip-style sensors the clip may open partially and allow invasion of environmental light when the patient's finger is bent. The sensor body 68 may be configured to minimize interference of light from outside the sensor 12. The wings 74 may be configured to prevent light from entering the sides of the sensor 12, and a lip 78 may be configured to prevent light from entering the end of the sensor 12. The sensor body 68 may also be configured such that the sensor 12 covers only the end of the

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patient's digit 72. For example, the sensor 12 may extend from the tip of the patient's digit 72 to an area short of a first digit joint 80. In this embodiment, the sensing component assembly 66 may remain securely in place and generally flush with the tissue of the patient's digit 72 even when the digit joint 80 is bent. In addition, the sensor body 68 may be configured to enable a fingernail 82 to protrude from the sensor 12 over the lip 78.

[0032] Turning now to FIG. 4, an exploded view of the sensor 12 is shown. The sensing component assembly 66 may include a casing 84 with a top 86, a bottom 88, and a lateral raised ridge 90. The sensing components, including the emitter 26, the detector 28, and any electrical components to enable their operation, may be enclosed in the casing 84. The casing 84 may be composed of any suitable rigid or semi-rigid material, such as a plastic or metal. By installing the emitter 26 and the detector 28 in a substantially rigid casing 84, they may be held at a substantially fixed optical position with respect to one another, thus limiting the modulations of detected light that may occur and the resulting measurement errors.

[0033] The casing 84 may be formed by any suitable means. In an embodiment, the top 86 and the bottom 88 may be formed separately by injection molding then coupled together to form the casing 84 around the sensing components. The top 86 and the bottom 88 may be configured such that they snap together to form the casing 84, or alternatively they may be coupled together using some form of adhesive. In another embodiment, the sensing components may be positioned within a die or mold and overmolded to form the casing 84. In addition, the casing 84 may be sufficiently water-tight that the sensor 12 and/or the sensing component assembly 66 may be washed and reused. The lateral raised ridge 90 may be configured to aid in proper positioning of the sensing component assembly 66 on the patient's digit 72 and to prevent the detector 28 from detecting scattered light from the emitter 26 that has not entered the patient's tissue.

[0034] The sensing component assembly 66 and the sensor body 68 may be coupled together by any suitable method. For example, according to one embodiment, the sensing component assembly 66 and the sensor body 68 may be manufactured separately, then coupled together. For example, the sensor body 68 may be formed by injection molding then attached to the sensing component assembly 66 adhesively, such as via an adhesive layer, or mechanically, such as via slots and tabs. In an embodiment, the sensing component assembly

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66 and the sensor body 68 may be coupled together by the user. This method and configuration may be advantageous where the sensing component assembly 66 is capable of being reused and the sensor body 68 is configured to be disposable.

[0035] In another embodiment, the sensing component assembly 66 may be positioned within a die or mold, and overmolded to attach the sensor body 68. In this embodiment, to prevent separation of the sensor body 68 from the sensing component assembly 66, the material used to form the sensor body 68 may be selected such that the sensor body 68 bonds with the sensing component assembly 66 during the overmolding process. Techniques for protecting the sensing components from excessive temperatures may be employed. For example, in an embodiment, the emitter 26 and/or the detector 28 may include respective translucent windows, such as a plastic or crystal window, adjacent the mold to prevent coating from being applied over the window. In an embodiment, the material adjacent such windows may be composed of a material, such as beryllium copper, which prevents the heat of the injection molding process from being conveyed through the windows to the sensing components. For example, in an embodiment, a beryllium copper material initially at about 40°F may be adjacent the windows associated with the emitter 26 and/or the detector 28 to prevent coating of the windows and heat transfer to the respective sensing components.

[0036] Another embodiment of a sensor 92 for use with the patient monitoring system 10 of FIG. 1 is illustrated in FIG. 5. In this embodiment, the sensor 92 may include a sensor body 94 that may be formed integrally with the sensing components, including the emitter 26, the detector 28, and any electrical components to enable their operation. For example, in an embodiment, the sensing components may be positioned within a die or mold and overmolded with the material used to form the sensor body 94, thereby forming the entire sensor 92 of a flexible material. The sensor body 94 may be composed of any suitable material, as described above in reference to FIGS. 2-4. The sensor 92 may therefore be generally a unitary, expandable, semi-rigid molded device with no crevices in which unwanted particles may accumulate.

[0037] FIG. 6 illustrates another embodiment of a sensor 96 for use with the patient monitoring system 10 of FIG. 1. In an embodiment, the sensor body 98 may be generally tubular and have a lengthwise opening 99. A top flap 100 of the sensor body 98 may be

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configured to expand vertically, as indicated by an arrow 102, to accommodate larger digits, swelling or edema. The sensor body 98 may be composed of any suitable material, as described above in reference to FIGS. 2-4. In addition, the sensor body 98 may include an opening 104 to enable protrusion of the fingernail 82 from the patient's digit 72 (FIG. 3). As with the sensors 12 and 92 illustrated in FIGS. 2-5, embodiments of the sensor 96 may include a generally rigid or semi-rigid sensing component assembly and a separate sensor body, or the sensing components may be integrated directly into the sensor body.

[0038] Further sensor improvements may also be incorporated into embodiments. For example, FIG. 7 illustrates another embodiment of a sensor 110 for use with the patient monitoring system 10 of FIG. 1. In this embodiment, the sensor 110 includes a stack of adhesive layers 112 disposed on an interior surface 114. As discussed above, incorporation of an adhesive on the interior surface 114 of the sensor 110 may further secure the sensor 110 to the patient's digit 72 (FIG. 3). However, some adhesives may lose their adhesion after repeated removal from and reapplication to a surface. Accordingly, the stack of adhesive layers 112 may allow the caregiver to remove the sensor 110, such as to check on the sensor site or move the patient, then reapply the sensor 110 with a fresh adhesive layer 112. That is, the top adhesive layer 112 may be removed to expose a fresh adhesive layer 112. Various embodiments of the adhesive layers 112 may be found in U.S. Patent No. 6,748,254, entitled "Stacked Adhesive Optical Sensor," and issued on June 8, 2004, which is herein incorporated by reference in its entirety for all purposes.

[0039] While the subject of this disclosure may be susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and have been described in detail herein. However, it should be understood that this disclosure is not intended to be limited to the particular forms disclosed. Rather, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the following appended claims. Indeed, the present techniques may not only be applied to reflectance type sensors for use in pulse oximetry, but also to retroflective and other sensor designs as well. Likewise, the present techniques are not limited to use on fingers and toes but may also be applied to placement on other body parts such as in embodiments configured for use on the ears or nose, or other locations.

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CLAIMS

What is claimed is:

1. A sensor, comprising:

an emitter and a detector, wherein the emitter and the detector are at a substantially fixed optical distance relative to one another; and

a generally expandable molded body configured to secure the emitter and the detector to a digit.

2. The sensor of claim 1, wherein the sensor is configured to secure the emitter and the detector to an end of the digit such that the sensor does not extend to a first joint of the digit.

3. The sensor of claim 1, wherein the expandable molded body is overmolded onto the emitter and the detector.

4. The sensor of claim 1, comprising a substantially rigid casing configured to house the emitter and the detector.

5. The sensor of claim 4, wherein the expandable molded body is an overmolded component capable of being affixed to the substantially rigid casing.

6. The sensor of claim 4, wherein the expandable molded body is a pre-molded component capable of being affixed to the substantially rigid casing.

7. The sensor of claim 6, wherein the pre-molded component is capable of being removably affixed to the substantially rigid casing.

8. The sensor of claim 1, wherein the expandable molded body comprises an elastomer with a durometer of about 15 to about 30 Shore A.

9. The sensor of claim 1, wherein the expandable molded body comprises a polyurethane, santoprene, silicone thermoset, medical grade elastomer, closed cell foam elastomer, and/or combinations thereof.

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10. The sensor of claim 1, comprising one or more adhesive layers adjacent an interior surface of the sensor, and configured to adhere the sensor to the digit.

11. The sensor of claim 1, wherein the sensor comprises a pulse oximetry sensor or a sensor for measuring a water fraction.

12. The sensor of claim 1, comprising a ribbon cable coupled to the emitter and the detector and capable of transmitting signals between the sensor and a monitor.

13. A sensor body, comprising a generally semi-rigid molded structure comprising a generally tubular interior and a generally lengthwise opening configured to enable expansion of the generally tubular interior to accommodate a digit.

14. The sensor body of claim 13, comprising a first opening at a first end of the semi-rigid molded structure configured to receive the digit.

15. The sensor body of claim 13, comprising a second opening at a second end of the semi-rigid molded structure configured to enable protrusion by at least a portion of the digit.

16. The sensor body of claim 13, comprising an elastomer with a durometer of about 15 to about 30 Shore A.

17. The sensor body of claim 13, comprising a polyurethane, santoprene, silicone thermoset, medical grade elastomer, closed cell foam elastomer, and/or combinations thereof.

18. A sensor body, comprising a generally flexible semi-rigid structure capable of being affixed to sensing components, and to secure the sensing components to a digit.

19. The sensor body of claim 18, wherein the generally flexible semi-rigid structure comprises a plurality of wings configured to enable expansion of the sensor body to accommodate the digit.

20. The sensor body of claim 18, wherein the generally flexible semi-rigid structure comprises a flap configured to enable expansion of the sensor body to accommodate the digit.

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21. The sensor body of claim 18, wherein the generally flexible semi-rigid structure comprises an opening configured to enable a nail of the digit to protrude therethrough.

22. The sensor body of claim 18, comprising an elastomer with a durometer of about15 to about 30 Shore A.

23. The sensor body of claim 18, comprising a polyurethane, santoprene, silicone thermoset, medical grade elastomer, closed cell foam elastomer, and/or combinations thereof.

24. A method of manufacturing a sensor, comprising overmolding a generally flexible semi-rigid sensor body around an emitter and a detector.

25. A method of manufacturing a sensor, comprising:
enclosing an emitter and a detector in a substantially rigid casing;
molding a flexible sensor body; and
coupling the substantially rigid casing adjacent the flexible sensor body.

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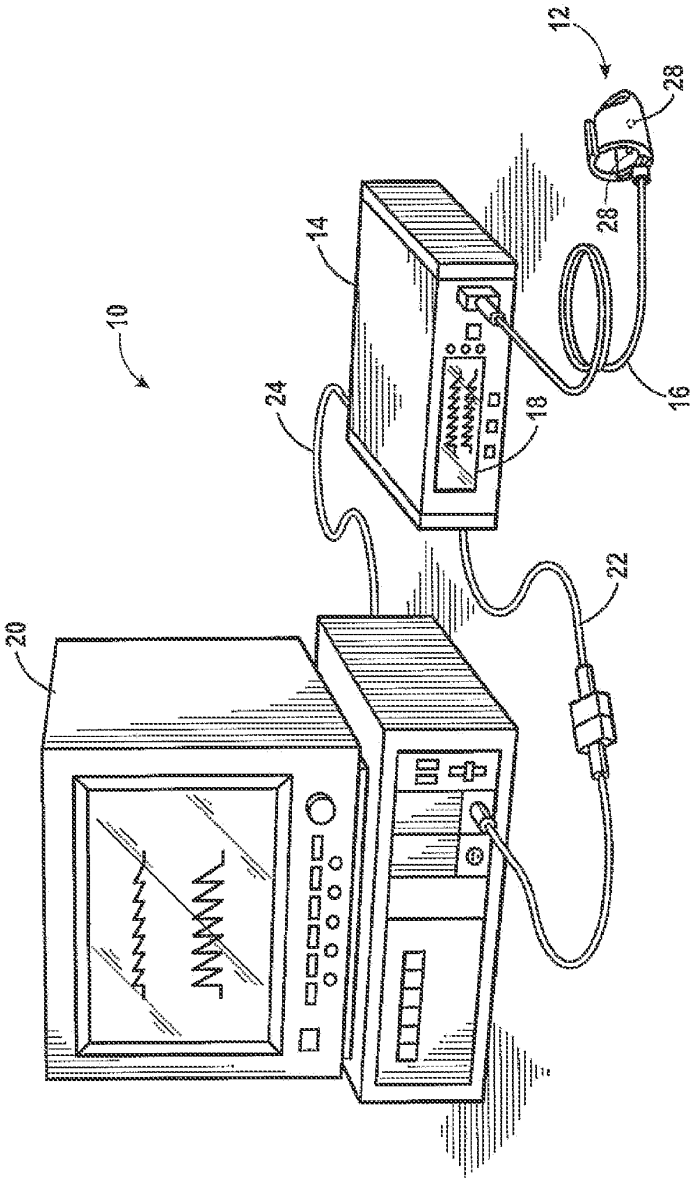


FIG. 1

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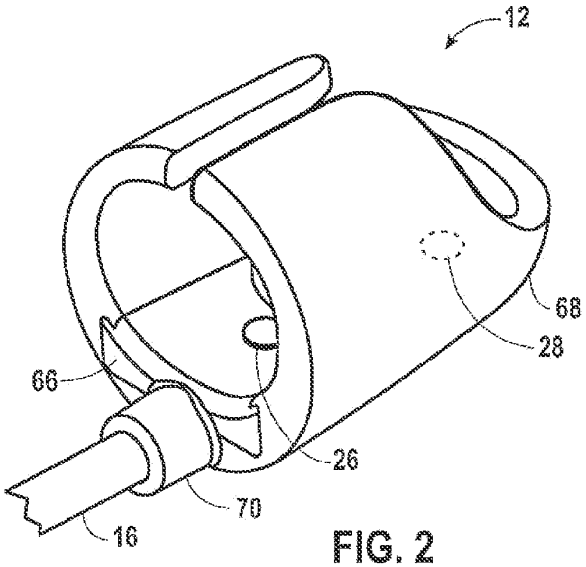


FIG. 2

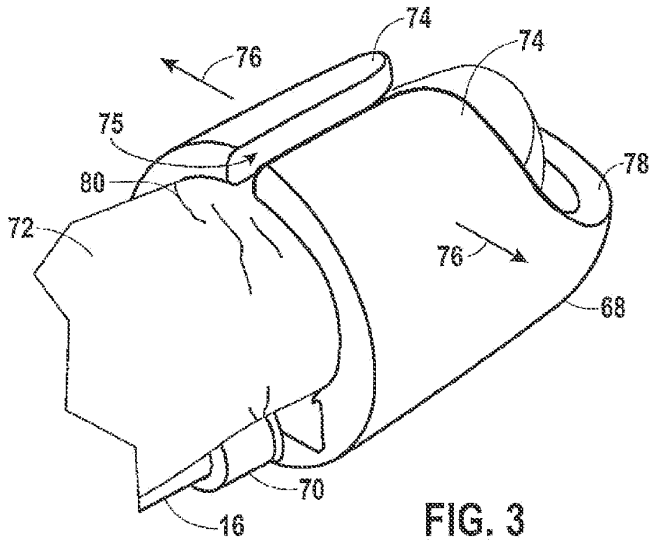


FIG. 3

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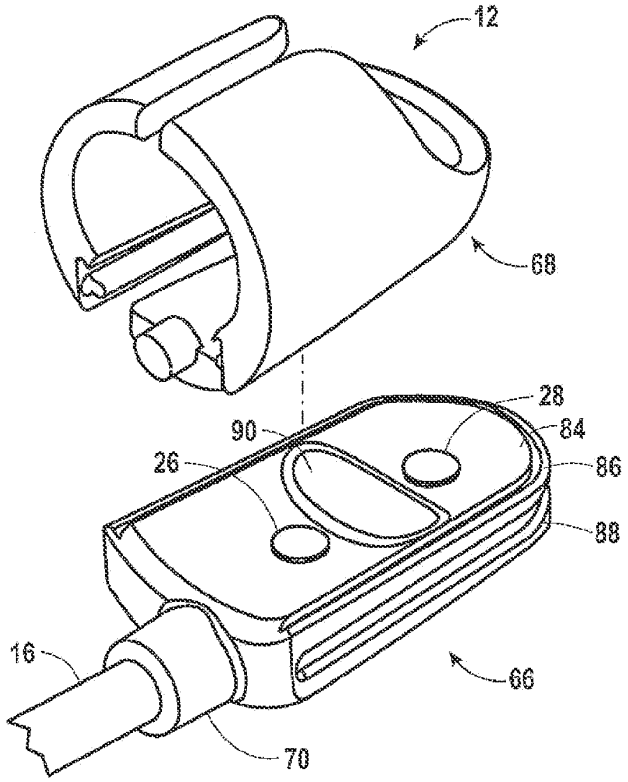


FIG. 4

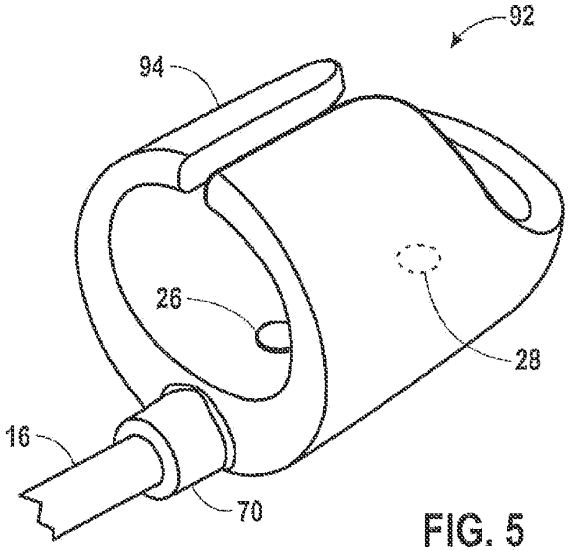


FIG. 5

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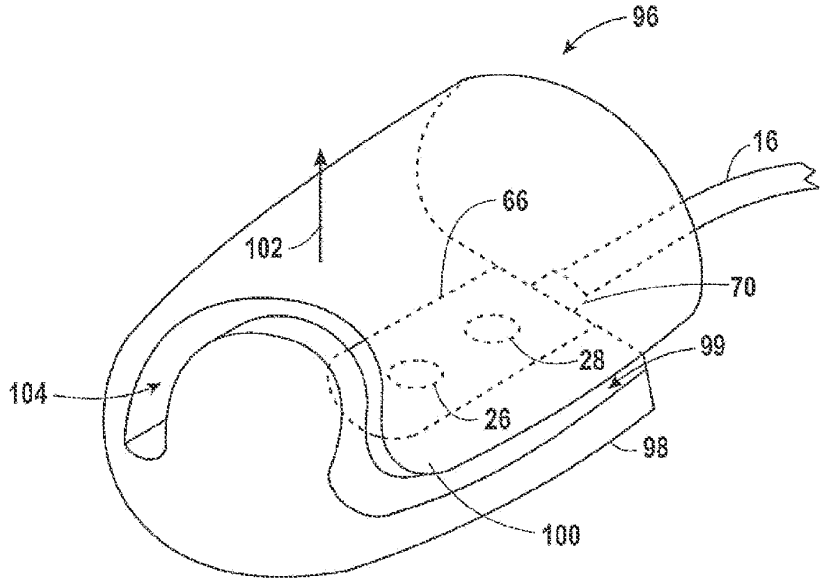


FIG. 6

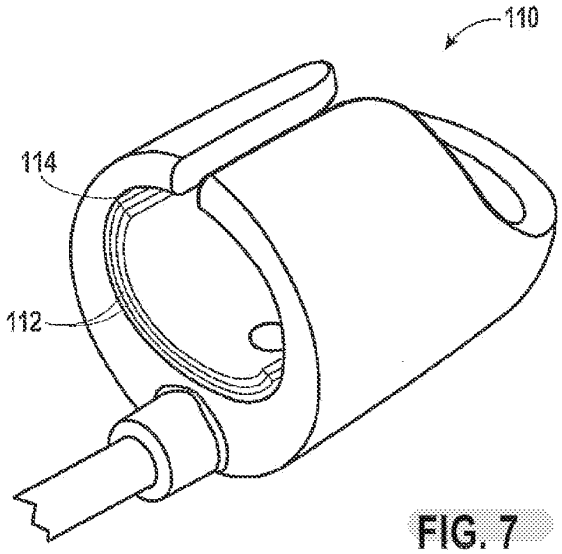


FIG. 7

Petitioner Samsung Ex-1004, 0375

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2008/086846

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B5/00
ADD. A61B5/103

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2007/019420 A (NELLCOR PURITAN BENNETT INC [US]; EGHBAL DARIUS [US]; COAKLEY JOSEPH [) 15 February 2007 (2007-02-15)	1-5,8-25
Y	abstract page 6, line 25 - page 7, line 20 page 8, line 11 - page 13, line 8 page 14, line 1 - page 15, line 9 figures 1,2,4-9	5-9, 15-17, 21-23

-/--

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 March 2009	02/04/2009

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

1

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

Petitioner Samsung Ex-1004, 0376

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2008/086846

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2007/041333 A (NELLCOR PURITAN BENNETT INC [US]; KLING CARL [US]; PALMER PHILLIP S [U) 12 April 2007 (2007-04-12) abstract	1-5, 8-14, 16-20, 22-25
Y	page 9, line 16 - page 11, line 2 page 13, line 24 - line 31 figures 5A,5B	5-9, 15-17, 21-23
X	US 2006/173247 A1 (MEDINA LILY A [US] MEDINA LILY ANJANETTE [US]) 3 August 2006 (2006-08-03) abstract paragraph [0036] - paragraph [0045]	1,2,4,6, 7,10-14, 18-20,25
Y	figures 1-4	8,9, 15-17, 21-23
X	EP 0 357 249 A (CRITIKON INC [US]) 7 March 1990 (1990-03-07) abstract	1-4,6,7, 9-14, 17-20, 24,25
Y	column 3, line 39 - column 5, line 31 column 6, line 6 - column 7, line 7 figures 1-8	5,8,15, 16,21-23

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

Petitioner Samsung Ex-1004, 0377

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2008/086846

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2007019420 A	15-02-2007	AU 2006278400 A1	15-02-2007
		CA 2618647 A1	15-02-2007
		CN 101262813 A	10-09-2008
		EP 1926421 A1	04-06-2008
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		US 2007032708 A1	08-02-2007
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WO 2007041333 A	12-04-2007	US 2007078315 A1	05-04-2007
US 2006173247 A1	03-08-2006	NONE	
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		ES 2057132 T3	16-10-1994
		GR 89100491 A	22-08-1990
		US 4825872 A	02-05-1989

Petitioner Samsung Ex-1004, 0378

Blood analyzer
List of publications
Publication date

- Application number 2002JP-0083011 Date 2002-03-25 Register
  - JP2003275192 A Published application 2003-09-30

English Title

Blood analyzer

Other Title 血液分析装置

English Abstract (Native or MT)

PROBLEM TO BE SOLVED: To resolve problems in a hemoglobin analyzer wherein a finger has to be pressed against a light receiving part by proper force for accurate measurement, a clip type has an oppressive feeling and an open type needs skill, and blood sampling causing pain to a patient is needed to measure hemoglobin A1c.
SOLUTION: By arranging light emitting parts in upper and lower sides of a holder for inserting a finger, a ball of the finger is pressed against the light receiving part by the proper force. An indicator displaying a component ratio of hemoglobin is arranged facing upward in the upper side of the holder.
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Other Abstracts

【課題】 ヘモグロビン分析装置では、正確に測定するには指を受光部に適切な力で押し当てなければならなかった。クリップタイプは圧迫感があり、オープンタイプは熟練が必要であった。また、ヘモグロビンA1cを測定するためには採血が必要で、患者には苦痛をあたえていた。

Application Language	JAPANESE (JPN)
Inventor(s)	EGAWA SHUNJI
Inventor(s)	柄川 俊二

Applicant/Assignee CITIZEN WATCH| $ 1 876 M

Assignee	シチズン時計株式会社 Reg. Nb: 1960
Applicant/Assignee Address	CITIZEN WATCH CO LTD , 1960
Patent Assignee History	CITIZEN WATCH CO LTD
Application Numbers & Dates	JP2002083011 2002-03-25 [2002JP-0083011]
Priority Numbers & Dates	JP2002083011 2002-03-25 [2002JP-0083011]

Technology domain	Measurement Medical technology

US codes history

IPC codes	G01N-021/27* A61B-005/145 A61B-005/1455 G01N-021/35 G01N-021/3577 G01N-021/359
IPC codes history	G01N-021/27* A61B-005/145 A61B-005/1455 G01N-021/35 G01N-021/3577 G01N-021/359
JP codes	A61B5/14 310 A61B5/14 322 A61B5/145 A61B5/1455 G01N21/27 Z G01N21/35 104 G01N21/35 107 G01N21/35 Z G01N21/3577 G01N21/359
F-Terms (File forming terms)	2G059 AA01; 2G059 BB13; 2G059 CC07; 2G059 CC12; 2G059 CC18; 2G059 DD13; 2G059 EE01; 2G059 EE11; 2G059 FF06; 2G059 GG02; 2G059 GG03; 2G059 HH01; 2G059 HH02; 2G059 HH06; 2G059 JJ02; 2G059 JJ26; 2G059 KK03; 2G059 MM01; 2G059 MM09; 2G059 PP04; 4C038 KK01; 4C038 KL05; 4C038 KL07; 4C038 KX04
Notes	Number of Claims: 3

Description

[0001] [Technical Field of the Invention] The present invention relates to a mounting structure for a blood analysis device that analyzes components in blood in a non-invasive manner.

[0002] [Conventional Technology] a pulse oximeter that measures oxygen saturation of arterial blood is an example of a conventional device for testing blood components without blood sampling. This is intended to non-invasively measure the percentage of hemoglobin bound to oxygen from the hemoglobin in the arterial blood, and has been used in a variety of medical settings due to the ease of use and reasonable cost of the device. For example, intra-operatively and post-operatively intensive care laboratories continuously monitor patient conditions. Home oxygen therapy has also been used to grasp the condition of patients. Emergency medicine has been used to quickly grasp the patient's body during transportation. Furthermore, it is also used to check the health status of climbing at high hills. A finger of a hand is typically used for the measurement site, but the structure of the probe and the main body attached to the finger of the measurement site varies depending on the measurement purpose and environment.

[0003] A typical pulse oximeter structure is a separate type in which the main body and the probe are separated, and the probe is a clip type in which fingers are clamped between upper and lower parts and a spring presses against the fingers. An example of this separate clip type pulse oximeter is disclosed in JP 64-500495 a. In this way, the torsion spring is attached to the cover and the base, and spring force is applied in the closing direction. Cup-shaped upper cushions and cup-shaped lower cushions are respectively attached to the cover and the base, and lightly pressing force is applied to the patient's

fingers via both cushions. In this way, the pulse oximeter must maintain a constant distance between the light receiving element and the biological tissue serving as the site of measurement, i.e., the finger, and the biological tissue. This clip type can accommodate variations in thickness when an adult finger is used. And during surgery, it was suitable for continuous monitoring of immobile patients, such as post-operatively intensive care rooms. However, clip types felt pressure when worn and lack comfort. In addition, a separate pulse oximeter has poor portability and is not suitable for single-shot measurement without requiring long measurements.

[0004] A different structure is a ring-type pulse oximeter that can live while wearing a main body and a probe in a small integrated manner. A commercially available ring pulse oximeter is one in which the ring size can be selected from three diameters 21 mm, 19 m m, and 16 mm in order to accommodate the thickness of the finger. However, with this method, it was not possible to apply an appropriate pressing force to the finger depending on the thickness of the finger, making stable measurements difficult. In addition, in this ring-type structure, the measurement site is not the tip of the finger (the tip of the finger), but rather the base of the finger (the base of the finger). as a result, the measurement site becomes thicker and does not easily receive the transmitted light, and accurate measurement cannot be performed. Furthermore, the operation of inserting and mounting a small ring type pulse oximeter at the base of the finger was not appropriate for one-time measurement, such as during emergency transport or climbing at high, which does not require long measurements.

[0005] In addition, as a further different structure, there is an open type in which the probe and the main body are integrated and there is a finger insertion hole. A commercially available open-type pulse oximeter is inserted into a right-hand second finger (index finger) insertion hole 11 and lightly grips the body with the other finger of the right hand. Then, the second finger of the measurement target object is lightly pressed against the light-receiving unit of the insertion hole. This is because oxygen saturation can be easily measured in approximately 10 seconds when measurement is performed once, and is small in size and good in portability. therefore, this is suitable for grasping of the body of a patient in an emergency and checking of the health status of climbing at a high level. Mounting the measurement site is a simple operation of simply inserting a finger into the insertion hole, but this operation requires skill in the art. If the finger is pressed too strong, pulsations will be hindered and blood flow will stop, which may not be measured. conversely, if the finger is too weak, the finger may move and be erroneously recognized as pulsatile. While holding the body, pressing the pad of the finger against the receiver with an appropriate pressing force is required to be skilled.

[0006] Hemoglobin A1c (also referred to as glycohemoglobin) is clinically used for the diagnosis and examination of diabetes in addition to oxygen saturation. This examines the state in which hemoglobin contained in red blood cells in the blood has bonded to glucose in the blood. Hemoglobin binds with glucose depending on the glucose concentration in the blood. Hemoglobin A1c then reflects the average blood glucose level of the past 1 to 2 months. In the measurement of hemoglobin A1c, venous blood of a patient was typically collected and analyzed by high-performance liquid chromatography or the like,

but this method of blood collection caused pain to the patient. In addition, the analyzer was also large and expensive.

[0007] [Problem to be Solved by the Invention] The clip type hemoglobin analyzer described above is suitable for continuous monitoring of hemoglobin components, but is not suitable for one-time measurement of oxygen saturation during emergency transport without the need for lengthening or climbing at elevated temperatures. An open-type pulse oximeter is suitable for measuring oxygen saturation in a single shot manner, but a finger must be pressed against the light-receiving part with an appropriate force in order to accurately measure oxygen saturation. Then, it has to be skilled in order to properly apply the force. Furthermore, hemoglobin A1c is measured in the diagnosis or examination of diabetes, but this is a method of blood sampling and analyzing the blood, which has caused pain to patients.

[0008] An object of the present invention is to solve the problems described above, and to be able to hold the pad of a finger against a light-receiving unit with an appropriate pressing force, without imparting a feeling of pressure to the finger tip and without requiring skilled practices. This mounting structure also provides a hemoglobin analyzer that can obtain accurate and stable analysis results.

[0009] A blood analysis device includes a housing, a holder into which a finger is inserted, a light emitting part that irradiates the finger with light, a light receiving part that receives transmitted light across the finger, a circuit that converts a photocurrent of a light receiving element in the light receiving part into a voltage and calculates a component ratio of blood, and a display device that displays the component ratio, The holder is configured such that a finger is inserted into the holder with the palm of the hand visually appearing, the light receiving element is disposed between the visually appearing side of the housing and the holder, the light emitting element is disposed between the non-visually appearing side of the housing and the holder, and the holder is pressed against the finger using gravity.

[0010] Embodiments of the present invention will be described in detail below with reference to the drawings. FIGS. 2 (a) and 2 (a) (b) are external views of a hemoglobin A1c analyzer according to an embodiment of the invention. Fig. 2 (a) (a) is a top view, and Fig. 2 (a) (b) is a side view. Fig.3 is a mounting diagram illustrating the posture at the time of measurement of the hemoglobin A1c analyzer according to the embodiment of the invention. Fig.1 is a cross-sectional view illustrating a sensor unit structure of a hemoglobin A1c analyzer according to an embodiment of the invention. Fig.4 is a block diagram of a hemoglobin A1c analyzer according to an embodiment of the invention.

[0011] First, the appearance of the hemoglobin A1c analyzer according to the present embodiment will be described using FIGS. 2 (a) and (b). This is a hemoglobin A1c analyzer for diagnosing and testing diabetes. the analyzer 10 measures the proportion of hemoglobin contained in red blood cells in the blood that has bonded to glucose in the blood. On a side surface of the analyzer 10 is an insertion hole

11 into which a measurement site is inserted, and has a substantially cylindrical shape so that a finger of a patient is inserted. A switch 12 that turns on the power source and starts analysis, and a display device 13 that displays the analysis results are provided on the top surface. Hemoglobin A1c, which is an indication of glycemic control, is displayed on the indicator 13. The housing 14 is the outer sheath of the analyzer 10 made of plastic.

[0012] Next, a method of using the hemoglobin A1c analyzer according to the present embodiment will be described using Fig.3. A finger is inserted into the insertion hole 11. Standard finger usage is performed by inserting the third finger (middle finger) of the right hand into the insertion hole 11, lightly supporting the housing 14 of the analyzer 10 with the second finger (index finger) and the fourth finger (ring finger) on both sides, and facing the palm upward. This is the standard wearing posture at the time of measurement. In this case, the biological tissue 1 to be measured is the third finger of the right hand. When the switch 12 is pressed while still in this position, the power is turned on and the analysis is initiated. For example, the switch 12 is disposed on a top surface or facing upward so that it can be easily pressed by the first finger (thumb) of the right hand. The hemoglobin A1c, which is the result of the analysis, is displayed on the indicator 13 facing upward in the same manner as the switch 12, and thus can be easily read. That is, a finger is inserted with the palm of the hand on the visually perceptible side, and the display on the display device 13 disposed on the visually perceptible side is read while the palm remains in this posture.

[0013] Next, a sensor unit structure of the hemoglobin A1c analyzer according to the present embodiment will be described using Fig.1. First, the insertion hole 11 includes a holder 27 having a substantially cylindrical shape with a closed tip, and the biological tissue 1, which is a finger, is inserted so as to abut the tip of the holder 27. The holder 27 is provided with a light-receiving filter 26 at a portion with which a finger pad makes contact, and a diffusion plate 25 at a fingernail side, which is an opposite side thereof. The diffusion plate 25 is formed of a transparent polystyrene (PS) resin or acrylic (PMMA) resin, and the light emitting elements 21, 22, and 23 are disposed in close proximity to each other behind the diffusion plate 25. The light emitting devices 21, 22, and 23 are chip-type light emitting diodes having peak emission wavelengths of λ1, λ2, and λ3, respectively. Although the light-emitting elements 21, 22, and 23 are disposed in close proximity, it is not possible to emit light from the same position. In order to minimize the error due to this, the diffuser plate 25 is inserted to convert the light into surface light emitted by the diffuser plate 25 rather than point light emitted by the chip type light emitting diodes. In this way, the influence of the optical path difference between the light emitting elements 21,22 and 23 is eliminated. Note that the light emitting elements 21, 22, and 23 and the diffusion plate 25 constitute a light emitting part.

[0014] The light-receiving filter 26 is an optical filter that transmits the emission wavelengths λ1, λ2, and λ3, but attenuates other fluorescent lamps and sunlight, and reduces the effects of external light leaking from the gap between the insertion hole 11 and the biological tissue 1. Further, the light-receiving filter 26 has a dust-proofing effect, and cleaning can be performed easily. A light-receiving element 24 is disposed behind the light-receiving filter 26. The light receiving element 24 is a

photodiode having a sensitivity wavelength range including emission wavelengths λ1, λ2, and λ3. Note that the light-receiving element 24 and the light-receiving filter 26 constitute a light-receiving unit. The light receiving element 24 is mounted on the circuit 30, and hemoglobin A1c is calculated from the change in photoelectric current due to pulsation at each wavelength. The calculation result is displayed by a display device 13 connected to the circuit 30. The indicator 13 is on the upper side of the holder 27 and faces upward, making it easy to read.

[0015] As described above, since the test subject is in a posture where the palm and the indicator 13 face upward, the receiver filter 26 naturally lightly presses against the pad of the finger inserted into the insertion hole 11 using gravity applied to the body weight of the analyzer 10. In this way, it is important that the filter 26 maintain a posture in which the pad of the finger is lightly pressed against during measurement. If pressed too hard, the blood flow is reduced and the beat cannot be accurately detected. On the other hand, when the optical position of the blood vessel becomes unstable, the contact state between the pad of the finger and the light-receiving filter 26 tends to change, and the optical position of the blood vessel becomes unstable. as a result, the optical position of the blood vessel may be erroneously recognized as a beat due to the influence of noise caused by the movement of the finger. In other words, the light-receiving filter 26 and the light-receiving part of the light-receiving element 24 are disposed between the visually perceptible side of the housing 14 and the upper side of the holder 27, and the light-emitting part is disposed on the non-visually perceptible side of the housing 14 and the lower side of the holder 27. Then, gravity is utilized to press against the pad of the finger by the holder 27.

[0016] Note that the body weight of the analyzer 10 is approximately from 50 to 100 grams, and is suitable for lightly pressing the finger pad with the light-receiving filter 26 of the light-receiving unit and the nearby holder 27. In addition, the fingers inserted into the insertion holes 11 are the third fingers of the right hand, but the present invention is not limited to these fingers. Any finger may be used as long as the finger pad is lightly pressed against the receiver filter 26.

[0017] Next, a block diagram of a hemoglobin A1c analyzer according to an embodiment of the invention will be described using Fig.4. The light-emitting elements 21, 22, and 23 that emit light of wavelengths λ1, λ2, and λ3 sequentially light up in response to the output of the light emission drive circuit 31. The finger, which is the biological tissue 1, is irradiated with light from these light-emitting elements 21,22,23. The irradiated light is absorbed by various hemoglobin types of the biological tissue 1, but is also scattered by the red blood cells. The transmitted light is received by the light receiving element 24 disposed facing each other across the biological tissue 1. Here, the emission wavelengths λ1, λ2, and λ3 are set to 630 nm, 680 nm, and 940 nm, respectively.

[0018] The photocurrent at each wavelength of the light receiving element 24 corresponds to the transmitted light amounts I1, I 2, and I3 after being attenuated by the biological tissue 1. The amplifier 32 converts the photocurrent of the light receiving element 24 into a voltage and amplifies the voltage.

Note that the amounts of transmitted light I1, I2, and I3 at each wavelength include pulsating components corresponding to pulsating fluctuations.

[0019] In the multiplexer (MPX) 33, the output signal of the amplifier 32 is divided for each wavelength of λ1, λ2, and λ3, and supplied to the band-pass filters (BPF) 34, 35, and 36. High frequency noise components included in each signal are removed from the BPF34, 35, and 36, and amplitude signals corresponding to pulsating components of the transmitted light for each of the wavelengths λ1, λ2, and λ3 in the biological tissue 1, that is, the apical volume pulse waves for each of the wavelengths are obtained.

[0020] The pulse wave detection circuits (DET) 37, 38, and 39 detect signals corresponding to amplitude values corresponding to pulsing of the transmitted light by detecting the respective output signals from the BPF34, 35, and 36. These detection signals correspond to pulsating fluctuations ΔA1, ΔA2, and ΔA3 of the transmitted light at the respective wavelengths λ1, λ2, and λ3 in the biological tissue 1, and are analog-to-digital converted data. The output signals ΔA1, ΔA2, and ΔA3 of the DET37, 38, and 39 are supplied to the calculation means 40, and the component ratio of each hemoglobin is calculated. Then, the component ratio of hemoglobin A 1 c is displayed in the display means 41. Note that the circuit 30 includes an amplifier 32, a multiplexer 33, band-pass filters 34, 35, and 36, pulse wave detection circuits 37, 38, and 39, and calculation means 40.

[0021] The above is a description of the hemoglobin A 1 c analyzer according to the present embodiment. The present invention can also be applied to a pulse oximeter that measures oxygen saturation, which is the percentage of oxyhemoglobin combined with oxygen, relative to the total hemoglobin, by a similar mounting method. Also, spectroscopic analysis has similarly developed non-invasively measuring glucose concentration in blood. The present invention can also be used in such a blood glucose measurement device. Furthermore, the present invention can also be used in blood analysis devices for lipids and the like in blood.

[0022] [Effect of the Invention] As described above, according to the present invention, regardless of the thickness of a finger, whether the finger is thick or thin, the light-receiving unit can be pressed against the pad of the finger with an appropriate pressing force. In addition, there is no need for skilled practices to mount the finger, and the pressing force of the pad of the finger can be easily maintained constant. By pressing the pad of the finger with an appropriate force in this manner, the pulsatile component of the transmitted light of the living body can be accurately measured, and the component ratio of hemoglobin can be accurately determined. When oxygen saturation is measured during emergency transport or during climbing at high climbing or the like, and when hemoglobin A1c is measured at home without having to be measured for a long time, accurate measurement can be performed without being affected by the degree of skill in the patient. In addition, since the probe structure is simplified, a compact and inexpensive structure is achieved. In addition, there is an effect that the measurement can be performed comfortably without a feeling of pressure.

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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
31 October 2013 (31.10.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/163326 A1

(51) International Patent Classification:
H04L 29/08 (2006.01) *G06Q 30/00* (2012.01)
H04W 4/00 (2009.01)

(21) International Application Number:
PCT/US2013/038038

(22) International Filing Date:
24 April 2013 (24.04.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

61/637,834	24 April 2012 (24.04.2012)	US
61/670,226	11 July 2012 (11.07.2012)	US
61/693,169	24 August 2012 (24.08.2012)	US
61/701,457	14 September 2012 (14.09.2012)	US
61/713,239	12 October 2012 (12.10.2012)	US
61/716,373	19 October 2012 (19.10.2012)	US
61/717,964	24 October 2012 (24.10.2012)	US
61/728,677	20 November 2012 (20.11.2012)	US
61/745,395	21 December 2012 (21.12.2012)	US
61/745,308	21 December 2012 (21.12.2012)	US
13/773,336	21 February 2013 (21.02.2013)	US
13/773,379	21 February 2013 (21.02.2013)	US
13/833,227	15 March 2013 (15.03.2013)	US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP,

[Continued on next page]

(54) Title: SYSTEM FOR DELIVERING RELEVANT USER INFORMATION BASED ON PROXIMITY AND PRIVACY CONTROLS

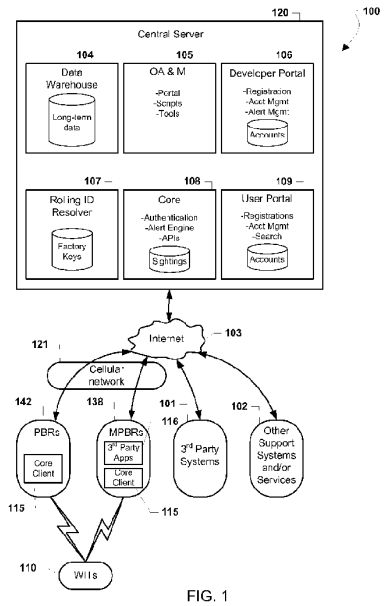


FIG. 1

(57) Abstract: Methods, systems and devices for providing relevant user information to devices within proximity of a user. A wireless identity transmitter associated with the user periodically broadcasts messages that include obscured identifiers. A proximate proximity broadcast receiver may receive and relay the broadcast messages to a central server which may process the included information. Based on categories related to the proximity broadcast receiver and the user, the central server may identify subsets of stored profile information about the user that are relevant to the proximity broadcast receiver. The central server may transmit relevant profile information to devices to assist in activities associated with the proximity broadcast receiver. In an embodiment, the central server may only transit relevant profile information that is authorized by the user via permissions associated with the profile. Further, the central server may transmit payment authentication profile information for use by point-of-sale devices within proximity of the user.

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KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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

Published:

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

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

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SYSTEM FOR DELIVERING RELEVANT USER INFORMATION BASED ON PROXIMITY AND PRIVACY CONTROLS

RELATED APPLICATIONS

[0001] The present application is a continuation-in-part of and claims priority to U.S. Patent Application No. 13/773,379, titled "Platform for Wireless Identity Transmitter and System Using Short-Range Wireless Broadcasts," filed February 21, 2013 and U.S. Patent Application No. 13/773,336, titled "Preserving Security By Synchronizing a Nonce or Counter Between Systems," filed February 21, 2013, each of which claims the benefit of priority to U.S. Provisional Application No. 61/601,620 , filed February 22, 2012, U.S. Provisional Application No. 61/637,834, filed April 24, 2012, U.S. Provisional Application No. 61/693,169, filed August 24, 2012, U.S. Provisional Application No. 61/670,226, filed July 11, 2012, U.S. Provisional Application No. 61/701,457, filed September 14, 2012, U.S. Provisional Application No. 61/713,239, filed October 12, 2012, U.S. Provisional Application No. 61/716,373, filed October 19, 2012, U.S. Provisional Application No. 61/717,964, filed October 24, 2012, U.S. Provisional Application No. 61/728,677, filed November 20, 2012, and U.S. Provisional Application No. 61/745,395, filed December 21, 2012, U.S. Provisional Application No. 61/745,308, filed December 21, 2012, the entire contents of all of which are hereby incorporated by reference.

BACKGROUND

[0002] Efficient, directed customer service is often difficult for merchants, retailers, and other businesses to accomplish. For market or service models that utilize numerous locations and customer service representatives, merchants may not be able to immediately address and attend to customers with seamless, "high touch" service. In particular, counter staff, waiters, and attendants may have to conduct "cold start" interactions with customers to learn the customers' identities, preferences, and particular needs. For example, customer service personnel may

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have to ask many questions of customers to discover preference information, such as favorite colors/styles of clothing, sizing information, shoe size, and other essential data related to the customers' experience. Merchants may benefit from an automated process that provides such customer information to expedite, customize, and improve dining, shopping, and other service experiences.

[0003] Further, when customers do provide essential customer information, merchants may access non-essential customer information that is unnecessary for serving the customer. For example, to meet with state alcohol licensing regulations, a bartender may request to see a customer's driver's license to confirm a legal drinking age and, as a result, may view the customer's address and other unrelated personal information. Customers may desire a more controlled manner of delivering personal information to services that protects privacy by only disclosing information authorized by the customers.

[0004] Additionally, retailers, merchants, and payment providers are trying to innovate around new payment technologies and processes utilizing mobile devices and enhanced foot traffic metrics. A key problem these providers are trying to solve involves hands-free payment via proximity. Currently providers are using global positioning systems (GPS) and near-field communication (NFC) to try to achieve a hands-free payment authentication system, but each technology has its own advantages and disadvantages. In particular, some providers may use geofencing GPS technology to establish a virtual fence, however GPS geofencing requires a much larger radius that what is necessarily ideal for a payment engagement. For example many providers may use a geofence radius of 300 feet which may place a customer into a point-of-sale system for payment engagement when he/she is not even located within the retail store. Additionally problematic, in an area with numerous closely positioned retailers (e.g., a mall), retailer geofences may overlap and cause a customer to be in proximity for payment engagement at many merchants' stores at the same time. Further, due to various interferences, GPS does not work well within buildings. NFC systems may provide more granular proximity detections useful

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for hands-free payment engagements. However, NFC may utilize too small a proximity for hands-free payments (e.g., less than one foot radius), and NFC devices used in payment engagements may need to be pulled out and bumped or come very close to point-of-sale devices (e.g., cash registers, etc.).

SUMMARY

[0005] The various embodiments provide systems, devices, and methods for dynamically providing relevant user information to devices within proximity of a user, such as a customer within a retail store. In general, a compact wireless identity transmitter associated with a registered user (or customer) may be configured to broadcast messages that include a unique and secure identification code via a short-range wireless radio, such as a Bluetooth® Low Energy (LE) transceiver. The identification broadcast packets ("broadcast messages") may be received by physically proximate proximity broadcast receivers (PBR), which may be dedicated receivers, smartphones configured with a PBR application, tablet computers configured with a PBR application, and stationary receivers, to name just a few examples. The broadcast messages may be received by proximity broadcast receivers when the wireless identity transmitter is within reception range (e.g., within 0 to 25 feet). Proximity broadcast receivers may be mobile (e.g., smartphones configured with a PBR application) or stationary. Stationary proximity broadcast receivers may be positioned in strategic locations, such as in a movie theater, in or near stores within a shopping mall, at various locations within an amusement park, near doors of a house, and near particular product displays within a retail store. Because the wireless identity transmitter broadcasts short-range wireless signals, the proximity of the wireless identity transmitter to the areas may be recognized by reception of the signals by a proximity broadcast receiver located in the area. As the user travels through the place (e.g., a retail store), the proximity broadcast receivers may receive broadcast messages from user's wireless identity transmitter.

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[0006] Proximity broadcast receivers may relay received broadcast messages, along with other information (e.g., timestamp data, proximity information, etc.), to a central server in the form of sighting messages. Such a central server may use the information received in sighting messages to track the wireless identity transmitter, and thus a user associated with that device. The central server may maintain a database of relayed information that may represent both historical and actively updated information for the customer's wireless identity transmitter, such as proximities to proximity broadcast receivers and/or point-of-sale devices over a period. The central server may use the identification code within the relayed messages to identify the wireless identity transmitter, and thus the user of the device.

[0007] Once the user is identified as being within proximity of a proximity broadcast receiver, the central server may be configured to identify profile information associated with the user and relevant to the proximity broadcast receiver and/or a registered service deploying the proximity broadcast receiver. For example, the central server may identify information indicating the user's food preference as relevant to a restaurant deploying the proximity broadcast receiver. In various embodiments, the central server may compare information within profiles associated with both the user and the registered service related to the proximity broadcast receiver to identify relevant or matching profile information. The central server may transmit such relevant profile information to the proximity broadcast receiver or another device associated with the proximity broadcast receiver (e.g., another computing device within the same restaurant). In this way, the central server may not divulge the entirety or unnecessary information within the user's stored profile, and thus third-parties, such as stores and restaurants, may only gain access to information on a "need-to-know" basis. In various embodiments, the user may provide permissions (or permissions settings) that are stored and used by the central server to protect the privacy of the user. For example, the central server may only identify and transmit profile information that is authorized by the user for transmission to a particular store or

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type of business. Thus, the user may provide his/her information only when a possible recipient may need the information and is authorized to receive it by the user.

[0008] In another embodiment, the central server may identify and transmit profile information that may be used to authenticate payments related to the user. The central server may determine when the user is within proximity of a point-of-sale device within a place, such as a cash register device within a retail store, and may transmit payment-related profile information to the point-of-sale device. For example, the central server may transmit a photograph or signature sample of the user to a device for verification by a cashier. Transmitting payment authentication information authorized by the user for delivery may promote proximity payment authentication services, such as identification confirmation, queuing for proximity payments, and expedited payment for goods while in line at a cash register

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The accompanying drawings, which are incorporated herein and constitute part of this specification, illustrate exemplary embodiments of the invention, and together with the general description given above and the detailed description given below, serve to explain the features of the invention.

[0010] FIG. 1 is a system diagram illustrating network components suitable for use in various embodiments.

[0011] FIG. 2 is a communication system diagram illustrating network components of embodiment architectures suitable for use in various embodiments.

[0012] FIG. 3 is a process flow diagram illustrating an embodiment method for broadcasting an identifier from a wireless identity transmitter.

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[0013] FIG. 4 is a process flow diagram illustrating an embodiment method for a wireless identity transmitter receiving configuration settings after performing boot-up operations.

[0014] FIG. 5 is a process flow diagram of an embodiment method for a wireless identity transmitter performing two-way wireless communications with a proximity broadcast receiver.

[0015] FIG. 6 is a component diagram illustrating various modules within a mobile proximity broadcast receiver suitable for use in various embodiments.

[0016] FIG. 7 is a process flow diagram illustrating an embodiment method of a mobile proximity broadcast receiver relaying a wireless identity transmitter's identifier along with other data such as a time or location.

[0017] FIG. 8 is a call flow diagram for responding to a user request for a wireless identity transmitter's location in accordance with various embodiments.

[0018] FIG. 9 is a process flow diagram illustrating an embodiment method of performing code within a received broadcast message.

[0019] FIG. 10 is a process flow diagram illustrating an embodiment method of receiving an instruction from a central server in response to transmitting a sighting message based on proximity to a wireless identity transmitter.

[0020] FIG. 11 is a process flow diagram illustrating an embodiment method for a proximity broadcast receiver relaying a received broadcast message to and receiving a return message from a central server.

[0021] FIG. 12 is a component diagram illustrating various modules within a central server suitable for use in various embodiments.

[0022] FIG. 13 is a diagram illustrating a wireless identity transmitter registration process for use in various embodiments.

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[0023] FIGS. 14A and 14B are process flow diagrams illustrating embodiment methods for a central server to process sighting messages received from proximity broadcast receivers.

[0024] FIGS. 15A-B are call flow diagrams illustrating communications between a wireless identity transmitter, a proximity broadcast receiver, and a central server in accordance with various embodiments.

[0025] FIG. 16 is a process flow diagram illustrating an embodiment method for a central server receiving sighting messages from a proximity broadcast receiver and transmitting return messages including various data.

[0026] FIG. 17 is a process flow diagram illustrating an embodiment method for a central server determining whether a proximity broadcast receiver has lost a wireless identity transmitter.

[0027] FIGS. 18A and 18C are communication system diagrams of mobile proximity broadcast receivers in communication with a wireless identity transmitter.

[0028] FIGS. 18B and 18D are process flow diagrams illustrating embodiment methods for determining the location of the wireless identity transmitter in the communication systems illustrated in FIGS. 18A and 18C, respectively.

[0029] FIG. 19 is a process flow diagram illustrating an embodiment method for a server handling a rolling identifier.

[0030] FIG. 20 is a process flow diagram illustrating embodiment operations by a wireless identity transmitter and a central server for transmitting and processing rolling identifiers encrypted with an encryption algorithm.

[0031] FIG. 21A is a process flow diagram illustrating an embodiment method for a wireless identity transmitter generating and broadcasting rolling identifier payloads using an encryption algorithm.

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[0032] FIG. 21B a process flow diagram illustrating an embodiment method for a central server receiving and handling rolling identifier payloads using an encryption algorithm.

[0033] FIG. 22 is a process flow diagram illustrating embodiment operations by a wireless identity transmitter and a central server for transmitting and processing rolling identifiers using a pseudo-random function.

[0034] FIG. 23A is a process flow diagram illustrating an embodiment method for a wireless identity transmitter generating and broadcasting rolling identifier payloads using a pseudo-random function.

[0035] FIG. 23B a process flow diagram illustrating an embodiment method for a central server receiving and handling rolling identifier payloads using a pseudo-random function.

[0036] FIG. 24A is a process flow diagram illustrating an embodiment method for a wireless identity transmitter generating and broadcasting messages with rolling identifiers and encoded counters.

[0037] FIGS. 24B-24C are process flow diagrams illustrating embodiment methods for a central server receiving and handling messages including rolling identifiers and encoded counters.

[0038] FIG. 25 is a diagram illustrating an embodiment scenario including a wireless identity transmitter in communication with a proximity broadcast receiver, and a mobile device displaying information received from a central server.

[0039] FIGS. 26A-26B are process flow diagrams illustrating embodiment methods for a central server to transmit relevant profile information to a computing device.

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[0040] FIGS. 27A-27B are diagrams illustrating embodiment data tables that include a user's profile information that may be stored by a central server and transmitted in response to receiving a sighting message.

[0041] FIGS. 28A-28B are diagrams illustrating various proximity broadcast receivers and a mobile device receiving different authorized information based on related profiles.

[0042] FIG. 28C is a process flow diagram of an embodiment method for a central server to identify authorized data to share based on two different profiles.

[0043] FIGS. 29A-29B are diagrams illustrating a first mobile device sharing authorized profile information in response to receiving short-range wireless signals from a second mobile device within proximity.

[0044] FIG. 29C is a process flow diagram of an embodiment method for a first mobile device to share authorized profile information in response to receiving short-range signals from a second mobile device within proximity.

[0045] FIG. 30 is an illustrative display of payment authentication information on a local computing device in accordance with an embodiment.

[0046] FIG. 31 is a process flow diagram of an embodiment method for a central server to transmit payment authentication information in response to receiving a sighting message from a proximity broadcast receiver within a retail store.

[0047] FIGS. 32A-32C are process flow diagrams of embodiment methods for a local computing device to utilize payment authentication information to conduct transactions within a retail store.

[0048] FIGS. 33A-33B are component block diagrams of wireless identity transmitters in accordance with various embodiments.

[0049] FIGS. 34A-34B are component block diagrams of proximity broadcast receivers in accordance with various embodiments.

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[0050] FIG. 35 is a component block diagram of a mobile device suitable for use in various embodiments.

[0051] FIG. 36 is a component block diagram of a server device suitable for use in various embodiments.

DETAILED DESCRIPTION

[0052] The various embodiments will be described in detail with reference to the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts. References made to particular examples and implementations are for illustrative purposes, and are not intended to limit the scope of the invention or the claims.

[0053] The word "exemplary" is used herein to mean "serving as an example, instance, or illustration." Any implementation described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other implementations.

[0054] The term "mobile device" is used herein to refer to any one or all of cellular telephones, smart-phones (e.g., iPhone®), web-pads, tablet computers, Internet enabled cellular telephones, WiFi enabled electronic devices, personal data assistants (PDA's), laptop computers, personal computers, and similar electronic devices equipped with a short-range radio (e.g., a Bluetooth® radio, a Peanut® radio, a WiFi radio, etc.) and a wide area network connection (e.g., an LTE, 3G or 4G wireless wide area network transceiver or a wired connection to the Internet). Reference to a particular type of computing device as being a mobile device is not intended to limit the scope of the claims unless a particular type of mobile device is recited in the claims.

[0055] The term "broadcast message" is used herein to refer to short-range wireless broadcast signals broadcast by wireless identity transmitters (defined below) that may include identification information (i.e., identifiers) associated

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with the wireless identity transmitters and/or their users. Such identifiers may be periodically changed and encrypted, encoded, or otherwise obscured (i.e., rolling identifiers). In various embodiments, broadcast messages may include other identifying information, such as Bluetooth® MAC addresses and counters, which may also be encrypted. Additionally, broadcast messages may include metadata and other data, such as characteristics of the transmitting wireless identity transmitter (e.g., device type), sensor data, and/or commands or other instructions. In various embodiments, broadcast messages may be transmitted via a wireless communication protocol, such as Bluetooth® Low Energy, WiFi, WiFi Direct, Zigbee®, Peanut®, and other RF protocol. In various embodiments, because of the high unreliability of certain short-range transmission channels, broadcast messages may be single packet transmissions limited to a certain size (e.g., 80 bits, 10 bytes, 20 bytes, etc.). For example, the payload of an embodiment broadcast message may be 80 total bits, including 4 bits that indicate battery status information and 76 bits that indicate a rolling identifier. As another example, an embodiment broadcast message may include 20 bits representing a counter and 60 bits representing a rolling identifier, such as generated with a pseudo-random function or encryption algorithm.

[0056] The term "wireless identity transmitter" is used herein to refer to a compact device configured to periodically transmit broadcast messages via short-range wireless transmitters. Wireless identity transmitters may be mobile, such as when carried or affixed to mobile persons or items, or alternatively may be stationary, such as when installed within buildings. Wireless identity transmitters may store and be associated with a unique device identifier (i.e., a "*deviceID*"), such as a factory ID. In an embodiment, the unique device identifier may be a code 56-bits in length. In various embodiments, for security purposes, this unique device identifier, along with other data (e.g., counter values), may be encoded, encrypted, or otherwise obfuscated when included within broadcast messages as a "rolling identifier." Wireless identity transmitters may be configured to maintain inaccurate time (e.g., UTC) information, such as by using

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a 30 ppm 16 kHz crystal oscillator as a clock. In an embodiment, the wireless identity transmitter may be within or a mobile device, or alternatively, operations may be performed by a mobile device that are similar to the operations of the wireless identity transmitter. For example, a smartphone may execute software that configures that smartphone to utilize its Bluetooth® radio to transmit broadcast messages that include a secured, unique identifier. Wireless identity transmitters are described in more detail below with reference to FIGS. 33A-33B. In various figures and diagrams of this disclosure, wireless identity transmitters may be referred to as "WIT" or "WITs".

[0057] The term "proximity broadcast receiver" is used herein to refer to devices that are configured to receive broadcast messages, such as transmitted by wireless identity transmitters. In various embodiments, proximity broadcast receivers may be stationary devices (or "stationary proximity broadcast receivers") permanently positioned throughout places (e.g., buildings, retail stores, etc.) or alternatively may be mobile devices configured to operate as proximity broadcast receivers (or "mobile proximity broadcast receivers"). For example, a smartphone may be configured to receive broadcast messages and operate as a mobile proximity broadcast receiver. Reference to a particular type of computing device as being a proximity broadcast receiver is not intended to limit the scope of the claims unless a particular type of device is recited in the claims. Further, unless otherwise indicated, references to proximity broadcast receivers throughout this disclosure are not intended to limit any method or system to a particular type of proximity broadcast receiver device (e.g., wireless or stationary). Proximity broadcast receivers are described in more detail below with reference to FIGS. 34A-34B. In various figures and diagrams of this disclosure, proximity broadcast receivers may be referred to as "PBR" or "PBRs," and mobile proximity broadcast receivers are referred to in the figures as "MPBR" or "MPBRs."

[0058] The terms "identity transceiver" and "wireless identity transceiver" are used herein to refer to devices that are configured to receive and transmit

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broadcast messages. In other words, an identity transceiver may function as both a proximity broadcast receiver and an identity transmitter. For example, a smartphone may be configured to broadcast short-range signals that include its unique identifier as well as receive broadcast messages from wireless identity transmitters within proximity. Throughout this disclosure, various operations may be described as being distinctly performed by either a wireless identity transmitter or a proximity broadcast receiver, however, those skilled in the art should appreciate that a device configured to operate as an identity transceiver may be configured to perform any or all of the same operations and thus may be interchangeable with references to either a wireless identity transmitter or a proximity broadcast receiver.

[0059] The term "sighting message" is used herein to refer to reports, signals, and/or messages sent by proximity broadcast receivers to a central server in response to receiving broadcast messages from wireless identity transmitters. Sighting messages may be transmissions that include part or all of the information encoded in received broadcast messages, including any obscured or encrypted information, such as identifiers of wireless identity transmitters. Additionally, sighting messages may include metadata and other information (or "associated data"), such as the sending proximity broadcast receivers' identification information (e.g., device ID, third-party affiliations, etc.), whether the proximity broadcast receiver paired with a wireless identity transmitter, transmissions context information (e.g., a code indicating the sighting message is related to an alert or a registered service), information regarding software or applications executing on proximity broadcast receivers (e.g., app IDs), location information, proximity information with respect to known areas within a place, and timestamp data. In an embodiment, sighting messages may also include authentication information (e.g., secret keys, passes, special codes, digital certificates, etc.) that may be used by a central server to confirm the identification (or identification information) of proximity broadcast receivers transmitting the sighting messages. For example, a sighting message may

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include a code from a hash function that can be decoded by the central server to ensure the sending proximity broadcast receiver is associated with a particular registered service. In various embodiments, sighting messages may be sent immediately after receipt of broadcasts (e.g., when related to an alert), buffered, or scheduled along with other scheduled transmissions.

[0060] The various embodiments provide methods, devices, and systems for dynamically providing user profile information to computing devices within proximity of a wireless identity transmitter associated with a user in a trusted architecture. Using a proximity-based signaling system, the embodiments provide mechanisms for delivering user profile information as permitted by the user to the organization where the user is standing in a manner that can be trusted by both the user and the recipient, such as a merchant. For example, when a user approaches a proximity broadcast receiver, such as at a merchant check out counter, that proximity broadcast receiver receives signals broadcasted by the user's wireless identity transmitter. The proximity broadcast receiver relays identity information obtained from the received broadcast signal in a sighting message sent to a central server trusted that by both the user and the merchant. The central server uses the identity information received in the sighting message to access a data record that includes user profile information (e.g., photo, name, address, credit card numbers, etc.). The central server may send a portion of the user's profile information, selected based on user privacy settings and permissions, to a merchant computing device, such as a computing device near or coupled to the proximity broadcast receiver. Since the central server is trusted by the merchant and the user profile information is sent to the merchant only when the user is close to the proximity broadcast receiver, the merchant can rely on the profile information to complete a transaction with the user.

[0061] In various embodiments, the wireless identity transmitter may be a compact device configured to transmit a packet with an identification code in a format that can be received by any proximity broadcast receiver within range of the short-range wireless broadcast. Since the wireless identity transmitter relies

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on relatively short-range wireless signaling (e.g., short-range radio signals, Peanut®, Zigbee®, RF, WiFi, Bluetooth® Low Energy signals, light signals, sound signals, etc.) to transmit broadcast messages that include its identifier, only proximity broadcast receivers within proximity of the transmitter may receive such broadcast messages. Thus, a proximity broadcast receiver's own location may provide an approximate location for the wireless identity transmitter at the time of receipt of a broadcast message. Wireless identity transmitters may be deployed by various parties registered with the central server, such as government agencies, merchants, retailers, and stores. In an embodiment, the broadcast range of wireless identity transmitters may be three or less to one hundred feet while within a retail store.

[0062] Proximity broadcast receivers, in particular mobile proximity broadcast receivers (e.g., smartphones, etc.), may be configured with processor-executable instructions, such as an application that users may download or that may be incorporated in the device by the manufacturer. By configuring many mobile devices with such an application, a wide spread network of proximity broadcast receivers may be deployed for little or no cost, taking advantage of the popularity of smartphones. Stationary proximity broadcast receivers may be deployed in strategic places, such as throughout retail stores, to supplement the network of smartphones. Proximity broadcast receivers may be located coincident to, within, or otherwise within proximity of certain areas within a place, such as merchandise displays in a move theater, point-of-sale devices, or an entrance to a retail store. For example, a proximity broadcast receiver may be on top of, next to, or within a product display arranged within a product aisle. Point-of-sale devices may coincide with either stationary proximity broadcast receivers or wireless identity transmitters deployed within an area (e.g., a retail store) to detect nearby customers. For example, a cash register device may coincide with a wireless identity transmitter that broadcasts messages related to a merchant.

[0063] Each proximity broadcast receiver receiving a broadcast message from the wireless identity transmitter may pass information to a central server for

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processing, such as by transmitting sighting messages including the rolling identifier of the wireless identity transmitter. Sighting messages transmitted by proximity broadcast receivers to the central server may include part or all of the information encoded in received broadcast messages from proximate wireless identity transmitters, including any rolling, obscured, or encrypted information related to the wireless identity transmitters. In various embodiments, sighting messages may be sent immediately after receipt of broadcast message (e.g., when related to an alert), buffered, scheduled along with other scheduled transmissions, or otherwise based on characteristics of broadcast message. Sighting messages may include metadata, header information, or other encodings to indicate various reported data. For example, a sighting message may contain metadata that includes a code for a particular merchant, and may therefore indicate that the sighting message was transmitted by a proximity broadcast receiver within the merchant's store. As another example, a sighting message may contain metadata that includes a code indicating a user's smartphone and therefore the proximity broadcast receiver may be a mobile proximity broadcast receiver belonging to the user. In an alternative embodiment, a local computing device, such as a retail store server or router, may receive sighting messages from proximity broadcast receivers and may in turn pass each sighting message to the central server.

[0064] Upon receipt of sighting messages, the central server may decode, decrypt, or otherwise access obscured information (e.g., rolling identifiers) within the sighting messages. For example, the central server may decode a broadcast message within a sighting message and determine the customer associated with the broadcast message using data stored within a registration database. Based on the location of a proximity broadcast receiver that transmitted a sighting message, the central server may determine the proximity of the related broadcast message, or the approximate proximity. For example, since a stationary proximity broadcast receiver that transmits a sighting message is within proximity of a customer's wireless identity transmitter at the time of receiving a broadcast message, the central server may determine the customer's

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wireless identity transmitter is within several feet of the GPS coordinates indicated in the proximity broadcast receiver's sighting message or known to the central server in the case of fixed proximity broadcast receivers. Further, the central server may be configured to transmit messages in response to receiving and processing sighting messages. For example, the central server may transmit return messages to devices associated with a merchant/retailer/store, such as a store server, a point-of-sale device (e.g., a cash register device), a mobile device or other computing device used by an employee of the merchant (e.g., a tablet device used by a waiter/hostess/customer service rep, etc.), and/or a proximity broadcast receiver associated with the merchant (e.g., a stationary proximity broadcast receiver that relayed the broadcast signal from the customer's wireless identity transmitter).

[0065] In various embodiments, the central server may serve as a trusted "middle-man" that delivers certain profile information to devices associated with registered services (e.g., retailers, merchants, marketing services), and only when the user's wireless identity transmitter is in proximity with a proximity broadcast receiver of the registered service. In other words, the central server may act as an indirection mechanism that transmits subsets of a user's profile when the user is within proximity of a registered service's devices. The central server may store profiles (or profile information) of users received during registration procedures. For example, a user may be required to submit personal information to the central server when activating a wireless identity transmitter and/or a mobile proximity broadcast receiver. During such a registration, users may indicate various profile information describe the users' interests, personal demographics or personal information (e.g., race, gender, age, etc.), characteristics, issues, needs, wants, and preferences regarding various topics. For example, profile information may include a user's birth date, residence, medical information, health conditions (e.g., food allergies), age, customer preferences, and clothing size information (e.g., shirts, pants, shoes, etc.). As another example, profile information may indicate preferences for certain products, colors, styles, brands, sellers, stores,

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communities, websites, shopping experiences (e.g., how to be approached by salespersons), foods, beverages, and automobiles.

[0066] The central server may categorize or otherwise label all profile information associated within user profiles. For example, individual pieces of data provided by a customer may be labeled as relating to "Food," "Clothes," "Entertainment," "Personal," "Health," "Politics," etc. The types of categories may be simple, discrete headings (e.g., "Shopping") and/or may include detailed sub-categories/groups (e.g., Shopping->Shoes->Sandals). In an embodiment, the central server may obtain (or "scrape") profile information from other databases or online services users may be affiliated with or use to store personal information. For example, the central server may perform operations to receive preference information, shopping history, personal data, and other historical information about the user from shopping accounts or websites, such as an Amazon shopping profile/account, or social networking accounts, such as a Facebook, LinkedIn, MySpace, or FourSquare account.

[0067] In an embodiment, the profile information may be continually updated based on scheduled operations by the central server (e.g., the central server may query an Amazon account daily to detect shopping patterns or preferences) and/or from received sighting messages associated with the user. For example, the central server may determine the user was last in a certain restaurant based on broadcast signals being received by stationary proximity broadcast receivers within that restaurant. Additionally, the central server may determine profile information based on the user's behavior over time. For example, the central server may store indicators that the user prefers a certain sporting team based on recorded attendance at a sporting event.

[0068] In various embodiments, the central server may determine categories describing profile information based on predefined relationships. For example, a certain profile creation question presented to the user during registration may be related to a "Job" category. Users may also manually modify and/or set

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categories for profile information stored within the central server. Further, the central server may process stored profile information using natural language processing to determine the nature or topic of particular data within a profile. Alternatively, the central server may simply prompt parties registering with the central server, such as individual users or registered services (e.g., merchants, retailers, etc.), to provide categories that describe their primary demographics (e.g., "Shoe store," "customer," etc).

[0069] The central server may also store permissions corresponding to user profiles that may indicate how the central server is authorized to share profile information with third-parties, such as merchants, government entities, and/or other users (i.e., registered services). The terms "permissions" or "permissions settings" are used herein to refer to settings, tags, flags, or other information that indicates whether a user authorizes to have various information stored within a profile provided to third-parties, merchants, retailers, and other registered services. Permissions may be set, provided, or otherwise indicated during procedures initiated and/or participated in by users, such as during registration as a user with the central server or during configuration of a wireless identity transmitter. For example, a user may update his/her permission settings to indicate a certain store may subsequently receive messages including the user's preference of cola drink. Permissions may indicate authorizations for individual recipients (e.g., no information sharing with Restaurant B), general types of recipients (e.g., information sharing is authorized for all hospitals), individual pieces of profile information (e.g., birth date is private), or sections of profiles (e.g., any data related to shopping habits is public), and any combination of similar authorizations (e.g., birth date is authorized for any recipient EXCEPT Restaurant B). Alternatively, permissions may include global settings for all profile information (i.e., an entire profile is private/public).

[0070] During and after registration, users may set profile permissions that may indicate subsets (e.g., "windows") of the stored profile information that may be provided to particular registered services or in particular circumstances. For

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example, a user may indicate that all personal information stored within his/her profile, such as birth date, address, and health information, may be private and thus may not be disclosed to any merchant. As another example, the user may indicate that his/her shopping preferences may be shared with merchants who offer particular products or services. When permissions are stored, the central server may only transmit profile information that is authorized, regardless of its relevant to a registered service. With permissions, the central server may provide profile information that assists third-parties in providing improved services to users while maintaining relative anonymity of the users.

[0071] In another embodiment, permissions may indicate a hierarchy of profile information that may be shared with third-parties. Such a hierarchy may indicate various conditions or categories must be present for certain profile information to be authorized for transmission to a registered service. For example, a user may indicate permissions settings that enable the central server to share basic information with a restaurant hostess (e.g., share the user's first name), more specific information with the restaurant's bartender (e.g., the user's is above the legal drinking age), and more information with the restaurant's waiter (e.g., a signature or photo for payment authentication).

[0072] In response to receiving a sighting message corresponding to broadcast messages from a user's wireless identity transmitter, the central server may identify profile information within the user's profile that is relevant to a registered service related to a received sighting message. Relevant profile information may be determined by matching categories related to the user and the registered service. Registered services may be associated with various categories that describe at least one of the services offered, the products offered, the type of business, demographics, interests, and/or target audience of the registered service. For example, a show seller that is registered with the central server may be associated with the categories of "Shoes," "Stores," and "Shopping," and thus the central server may identify profile information within the user's profile that relate to the categories of "Shoes," "Clothing," and/or "Shopping," such as prior

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sneaker purchases or preferences in sneaker brands or shoe design. In an embodiment, the central server may find matches of categories related to information stored in two different profiles corresponding to the sighting message. For example, the central server may compare a first profile of the registered service (or another user) and a second profile of the user to find any similar or matching categories to determine relevant profile information of the user.

[0073] When there is relevant profile information that is authorized for sharing based on permissions, the central server may transmit a return message including the relevant profile information. For example, the central server may transmit a message to a computer within a retail store that instructs customer service representatives in the retail store to approach the user by name and show him/her shoes that are in his/her size. As another example, a waiter receiving food/beverage preferences profile information on a tablet device may offer a preferred drink or food selection, or alternatively avoid offering food with nuts when the profile information indicates a customer has a nut allergy.

[0074] In an embodiment, profile information may be shared between mobile devices without transmitting messages to the central server. For example, in response to receiving a short-range wireless signal from a first device within proximity that shares data from a first user's profile information, a second mobile device may respond with a transmission that includes certain profile information of a second user. In another embodiment, the central server may transmit payment authentication information to a point-of-sale device (e.g., a cash register computing device) when a user is determined to be within proximity. The term "payment authentication information" is used herein to refer to information stored within a user's profile that may be utilized by third-parties to confirm the user's identity and otherwise facilitate a transaction. For example, payment authentication information may include address information, email addresses, photographs, audio samples of a user's voice, and signature samples that may be used to verify the identity of the user carrying a wireless identity transmitter

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within a retail store. Additionally, payment authentication information may include financial information, such as a user's credit card information (e.g., number, expiration date, etc.) or information about a preferred banking account. Store agents (e.g., customer service representatives, managers, cashiers, salesmen, etc.) may use payment authentication information to approach users waiting in line to efficiently conduct transactions and provide "high-touch" service.

[0075] To transmit payment authentication information, the central server may compare the location of a proximity broadcast receiver that transmitted a received sighting message to known locations of point-of-sale device within a place, such as a retail store. For example, the central server may compare the location of the proximity broadcast receiver indicated within the sighting message to the locations of all cash register point-of-sale devices within the retail store. When the proximity broadcast receiver is within a certain proximity threshold of a point-of-sale device, the wireless identity transmitter related to the sighting message may be assumed to be near a payment area (e.g., waiting at a check-out counter, in line at a cash register, etc.), and so the central server may transmit payment authentication information to the retail store. For example, the central server may send a photo of the user to a cash register near the user to assist store employees operating the cash register. Payment authentication information may only be relevant when users are in a location that is likely to include payment transactions, such as in a cash register line. Thus, the central server may use a rather small proximity threshold to ensure data is not sent to point-of-sale devices when users are merely walking or alternatively when users are not in a payment area. In an embodiment, the proximity threshold may be three feet or less to twenty-five feet or more.

[0076] In various embodiments, proximity information of wireless identity transmitters may be estimated by proximity broadcast receivers and/or a server (e.g., a local computing device, a central server, etc.). Based on signal strength of received broadcast messages or concurrent sighting messages from more than

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one proximity broadcast receiver, a server may determine the proximity broadcast receiver closest to the wireless identity transmitter. In other words, a central server may determine the proximity broadcast receiver among a plurality of proximity broadcast receivers that is closest to a wireless identity transmitter. When the proximity broadcast receivers are placed in strategic places, such as on a cash register or embedded within aisles of a retail store, determining the proximity broadcast receiver that is closest to a transmitter possessed by a user may enable a server to determine the area or point-of-sale device the user intends to address (e.g., a particular check-out line).

[0077] In various embodiments, the operations to determine whether a wireless identity transmitter is within proximity of a point-of-sale device may be performed by a central server as described above, a local computing device, such as a retail store server, and/or proximity broadcast receivers. For example, a local computing device within the retail store may compare the location of a proximity broadcast receiver receiving a broadcast message to the locations of all cash register computing devices within the retail store to detect whether a wireless identity transmitter is within a proximity threshold.

[0078] In another embodiment, data within received sighting messages may be useful in generating statistical information and customer trending data (i.e., foot traffic information). For example, even when broadcast messages are received outside of the proximity threshold for a particular area within the retail store (e.g., the wireless identity transmitter is twenty-five to one hundred feet from a product aisle or point-of-sale device), data within the sighting message may be stored by the central server. The central server may store data from sighting messages in relation to users and collect valuable information about the users' habits while within places. Such data may include unique visitor counts, aggregated dwell time, specific customer dwell time, purchase conversions, passing-by data, and data useful in developing loyalty programs. Over time, the central server may receive and store proximity information of a particular customer's wireless identity transmitter to various areas within a place, and may

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determine paths the customer repeatedly made throughout the place. For example, the data may describe the customer as walking from the entry of a retail store to a particular department numerous times over a period of time. As another example, the data from sighting messages may show that the user went to a check-out area after visiting a particular department, indicating a completed transaction. The various statistical information and trending data may be used by merchants, retailers, and other registered services to create profit equations and understand customer behaviors.

[0079] In various embodiments, a place, such as a retail store, building, or location associated with a registered service, may utilize stationary proximity broadcast receivers to receive and relay broadcast messages from customers' wireless identity transmitters. Alternatively, the place may deploy stationary wireless identity transmitters and customers' mobile proximity broadcast receivers may receive and relay broadcast messages. In further embodiments, the place may employ both proximity broadcast receivers and wireless identity transmitters to receive, relay, and process data from both users carrying wireless identity transmitters and/or mobile proximity broadcast receivers. Regardless of the source of broadcast messages, the central server (or a local computing device) may determine approximate proximities between a proximity broadcast receiver and a wireless identity transmitter based on received sighting messages.

[0080] Additionally, based on identification of the proximity broadcast receiver and the wireless identity transmitter related to a received sighting message, the central server may be configured to determine which device is related to a registered service (e.g., a retail store) and which is related to a user (e.g., a customer). The term "registered service" may be used herein to refer to a party or service that is registered, authenticated, valid, or otherwise known to a central server and that may be related with sighting messages. Registered services may include merchants, retailers, services, stores (e.g., big-box retailers, local coffee shops, etc.), and various other third-parties that are registered with the central server. Registered services may also include known routines, actions, or services

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managed by the central server, such as particular searches or active alerts, or alternatively applications that may be executing on a mobile device (e.g., a third-party app). In an embodiment, registered services may further include any third-parties that have registered as developers with the central server. For example, a registered service may correspond to a merchant that has registered proximity broadcast receivers with the central server. In an embodiment, registered users (e.g., customers) employing mobile proximity broadcast receivers that transmit sighting messages in response to receiving broadcast messages from others' wireless identity transmitters (e.g., a merchant's stationary identity transmitter positioned within a retail store) may also be considered registered services by the central server.

[0081] For illustration purposes, a mobile proximity broadcast receiver (e.g., a smartphone configured to operate as a proximity broadcast receiver) carried by the user waiting in the check-out line may receive a broadcast message from a wireless identity transmitter positioned on top of the cash register point-of-sale device within the retail store and may transmit a sighting message to the central server. Upon receive of the sighting message, the central server may determine that the wireless identity transmitter belongs to the retail store based on the profile that corresponds to a rolling identifier and that the mobile proximity broadcast receiver is associated with a customer profile based on an identifier of the proximity broadcast receiver included within metadata in the sighting message. From this information, the central server may securely transmit payment authentication information to a cash register point-of-sale device within proximity of the customer's proximity broadcast receiver.

[0082] In various embodiments, a wireless identity transmitter may be configured to periodically generate new identification data (referred to as a rolling identifier) that may be decoded by a central server to reveal the unique device identifier and other identifying information of the wireless identity transmitter. For example, a wireless identity transmitter may be configured to periodically broadcast a Bluetooth® packet including an encoded version of the

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wireless identity transmitter's device identifier (i.e., *deviceID*). Such encryption of identifiers indicated in broadcast messages may be required to enable the central server to reliably identify the wireless identity transmitter that sent the broadcast message while forcing a third-party (e.g., passive attacker) to determine the origin of the broadcast message by guessing. For example, if the identifier was static, the third party could sniff the identifier, such as by impersonating a proximity broadcast receiver, and then use the identifier to track the wireless identity transmitter. Rolling identifiers may make such an attack impossible if the third party lacks the means of generating the encrypted identifiers.

[0083] In various embodiments, a single packet broadcast message may not support a payload that can fit cipher text of a conventional asymmetric key encryption, making standard private/public key pair encryption impossible. Additionally, communications between wireless identity transmitters and various devices, such as direct transmissions to proximity broadcast receivers or indirect messages to a central server, may be one-way and not utilize any back channels. Therefore, in various embodiments, the central server may process encrypted message payloads by pre-provisioning a shared secret key unique to each wireless identity transmitter. Such secret keys may be associated with each wireless identity transmitter's unique device identifier at the central server and may be used to decode data (e.g., identifiers) encoded by the each wireless identity transmitter. Performing an embodiment method, a wireless identity transmitter may use a streaming-like encryption algorithm (e.g., AES-CTR) to encrypt its device identifier, shared secret key, and a counter, broadcasting a payload that includes the encrypted data with and the counter in the clear. Performing another embodiment method, a wireless identity transmitter may use a pseudo-random function to encrypt the device identifier, shared secret key, and a counter, broadcasting a payload that includes the encrypted data without the counter in the clear. Performing another embodiment method, a wireless identity transmitter may use a combination of a streaming-like and pseudo-random

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function encryptions to generate a payload to broadcast. In an embodiment, the wireless identity transmitter and the central server may each have a cryptographically secure pseudo-random number generator or algorithm that is used to generate identifiers on a common time scale so that any given moment, the central server can calculate the identifier being transmitted by a particular wireless identity transmitter.

[0084] In various embodiments, the wireless identity transmitter may maintain a counter (or clock data) that periodically increments to represent the passage of time and that may be used in various encryption methods. When the wireless identity transmitter is powered on (or the battery is replaced), the counter may be set to a known initial value, such as 0. As the wireless identity transmitter functions, the counter may increment periodically (e.g., increment by one every several minutes/hour). If the wireless identity transmitter encounters inconsistent power (e.g., the battery is taken out or replaced), the counter may reset. Using such a counter, a wireless identity transmitter may be configured to periodically broadcast messages with encrypted payloads that include changing and encrypted device identification. In an embodiment, an encrypted payload may contain a concatenation of the device's unique identifier (i.e., the *deviceID*) and a current counter value for that wireless identity transmitter. In an embodiment, the wireless identity transmitter may encrypt the concatenated data using a secret key. Payloads may be broadcast at varying frequencies.

[0085] In an embodiment, the central server may be configured to identify wireless identity transmitters by matching received encrypted payloads with pre-generated payloads (or model payloads) corresponding to registered wireless identity transmitters. Based on information obtained during registration operations between the central server and wireless identity transmitters, the central server may store unique information about each wireless identity transmitter. For example, the central server may know the secret key, device identifier (or *deviceID*), and initial counter value of a wireless identity transmitter based on registration communications. Using such stored information, the

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central server may generate a series of model payloads the wireless identity transmitter is expected (or likely) to broadcast within a time period, such as a 24-hour period. If the central server receives a payload that matches any of these model payloads, the central server may determine the identity of the originating wireless identity transmitter as well as a loosely-accurate counter value within the wireless identity transmitter. Model payloads may be generated based off of a current, synched counter for each registered wireless identity transmitter (i.e., current model payloads). In an embodiment, the central server may also adjust for wireless identity transmitter clock skew by keeping a window of model payloads. For example, the central server may generate payloads using counter values representing times before and after an expected counter. The central server may also determine the period of the wireless identity transmitter clock by monitoring the change in the received payloads over time. In an embodiment, the central server may track changes of the reported counter values of a wireless identity transmitter and may report how inaccurate a device clock is for a particular period of time.

[0086] Model payloads may also be generated based off of initial counter values reported by each registered wireless identity transmitter during registration operations (i.e., initial model payloads). When a wireless identity transmitter is powered off and on again (e.g., rest, battery replaced, etc.), the wireless identity transmitter may reset to the original or initial counter value. If an encrypted payload received at the central server does not match any current model payload, the central server may compare the received encrypted payload to stored initial model payloads. When the central server finds an initial model payload matches the received encrypted payload (e.g., the wireless identity transmitter was reset), the central server may update a database to indicate the corresponding wireless identity transmitter's counter was reset, thus re-synchronizing with the reset wireless identity transmitter's clock.

[0087] In a situation in which a wireless identity transmitter pauses for a period but does not reset its counter used for generating encrypted payloads, payloads

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subsequently generated by the wireless identity transmitter may not match expected payloads stored in the central server (e.g., current model payloads and initial model payloads). Accordingly, the central server may determine that a pause occurred when model payloads and/or counter values do not match a received encrypted payload. The central server may identify the wireless identity transmitter by performing a brute-force search of all known and/or registered wireless identity transmitters represented in a database and decode the received encrypted payload based on recorded secret keys and device identifications. In an embodiment, the brute-force search may include only wireless identity transmitters that have not broadcast payloads recently received by the central server.

[0088] Additional precautions may be important to protect against security breaches, such as hacker attacks against databases associated with a central server, as well as to provide registered users (e.g., merchants, parents, children, etc.) peace of mind and confidence their privacy may be fully protected. Such privacy safeguards may be provided to parties registered with embodiment systems by storing identifying information (e.g., names, addresses, financial information, medical information, etc.) separately from other information related to tracking devices and/or proximity information of users. In particular, to avoid unintended leaking of personal information of registered merchants, customers, children, or individuals, embodiment systems may utilize "double-blind" architectures. For example, such a double-blind architecture may use a first unit (e.g., a server, database, or other computing hub) that stores and has access to information related to the proximity information or other location-based data of registered users' devices (e.g., wireless identity transmitters, proximity broadcast receivers, identity transceivers, mobile devices, etc.). In other words, the first unit may access information associated with sighting messages that indicate approximate locations/proximities of various users' devices. However, the first unit may not store uniquely identifying personal information, such as user names, addresses, and/or social security numbers. Instead, a second unit may store the

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identifying personal information without being configured to access any location/proximity information as used by the first unit. The first and second units may use anonymous identifiers that connect data stored within the two units without indicating the protected information stored in either unit. In an embodiment, the first and second units may be maintained by separate entities (e.g., service providers), and further, at least one of such entities may be trusted by registered users who provide identifying information.

[0089] The various embodiments may leverage a large infrastructure of mobile devices already in place. Many modern mobile devices, such as smartphones, are already equipped with multiple radios, including short-range radios such as Bluetooth® radios, and therefore may be configured to perform as mobile proximity broadcast receivers and receive identification codes from a proximate wireless identity transmitter. For example, a customer carrying a smartphone configured to operate as a mobile proximity broadcast receiver (or mobile identity transceiver) may receive broadcast messages from wireless identity transmitters within a retail store. Mobile devices are also often equipped with a clock that may provide a current time and a GPS receiver that may provide a current location whenever a wireless identity transmitter identifier is received. The mobile devices may communicate these identification codes, times, and locations via sighting messages to central servers through longer range network connections, such as a cellular radio connection. Thus, many of the large number of mobile devices already in use or soon to be in use may be incorporated as mobile proximity broadcast receivers to extend the reach of various embodiment systems.

[0090] By relying on the long range radios and other services of proximity broadcast receivers to report the location and time of received broadcast message (or "sightings") to a central server, wireless identity transmitters can be relatively small, inexpensive, and simple devices, including little more than a short-range radio, such as a Bluetooth® LE transceiver, and a battery. In various embodiments, wireless identity transmitters may also include additional short-

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range radios, such as Peanut® radios. In various embodiments, the wireless identity transmitters may not include a user interface, multiple radios, global positioning system (GPS) receiver, or other features common on mobile devices. Embodiment wireless identity transmitters may also consume very little power allowing them to be deployed without needing to be frequently recharged or replaced. These characteristics make them ideal for a wide variety of uses and implementation in a variety of physical configurations. For example, wireless identity transmitters may be easily hidden or incorporated into many different personal objects, such as buttons, watches, shoes, briefcases, backpacks, ID badges, clothing, product packaging, etc.

[0091] In further embodiments, wireless identity transmitters and proximity broadcast receivers may be configured to exchange transmissions using various wireless technologies, such as LTE-D, peer-to-peer LTE-D, WiFi, and WiFi Direct. In an embodiment, wireless identity transmitters may be configured to broadcast messages via a WiFi radio such that proximity broadcast receivers with WiFi transceivers may receive the broadcast messages. In such embodiments, wireless identity transmitters may utilize WiFi transmissions to broadcast identification information similar to WiFi access point broadcasts advertisements. For example, a wireless identity transmitter including a WiFi radio may be configured to transmit broadcast messages via WiFi transmissions with low power so that the reception range is limited, thereby providing a short-range radio signal with a range similar to that of Bluetooth® LE transmissions. In utilizing various wireless broadcast technologies and communication protocols with wireless identity transmitters, proximity broadcast receivers with limited capabilities may still be capable of receiving and processing broadcast messages from wireless identity transmitters. For example, a smartphone configured to operate as a mobile proximity broadcast receiver and including a WiFi transceiver but not a Bluetooth® LE radio may receive and process broadcast messages from a wireless identity transmitter configured to broadcast short-range signals with a WiFi radio. In an embodiment, wireless identity transmitters may

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broadcast over multiple radios, such as a Bluetooth® LE transceiver and a low-power WiFi transceiver, in order to enable more models of proximity broadcast receivers (e.g., more types of smartphones) to receive and relay sightings.

[0092] Wireless identity transmitters and proximity broadcast receivers are described throughout this disclosure as exchanging short-range wireless signals that include short-range RF signals, such as Bluetooth®, Bluetooth® Low Energy, Peanut, Zigbee, etc. However, such short-range wireless signals are not limited to short-range RF signals, and wireless identity transmitters may broadcast messages using other forms of wireless signaling, such as infrared light, visible light, vibration, heat, inaudible sound, and audible sound, as well as combinations of radio frequency (RF) signals and non-RF signals. For example, wireless identity transmitters may emit heat signals, such as infrared light, using infrared light-emitting diodes or other components capable of emitting infrared radiation. Additionally, wireless identity transmitters may emit vibration signals using vibration motors and other mechanical components capable of generating controlled vibrations. Wireless identity transmitters may also emit light signals from a number of common emitters, such as light emitting diodes, incandescent lights and projectors. Light signals may be received by light sensors (e.g., cameras) on proximity broadcast receivers, and may include visuals, such as lights, colors, and imagery (e.g., photos, projections, videos, symbols, etc.). Wireless identity transmitters may also or alternatively emit audible or inaudible (i.e., infrasonic or ultrasonic) sound signals from a speaker (e.g., a piezoelectric speaker). Sound signals may be received by a microphone of the proximity broadcast receivers, and may include a variety of sounds, such as beeps, voices, noise, clicks, ultrasounds, tones, and musical notes.

[0093] Wireless identity transmitters may be configured to broadcast the various short-range wireless signals in particular sequences, patterns, manners, durations, or manifestations such that proximity broadcast receivers may convert the signals into data in a manner similar to how RF signals (e.g., Bluetooth® LE signals) are interpreted in embodiments described herein. For example, a

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wireless identity transmitter may broadcast particular sequences of modulating visible or sound signals, such as strings of differing musical notes, changing images, or flashing lights that a proximity broadcast receiver may receive and convert into data that includes an identity of the wireless identity transmitter. In an embodiment, proximity broadcast receivers may convert such wireless signals into data (and vice versa) based on matching sequences of signals with patterns within predefined protocols. As an illustrative example, a wireless identity transmitter affixed to the outside of a child's clothing may periodically emit a sequence of flashes using an embedded light source (e.g., an LED bulb) that may be received, converted to data, and relayed by a proximity broadcast receiver to a central server for determining identification information related to the child. As another example, a wireless identity transmitter within a business establishment may be mounted on the ceiling and may periodically emit a sequence of flashes using an embedded light source that may be received, converted to data, and relayed by a proximity broadcast receiver to a central server to obtain coupons, announcements or customer-incentives tied to the customer being on the premises.

[0094] The various embodiments are described within this disclosure as including communication systems for providing intermediary communications between wireless identity transmitters, proximity broadcast receivers (e.g., mobile proximity broadcast receivers and stationary proximity broadcast receivers) and a central server that utilize short-range messaging (such as with Bluetooth® LE signaling) that enables proximity detection based simply on signal reception. However, the various embodiments are not limited to the described communication systems and methods, and other communication systems, protocols, devices, methods and messaging protocols may be used to convey information to a central server to enable identifying when customers are within proximity of predefined areas to enable the central server to distribute relevant information without disclosing unauthorized information of customers. For example, transceivers in a retail store may be configured to monitor for WiFi,

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Zigbee®, Bluetooth®, Peanut®, and/or other radio frequency signaling from customers' mobile devices or wireless broadcasting devices within proximity, and relay proximity information to a central server that delivers coupons to customers. Further, embodiments may not require determining exact locations for wireless identity transmitters and/or proximity broadcast receivers but instead may determine approximate and/or relative locations of devices between each other. Accordingly, references to determining location and/or distance throughout the disclosure may be for the purpose of determining proximity between signaling devices.

[0095] FIG. 1 illustrates an exemplary system 100 that may be used in various embodiments. In general, a central server 120 may be configured to receive, store, and otherwise process data corresponding to wireless identity transmitters 110. The central server 120 may be configured to exchange communications with various devices via the Internet 103, such as proximity broadcast receivers 142, mobile proximity broadcast receivers 138, third-party systems 101, and other support systems and/or services 102. The wireless identity transmitters 110 may broadcast messages that may be received by nearby proximity broadcast receivers 142 and/or the mobile proximity broadcast receivers 138 via short-range wireless signals. The proximity broadcast receivers 142, 138 may utilize long-range communications to relay received broadcast messages as sighting messages to the central server 120 via the Internet 103. For example, the proximity broadcast receivers 142 and mobile proximity broadcast receivers may utilize a cellular network 121 to transmit sighting messages to the central server 120. The third-party systems 101 may include merchant servers, retail store computing devices, computing devices associated with emergency services. The other support systems and/or services 102 may include computing devices associated with various technologies, such as computing devices utilized by users to provide registration information, systems that deliver user-relevant content (e.g., Qualcomm Gimbal™), and services that provide location-specific information (e.g., Qualcomm IZat™).

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[0096] The central server 120 may include several components 104-109 to perform various operations to process data, such as received from proximity broadcast receivers 142, 138, third-party systems 101, or other support systems and/or services 102. In particular, the central server 120 may include a data warehouse component 104 that may store long-term data (e.g., archived user data, past location information, etc.). The central server 120 may also include an operations, administration and management (or OA&M) component 105 that may manage, process and/or store software associated with user portal accesses, scripts, tools (e.g., software utilities, routines, etc.), and any other elements for administering the central server 120. The central server 120 may also include a developer portal component 106 that may store developer account data and perform registration, account management, and alert (or notice) management routines associated with developers, such as vendors or merchants that register to interact with users of wireless identity transmitters 110. The central server 120 may also include a rolling identifier (or ID) resolver component 107 that may store factory keys associated with wireless identity transmitters 110 as well as perform operations, software, or routines to match encrypted, encoded, rolling, or otherwise obfuscated identification information within received sighting messages with affiliated user data. The central server 120 may also include a user portal component 109 that may store user account data and perform registration, account management, and search routines associated with users, such as persons associated with wireless identity transmitters 110. The central server 120 may also include a core component 108 that may process sighting messages, execute an alert or notice engine module, handle application programming interface (API) commands, and exchange data with other components within the central server 120. The core component 108 is described below with reference to FIG. 12.

[0097] In various embodiments, the various system components 104-109 may be computing devices, servers, software, and/or circuitry that is included within, connected to, or otherwise associated with the central server 120. For example,

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the core component 108 may be a server blade or computing unit included within the central server 120. As another example, the data warehouse component 104 may be a remote cloud storage device that the central server 120 communicates with via Internet protocols. In an embodiment, the proximity broadcast receivers 142 and mobile proximity broadcast receivers 138 may be configured to execute a core client module 115 that may be software, instructions, routines, applications, operations, or other circuitry that enable the proximity broadcast receivers 142, 138 to process received broadcast messages from proximate wireless identity transmitters 110. The core client module 115 may also handle communications between the proximity broadcast receivers 142, 138 and the central server 120, such as transmitting sighting messages and receiving return messages from the central server 120. Further, the mobile proximity broadcast receivers 138 may be configured to execute third-party applications module 116 that may related to performing software instructions, routines, applications, or other operations provided by various third-parties (e.g., merchant apps). In an embodiment, when configured as registered services with the central server 120, the third-party applications module 116 may receive various data from the core client module 115. For example, a third-party application that is registered with the central server 120 may be configured to receive notifications from the core client module 115 when the user of the mobile proximity broadcast receiver 138 enters, remains, and/or leaves a particular place (e.g., a geofence, a retail store, etc.).

[0098] In another embodiment, the mobile proximity broadcast receivers 138 may be configured to receive and transmit broadcast messages and may also be referred to as "wireless identity transceivers." For example, a user may employ a smartphone that is configured to receive broadcast messages from nearby wireless identity transmitters 110 as well as broadcast signals that include identifying information associated with the user.

[0099] FIG. 2 illustrates an exemplary communication system 200 that may be used in various embodiments. The communication system 200 effectively

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enables wireless identity transmitters 110 (e.g., Bluetooth® LE transmitters) to transmit broadcast messages that include identification information to the central server 120 via a plurality of mobile proximity broadcast receivers 138 and/or stationary proximity broadcast receivers 142, without the need to negotiate a direct communication link. Such broadcast messages may be collected automatically by any proximity broadcast receiver within proximity (or broadcast range) of wireless identity transmitters. For example, a mobile proximity broadcast receiver 138 within a certain proximity may receive a broadcast message transmitted by a Bluetooth® radio within the wireless identity transmitter 110.

[0100] The communication system 200 may include a wireless identity transmitter 110. The wireless identity transmitter 110 may be coupled with various objects. For example, it may be embedded in a bracelet. The wireless identity transmitter 110 may transmit a short-range wireless signal 114, such as a broadcast message as described above. For example, this short-range wireless signal 114 may be a periodic broadcast of a packet, which includes the wireless identity transmitter's identification code. Alternately, the short-range wireless signal 114 may be an attempt to establish a wireless communication link with any of a plurality of mobile devices 138 that may be acting as proximity broadcast receivers. The short-range wireless signal 114 may be received by proximate proximity broadcast receivers, such as stationary proximity broadcast receivers 142 and/or mobile proximity broadcast receivers 138.

[0101] The short-range wireless signal 114 may be according to any of a variety of communication protocols, such as Bluetooth®, Bluetooth® LE®, Wi-Fi, infrared wireless, induction wireless, ultra-wideband (UWB), wireless universal serial bus (USB), Zigbee®, Peanut ®, or other short-range wireless technologies or protocols which have or which can be modified (e.g., by restricting transmit power) to limit their effective communication range to relatively short range (e.g., within about 100 meters). In some embodiments, the wireless identity transmitter 110 may use the low energy technology standardized in the

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Bluetooth® 4.0 protocol (or later versions). For example, in some embodiment systems a wireless identity transmitter 110 may periodically broadcast identification packets configured as an advertiser as described in the Bluetooth® 4.0 protocol, and proximate proximity broadcast receivers 142, 138 may be configured to act as scanners according to that protocol.

[0102] The Bluetooth® protocol and Bluetooth® devices (e.g., Bluetooth® LE devices) have a relatively short effective communication range, are widely used in deployed communication and computing devices, have standard advertising or pairing procedures that meets the discovery and reporting needs of various embodiments, and exhibit low power consumption, which make the protocol ideal for many applications of the various embodiments. For this reason, Bluetooth® and Bluetooth® LE protocols and devices are referred to in many of the examples herein for illustrative purposes. However, the scope of the claims should not be limited to Bluetooth® or Bluetooth® LE devices and protocol unless specifically recited in the claims. For example, Peanut® transceivers may be included within wireless identity transmitters 110 and may be used to transmit two-way communications with proximity broadcast receivers 142, 138 also configured to utilize Peanut® short-range radio transmissions.

[0103] The communication system 200 may include a plurality of stationary proximity broadcast receivers 142, which may be deployed by authorities, merchants, or various third-parties throughout a region, building, or place. Such stationary proximity broadcast receivers 142 may be designed specifically for wireless identity transmitters 110 (or include such tracking functions in addition to other primary functionality, such as traffic lights, utility transformers, etc.). Stationary proximity broadcast receivers 142 may be located in strategic locations within a locality, such as forming a perimeter about a community and/or being located in high traffic areas (e.g., major intersections and highway on-ramps). The stationary proximity broadcast receivers 142 may be in communication with a local area network 202, such as a WiFi network, that may include an Internet access server 140 that provides a connection 148 to the

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Internet 103. Stationary proximity broadcast receivers 142 may be connected to the local area network 202 by a wired or wireless link 146. In various embodiments, the stationary proximity broadcast receivers 142 may be contained within or located nearby the Internet access server 140. For example, the stationary proximity broadcast receivers 142 may be components within the Internet access server 140 or alternatively, may be placed on top of or to the sides of the Internet access server 140. In an embodiment, stationary proximity broadcast receivers 142 may be located in strategic places within a locality, such as forming a perimeter about a community and/or being located in high traffic areas (e.g., along aisles of a retail store, at entry ways to buildings, etc.). In an embodiment, stationary proximity broadcast receivers 142 may have additional functionality. For example, stationary proximity broadcast receivers 142 may also function as or be included within cash registers, point-of-sale devices, and/or display units within a retail store.

[0104] The communication system 200 may also include one or more mobile devices configured to act as mobile proximity broadcast receivers 138. The mobile proximity broadcast receivers 138 may be typical mobile devices or smartphones communicating with a cellular network 121 via long range wireless links 136 to one or more base stations 134 coupled to one or more network operations centers 132 by a wired or wireless connection 158. Such cellular network 121 may utilize various technologies, such as 3G, 4G, and LTE. The network operations centers 132 may manage voice calls and data traffic through the cellular network 121, and typically may include or may be connected to one or more servers 130 by a wired or wireless connection 156. The servers 130 may provide a connection 154 to the Internet 103. In the various embodiments, the mobile proximity broadcast receivers 138 may be mobile devices configured by an application or other software module to act as proximity broadcast receivers to relay reports of received broadcast messages from wireless identity transmitters 110 (i.e., sighting messages) to the central server 120 by way of the Internet 103. In an embodiment, stationary proximity broadcast receivers 142 may also

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communicate with the cellular network 121 via long range wireless links 136 to a base station 134.

[0105] Proximity broadcast receivers 138, 142 may be configured to report contacts (or sightings) with a wireless identity transmitter 110 to a central server 120 via the Internet 103. For example, the proximity broadcast receivers 142 may transmit a sighting message to the central server 120 that includes a rolling identifier corresponding to the identity of a user of the wireless identity transmitter 110. Each time a proximity broadcast receiver 138, 142 receives an identifier from a wireless identity transmitter 110, the identifier may be associated with the time of the connection and the location of the proximity broadcast receiver 138, 142, and this information may be transmitted to the central server 120, such as within a sighting message. In some embodiments, the identifier, the time, and the location of the contact may be stored in the memory of the proximity broadcast receiver 138, 142 (or an intermediary server 130, 140) for later reporting, such as in response to a query message broadcast or multicast by the central server 120. Also, the central server 120 may store location information reported by sighting messages in a database, which may be used for locating, tracking or otherwise monitoring movements of the wireless identity transmitter 110.

[0106] In an embodiment, mobile proximity broadcast receivers 138 may be configured to exchange short-range wireless signals 189 with stationary proximity broadcast receivers 142. In other words, a mobile proximity broadcast receiver 138 may be configured to operate as a wireless identity transceiver that is capable of receiving short-range wireless signals 114 (i.e., broadcast messages) from the wireless identity transmitter 110 as well as transmitting short-range wireless signals 189 for receipt by proximity broadcast receivers 142.

[0107] In an embodiment, proximity broadcast receivers 138, 142 may transmit wireless signals 188 to a wireless router 185, such as part of the local area network 202, which may provide a connection 187 to the Internet 103. For

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example, the stationary proximity broadcast receivers 142 may transmit sighting messages that include data from broadcast messages transmitted by the wireless identity transmitter 110 to a WiFi wireless router 185.

[0108] The central server 120 may also be connected to the Internet 103, thereby allowing communication between proximity broadcast receivers 142, 138 and the central server 120. As described above, the central server 120 may include a plurality of components, blades, or other modules to process sighting messages and data received from proximity broadcast receivers 142, 138. Further embodiments may provide a direct connection (not shown) between the central servers 120 and any of the mobile device network components, such as the network operations centers 132, to more directly connect the proximity broadcast receivers 142, 138 and the central servers 120.

[0109] The communication system 200 may also include computing terminals 124, such as personal computers at home or work, through which users may communicate via the Internet 103 with the central server 120. Such terminals 124 may allow users, such as parents, police, fire, medical attendants, and other authorized authorities to register devices (e.g., wireless identity transmitters 110), access tracking records on the central servers 120, and/or to request that the central server 120 initiate a search for a particular wireless identity transmitter 110. In an embodiment, users may use such terminals 124 to register wireless identity transmitters 110, proximity broadcast receivers 142, 138 (e.g., smartphones configured to execute client software associated with the central server), and/or identity transceivers (not shown), such as by accessing web portals and/or user accounts associated with the central server 120. Similarly, third-parties, such as merchants, may use terminals 124 to register wireless identity transmitters 110, proximity broadcast receivers 142, 138 (e.g., stationary receivers configured to execute client software and relay broadcast to the central server), and/or identity transceivers (not shown).

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[0110] Based on the location of the proximity broadcast receivers 138, 142 within a place, multiple proximity broadcast receivers 138, 142 may be within the broadcast area of the wireless identity transmitter 110 and may concurrently receive broadcast messages. As described below with reference to FIGS. 28A-28D, the central server 120 may detect when proximity broadcast receivers 138, 142 concurrently (or within a certain time period) transmit sighting messages that indicate receipt of broadcast messages from the wireless identity transmitter. Such concurrent sighting messages may be used to determine more precise proximity information relating to the wireless identity transmitter at the time of broadcasting.

[0111] The communication system 200 may operate in a passive information gathering mode and/or an active search mode. In the passive information gathering mode, proximity broadcast receivers 138, 142 may continuously listen for broadcasts from any wireless identity transmitters 110, and report all identifier reception events via sighting messages (e.g., transmissions including identifiers, time and location) to the central server 120. When no active search is underway (i.e., no one is looking for a particular wireless identity transmitter 110), sightings of wireless identity transmitters 110 or received broadcast messages from wireless identity transmitters 110 may be stored in memory of the proximity broadcast receivers 138, 142 or the central server 120 for access at a later time. In order to protect privacy, such stored data may be stored for a limited period of time, such as a day, a week or a month, depending upon the person or asset being tracked. Then, if a person or asset is discovered to be missing, the stored data may be instantly accessed to locate and track the associated wireless identity transmitter 110, or at least determine its last reported location.

[0112] In a modification of the passive tracking mode, each proximity broadcast receiver 138, 142 may store IDs, times and locations corresponding to received broadcast messages (or contacts) from wireless identity transmitters 110 for a limited period of time. Alternatively, such information may be stored in servers

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130, 140 connected to such proximity broadcast receivers 138, 142. Then, if a person or asset associated with a wireless identity transmitter 110 is discovered missing, a search can be initiated by the central server 120 querying the proximity broadcast receivers 138, 142 (or servers 130, 140) to download their stored data (e.g., databases indicating contacts with wireless identity transmitters 110) for analysis and storage in a database of the central server 120.

[0113] In an embodiment, in order to limit the demands on civilian mobile devices configured to operate as mobile proximity broadcast receivers 138, the passive tracking mode may only be implemented on the stationary proximity broadcast receivers 142. While the fewer number of such devices means the tracking of wireless identity transmitters 110 may be less effective, this embodiment may nevertheless enable receiving broadcast messages and thus the tracking of wireless identity transmitters 110 through high-traffic zones, such as intersections, highway on/off ramps, bus stations, airports, etc.

[0114] In the passive information gathering mode/embodiment, a user may use the communication system 200 to request the location of a particular wireless identity transmitter 110, such as by sending a request from a terminal 124 to the central server 120. For example, a mother may log in on her home computer terminal 124 and request the location of the wireless identity transmitter 110 in her child's backpack. The request may include a serial number, code, or other identifier corresponding to the wireless identity transmitter 110. The central server 120 may search the stored identification messages for the serial number, code, or other identifier and return any reported locations matching entered information, along with the times of such locations were reported via sighting messages. In further embodiments, the serial number or code entered by the parent may be cross-referenced with the identifier that the requested wireless identity transmitter 110 communicates in broadcast messages and that are relayed to the central server 120 in sighting messages submitted by proximity broadcast receivers 138, 142. In this manner only an authorized user (i.e., someone who knows the access code, password, or other secret code associated with a

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particular wireless identity transmitter 110) can obtain information regarding a given wireless identity transmitter 110 even though data is being gathered continuously.

[0115] In the active search mode/embodiment, the central server 120 may instruct proximity broadcast receivers 138, 142 to actively search for a particular wireless identity transmitter 110 (i.e., a "targeted" wireless identity transmitter). An active search may be initiated in response to a request received from a terminal 124. Such a request may include the identifier for the particular wireless identity transmitter 110, or an account number/name that is or can be cross-linked to the identifier of the wireless identity transmitter 110. The central server 120 may transmit activation messages, such as via broadcast or multicast, to proximity broadcast receivers 138, 142 that may instruct proximity broadcast receivers 138, 142 to search for a particular wireless identity transmitter 110 and that may include an identifier of the targeted wireless identity transmitter 110 (i.e., target device ID). For example, an activation message corresponding to an active search for a targeted wireless identity transmitter 110 may include a rolling identifier that the wireless identity transmitter 110 changes periodically in an unpredictable manner and that is known to the central server 120. In an embodiment, activation messages transmitted, broadcast or multicast by the central server 120 may be sent only to proximity broadcast receivers 138, 142 within particular sectors or within a given distance of a particular location. Alternatively, the activation messages may identify particular sectors or a distance from a particular location to enable the proximity broadcast receivers 138, 142 to determine whether the activation message is applicable to them based on their own known location. In this manner the search can be focused on a given area, such as a sector encompassing the last known location of the wireless identity transmitter 110 or an eye witness sighting. By focusing the search in this manner, proximity broadcast receivers 138, 142 not within the sector of search need not be activated.

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[0116] In the active search mode/embodiment, in response to receiving activation messages from the central server 120 that include target device IDs and determining that they are within the identified sector of search, proximity broadcast receivers 138, 142 may configure their short-range radios (e.g., Bluetooth® radio) to listen for broadcast messages having the identifiers. In other words, the proximity broadcast receivers 138, 142 may be considered activated for a search and may or pairing attempts with an identifier look for the identifiers included in the activation message (i.e., target device IDs). In embodiments that do not rely on pairing with the wireless identity transmitter, proximity broadcast receivers 138, 142 matching an identifier within a received broadcast message to a target device ID within an activation message may promptly report the event to the central server 120 via sighting messages transmitted via links 146 or long-range wireless links 136. In embodiments that rely on pairing or an exchange of messages between the wireless identity transmitter and proximity broadcast receivers, proximity broadcast receivers 138, 142 may listen for and only complete communication handshaking or pairing with a device that broadcasts the target device ID, and ignore other pairing attempts. In this alternative embodiment, proximity broadcast receivers 138, 142 may be protected from pairing with unauthorized devices while in the active search mode. Also, proximity broadcast receivers 138, 142 may modify the pairing process in the active search mode to terminate the communication link as soon as the device ID is received, further protecting against pairing with unauthorized devices in the active search mode. In the active search mode/embodiment, proximity broadcast receivers 138, 142 receiving the target device ID may promptly report that event to the central server 120 via a wired or wireless link to the Internet 103. As mentioned above, such a report may include the location of the proximity broadcast receiver 138, 142 and the time when the identifier was received if the report is not transmitted immediately. In the active search mode/embodiment, each sighting message received by the central server 120 may be reported to an interested person or authority, such as in the form of a webpage showing an update location indicator on a map.

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[0117] Further, in the active search mode/embodiment, an authorized user, such as a police, FBI, fire/rescue or other person of authority may use the communication system 200 to activate a search for a particular wireless identity transmitter 110, such as by using a terminal 124 to provide the central server 120 with the target device ID and search location or sectors to be searched. For example, a mother discovering that her child is missing may call the police and provide them with an identifier of the wireless identity transmitter 110 concealed in her child's clothing. With the search activated, the central server 120 may transmit an alert (or message that indicates a search for a wireless identity transmitter has been activated) to proximity broadcast receivers 138, 142 within the initial targeted search sector. The central server 120 may then activate a webpage that presents a map of the search area and that may be maintained in near-real time so, that as relevant sighting messages are received, reported location information is displayed on the map. Authorized users may then access the website (or other information provided by the server) to coordinate in-person search efforts.

[0118] Of course, information gathered and stored in proximity broadcast receivers 138, 142 or in a database of the central server in the passive mode may be used upon initiation of an active search, such as to identify an initial search location or sector, track recent locations and movements, and to provide/display a history of locations reported by sighting messages that may be combined with near-real time search reports.

[0119] In another embodiment, the communication system 200 may further include a plurality of wireless identity transmitters (not shown in FIG. 2) that are placed throughout a building. In such a situation, the plurality's broadcast areas may cover a large portion of the enclosed area of such a building. For example, the building may be a retail store and the plurality of wireless identity transmitters may be permanently stationed throughout the sales floor of the building. As a mobile proximity broadcast receiver 138, such as a smartphone carried by a customer, moves throughout the building and within the broadcast

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areas of the plurality of wireless identity transmitters, the mobile proximity broadcast receiver 138 may receive broadcast messages associated with the building. In another embodiment, the Internet access server 140 may be configured to store, receive, and otherwise process information relevant to the building. For example, the Internet access server 140 may be configured to perform as a local server for a retail store or alternatively a point-of-sale device that is configured to perform software and operations for conducting transaction with customers. For example, the Internet access server 140 may be configured to perform operations related to a customer purchase within a retail store building.

[0120] FIG. 3 illustrates an embodiment method 300 for implementation in a wireless identity transmitter 110 (referred to as "WIT" in FIG. 3), a proximity broadcast receiver 142, and a central server 120. In block 302, a wireless identity transmitter 110 may broadcast a message that includes an identifier, such as a broadcast message as described above. For example, the wireless identity transmitter 110 may broadcast a Bluetooth® LE advertising packet that includes a rolling identifier as described herein. This may be accomplished in block 302 by a microcontroller within the wireless identity transmitter 110 determining that it is time to broadcast its identifier, configuring a suitable broadcast message (e.g., an advertisement packet as specified for Bluetooth® LE devices in the Bluetooth®4.0 protocol), and transmitting that packet via a short-range radio.

[0121] In various embodiments, the message broadcast by the wireless identity transmitter (i.e., the broadcast message) may include an identifier segment, such as a rolling identifier. In various embodiments, the broadcast message may also include additional segments, such as a type segment. The type segment may indicate the type of wireless identity transmitter. For example, wireless identity transmitters may be marketed for various purposes, such as child safety devices, dog collars, or security tags for stores. The wireless identity transmitters may have a different type segment based on the intended purpose (e.g., one code for child safety devices, a second code for dog collars, etc.). Type segments may be

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static and set by manufacturers, while the remaining portion of the identifier may be unique to each device, and may roll as described below. The type segment may also be changed by a user, such as when a wireless identity transmitter is reset for a different purpose or application.

[0122] In other embodiments, a broadcast message may also include one or more static or dynamic segments with instructions or commands to be implemented by a proximity broadcast receiver. Such command segments may also be passed along to instruct a central server or other network device. Command segments may be set or static, similar to type segments, or may vary over time based on various conditions, such as pairings or data from one or more proximity broadcast receivers. Such command settings may also be configured by a user of the wireless identity transmitter. Second or additional segments may also indicate the status of the wireless identity transmitter. For example, a second segment may indicate the remaining power or estimated time left before the battery dies. Proximity broadcast receivers or a central server may interpret this status and respond accordingly.

[0123] Returning to FIG. 3, in block 304, the wireless identity transmitter 110 may enter a sleep mode. For example, after broadcasting the broadcast message having the identifier, the wireless identity transmitter 110 may be configured to enter a power conservation state that may continue for a predetermined period of time. In various embodiments, the wireless identity transmitter 110 may sleep for a predetermined time, never sleep, or sleep for varying times determined based on various inputs. In block 306, the wireless identity transmitter 110 may wake up from the sleep mode, such as after the predetermined duration expires. In block 308, the wireless identity transmitter 110 may generate a new device identifier from an algorithm, such as a rolling identifier algorithm. For example, the wireless identity transmitter 110 may generate a rolling identifier using a pseudo-random function or a streaming-like encryption algorithm (e.g., AES-CTR), as described below. The wireless identity transmitter 110 may then return to block 302 to broadcast again. In an embodiment, the broadcast message may

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contain timing, counter, count-down, or scheduling information indicating the availability of the wireless identity transmitter for receiving messages. For example, the broadcast message may indicate that the wireless identity transmitter will accept incoming configuration messages within a specified time window. In various embodiments, the operations in blocks 302-308 may be performed by an identity transceiver (e.g., a smartphone configured to operate as both an identity transmitter and a proximity broadcast receiver).

[0124] As mentioned above, the algorithm (or rolling identifier algorithm) used in block 308 may generate a rolling identifier which is very difficult to predict or recognize by a device or system that does not know either an identity of the wireless identity transmitter 110 (e.g., a MAC or Bluetooth® ID), a decode key, and/or the algorithm used to generate the rolling identifier. As discussed below with reference to FIG. 19, the central server 120, configured with the algorithm (or a decoding algorithm) or a decode key, and in possession of the wireless identity transmitter 110 identities, can use the rolling identifier to determine a corresponding account or device identity. While method 300 shows the rolling identifier changing with every wake and broadcast cycle as one example, in other embodiments the identifier may be changed less frequently, such as once per minute, once per hour, etc. In such embodiments, the operation of generating a new identifier in block 308 may be performed only at the designated interval, so at other times upon waking (i.e., block 306) the wireless identity transmitter 110 may return to block 302 to broadcast the identifier. Various algorithms for generating rolling identifiers or other encoded identifiers, as well as other decoding algorithms, are discussed below as well as in related application_U.S. Patent Application No. 13/773,336, entitled "Preserving Security By Synchronizing a Nonce or Counter Between Systems," the entire contents of which are hereby incorporated by reference for purposes of algorithms for generating, transmitting and decoding rolling identifiers and other data.

[0125] The method 300 also illustrates operations that may be implemented in the proximity broadcast receiver 142. In block 312, the proximity broadcast

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receiver 142 may receive the broadcast message from the wireless identity transmitter 110. The proximity broadcast receiver 142 may receive the broadcast message when within proximity of the wireless identity transmitter 110 (i.e., within communication range). When the broadcasted message with included identifier is received, the proximity broadcast receiver 142 may analyze header or metadata within the received broadcast message, as well as parse and evaluate various data within the broadcast message. In an embodiment, the broadcast message may contain encrypted and non-encrypted data that the proximity broadcast receiver 142 may or may not be configured to decrypt or otherwise access. In block 314, the proximity broadcast receiver 142 may transmit a sighting message to the central server 120 including the identifier, location information, and time corresponding to the receipt of the broadcast message. This transmission may be accomplished via a wireless wide area network, such as a cellular data network coupled to the Internet. In various embodiments, the operations in blocks 312 and 314 may be performed by a stationary proximity broadcast receiver, a mobile proximity broadcast receiver, or alternatively, an identity transceiver (e.g., a smartphone configured to operate as both a transmitter and a receiver).

[0126] In general, sighting messages may include metadata or header information that may describe received broadcast messages (e.g., message size, indicators of subject matter, etc.), the proximity broadcast receiver 142, such as the proximity broadcast receiver identification (e.g., a code, username, etc.), indications of services with which the proximity broadcast receiver 142 is affiliated regarding the server (e.g., the proximity broadcast receiver 142 participates in a tracking program for a particular vendor, merchant, area, etc.), as well as the conditions at the time of receipt of the broadcast message. For example, the sighting message may include signal strength information of the received broadcast message. In an embodiment, sighting messages may each include codes, flags, or other indicators that describe the general topic, subject

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matter, or reason for the sighting message. For example, the sighting message may contain a flag that indicates a relation to an active alert.

[0127] Additionally, sighting messages may include location information of the proximity broadcast receiver 142. In particular, sighting messages may indicate network-specific information that relates to a location. For example, a sighting message may indicate the cell site (e.g., cell site ID), cellular network tower (e.g., cell tower ID), or other wireless network with which a mobile proximity broadcast receiver was in communication at the time of receipt of the broadcast message. Further, sighting messages may include more refined location information based on data from global positioning systems (GPS) or chips included within the proximity broadcast receiver 142. For example, the proximity broadcast receiver 142 may determine GPS information (i.e., GPS coordinates) of the proximity broadcast receiver 142 at the time of receipt of a broadcast message, including the coordinates in the corresponding sighting message. In an embodiment, sighting messages may also include sensor data from various sensors within the proximity broadcast receiver 142, such as accelerometers, gyroscopes, and magnetometers. Further, sighting messages may include authentication information that may confirm the legitimacy of the sighting message as coming from a known, registered, or otherwise valid proximity broadcast receiver 142. For example, authentication information included in a sighting message may include secret codes, certificates, or hash data that is shared between the proximity broadcast receiver and the central server 120.

[0128] In various embodiments, the proximity broadcast receiver 142 may generate sighting messages by appending data and various information to broadcast messages received from the wireless identity transmitter 110. In an embodiment, sighting messages may include the entirety of received broadcast messages or, alternatively, only portions of the received broadcast messages that the proximity broadcast receiver 142 determines to be of significance. For example, the proximity broadcast receiver 142 may extract particular header or

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metadata information from a broadcast message before generating a corresponding sighting message. As another example, the proximity broadcast receiver 142 may compress, abbreviate, truncate and/or summarize data within the broadcast message. In another embodiment, the proximity broadcast receiver 142 may simply redirect, relay, or retransmit received broadcast messages to the central server.

[0129] Sighting messages may be transmitted via a wireless or wired communication link, such as a wireless cellular network, a local area network configured to communicate via Internet protocols, a long-range radio communication link, or a short-range radio. For example, the proximity broadcast receiver 142 may transmit sighting messages over a cellular network via the Internet to the central server. As another example, the proximity broadcast receiver 142 may transmit sighting messages via a wired Ethernet connection.

[0130] Returning to FIG. 3, the method 300 also illustrates operations that may be implemented in the central server 120. In block 322, the central server 120 may receive the sighting message from the proximity broadcast receiver 142. In block 324, the central server 120 may associate an identifier indicated by the sighting message with the wireless identity transmitter 110. The central server 120 may associate the identifier within the sighting message with an account registered/created by a user. Associating the identifier with a particular wireless identity transmitter 110 or user account may be accomplished by comparing the identifier with a database of codes corresponding to the wireless identity transmitter 110 or user accounts to determine the database record in which information from the sighting message (e.g., location info) should be stored. Since in some embodiments the wireless identity transmitter 110 identifier changes (rolls) frequently, this process may involve comparing the identifier received in the sighting message to several possible serial codes generated by a pseudo-random number generator algorithm, or applying a reverse algorithm which uses the received identifier as an input and outputs the corresponding

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account number. In block 326, the central server 120 may store data from the sighting message in a database, such as location information and time data. For example, the central server 120 may determine the location of the proximity broadcast receiver 142 when the broadcast message was received based evaluating the received sighting message, and may store that data in a database linked to the wireless identity transmitter 110 or its user/owner.

[0131] In block 340, the central server 120 may perform an action in response to the sighting message, such as transmit a message to a recipient, send a coupon, and/or calculate rewards. In an embodiment, the central server 120 may transmit a return message to a recipient, such as the proximity broadcast receiver 142, that includes instructions, software, or codes indicating how the proximity broadcast receiver 142 may respond to the received broadcast message. For example, the return message may direct the proximity broadcast receiver 142 to transmit a link advertisement message. Recipients of such messages from the central server may include various devices and parties, including computing devices of registered services (e.g., merchants, emergency personnel), mobile devices of users, and proximity broadcast receivers (e.g., the proximity broadcast receiver 142 that received the broadcast message). In another embodiment, the central server 120 may use the stored data to identify when the wireless identity transmitter 110 enters, is within, and/or leaves a designated area. In other words, the central server 120 may identify when the wireless identity transmitter 110 comes within proximity, stays within proximity, or leaves proximity of a proximity broadcast receiver 142.

[0132] FIG. 4 illustrates an embodiment method 400 for a wireless identity transmitter (referred to as "WIT" in FIG. 4) receiving configuration settings after performing boot-up operations. Typically, wireless identity transmitters may only perform one-way communications, broadcasting signals for receipt by proximity broadcast receivers. However, wireless identity transmitters may be configured to selectively engage in two-way communications with other devices with similar short-range wireless signaling capabilities (e.g., Bluetooth® LE

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transceivers). In particular, upon initialization operations (or "booting-up"), a wireless identity transmitter may be configured to receive incoming short-range wireless communications from proximity broadcast receivers. For example, when a battery is replaced or inserted for the first time, the wireless identity transmitter may accept incoming Bluetooth® packets for a predefined period of time, such as sixty seconds. Alternatively, the wireless identity transmitter may receive incoming messages as part of power-cycling (e.g., receive for the sixty seconds after a reboot of the wireless identity transmitter).

[0133] Such incoming short-range wireless communications may include instructions, software, firmware, commands, or other code for setting values for configuration parameters utilized by the wireless identity transmitter for performing various functions. In particular, the incoming communications may include configuration settings (or values) the wireless identity transmitter may use to set or modify established configuration parameters associated with transmitting broadcast messages that include identification information of the wireless identity transmitter. In an embodiment, incoming communications that include configuration settings may be Bluetooth® signals (e.g., setters or getters) that may not require pairing operations between the sender and receiver (i.e., the wireless identity transmitter). In other words, the incoming communications may be non-pairing Bluetooth® advertisements.

[0134] Configuration parameters may include the transmit interval for transmitting broadcast messages (i.e., how often the wireless identity transmitter should broadcast packets that include its identity) and the transmit power for transmitting broadcast messages (i.e., what signal strength to use when broadcasting). For example, received configuration settings may vary the intervals (i.e., broadcasting frequency) at which the wireless identity transmitter broadcasts its identifier in a manner configured to facilitate accurate tracking of the wireless identity transmitter while conserving battery power. This may be important as setting transmit power configuration parameters may affect the battery service life of the wireless identity transmitter (e.g., a longer interval may

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include a longer sleep mode and thus decreased power consumption). In an embodiment, configuration parameters may also include a debug parameter that may be set or modified by a manufacturer or administrative party (e.g., a central server). The debug parameter may be utilized by software or algorithms executed by the wireless identity transmitter and may indicate when the wireless identity transmitter should generate new identifiers to broadcast (e.g., an interval for generating a new rolling identifier or Bluetooth® MAC address identifier). In another embodiment, incoming communications with configuration settings may include commands that instruct the wireless identity transmitter to change the data represented within broadcast messages, such as by entering/exiting an encoded mode. Alternatively, incoming communications may include instructions for the wireless identity transmitter to shorten its broadcast signal range to emulate near field communications (NFC).

[0135] In block 402, the wireless identity transmitter may boot-up. In other words, the wireless identity transmitter may be energized, initialized, and otherwise configured to operate from a hibernating, sleep, dormant, or otherwise deactivated state. In various embodiments, the boot-up operations may be performed in response to a user input (e.g., a button press), the insertion of a battery in the wireless identity transmitter, or receiving a short-range wireless signal (e.g., an activation signal). In block 403, the wireless identity transmitter's short-range radio may be activated. This activation may be accomplished by a timer or by the microcontroller determining that a duration has expired since the boot-up operations were performed or concurrently with the boot-up operations. In an embodiment, the activation of the short-range radio may be a routine within the boot-up operations in block 402.

[0136] In block 404, the wireless identity transmitter may broadcast a configuration message indicating there are configuration parameters that can be set in the wireless identity transmitter. For example, the configuration message may include the wireless identity transmitter's identity (or identifier) as well as an indication that a certain number or type of configuration parameters can be

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set, modified, or initialized by subsequent short-range wireless signals. In an embodiment, the configuration message may include a list of configuration parameters available to be set, such as the transmit interval.

[0137] In an alternative embodiment, the configuration message may include an indicator that the wireless identity transmitter is available to receive configuration settings. In such an embodiment, any responding devices, such as proximate proximity broadcast receivers, may transmit responses (e.g., Bluetooth® LE signals) that request the list of configuration parameters. In response to receiving such a request, the mobile proximity broadcast receiver may transmit a second message that includes the list of configuration parameters.

[0138] In determination block 406, the wireless identity transmitter may determine whether configuration settings are received, such as in a short-range wireless signal from a proximate proximity broadcast receiver or identity transceiver. The wireless identity transmitter may monitor the short-range radio to determine whether a response is received from a proximate device. A response may be in the form of a simple response packet or pulse that the wireless identity transmitter microcontroller can recognize, or alternatively, an advertisement according to the Bluetooth® LE protocol. If configuration settings are received (i.e., determination block 406 = "Yes"), in block 408 the wireless identity transmitter may set parameters based on the received configuration settings. For example, the wireless identity transmitter may set a value that indicates how often it transmits broadcast messages. If no configuration settings are received (i.e., determination block 406 = "No"), or if the wireless identity transmitter performs the operations in block 408, in determination block 410 the wireless identity transmitter may determine whether a configuration period has elapsed. For example, the wireless identity transmitter may evaluate a counter or timer to determine whether a predefined number of seconds (e.g., 60 seconds) have elapsed since the boot-up operations were performed. If the configuration period has not elapsed (i.e., determination block 410 = "No"), in optional block 411 the wireless identity transmitter may wait a period, such as a number of

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milliseconds, seconds, etc., and then may continue with the operations in block 404.

[0139] However, if the configuration period has elapsed (i.e., determination block 410 = "Yes"), in block 302' the wireless identity transmitter may broadcast a message including an identifier based on the configuration parameters. For example, the wireless identity transmitter may transmit a broadcast message at a signal strength indicated by configuration parameters set in response to receiving configuration settings (or values) from a nearby proximity broadcast receiver. In optional block 412, the wireless identity transmitter may go to sleep for a period based on the configuration parameters, such as a transmit interval configuration parameter. In block 308, the wireless identity transmitter may generate a new device identifier (e.g., rolling identifier) from an algorithm, and may continue with the operations in block 302'.

[0140] In alternate embodiments, the wireless identity transmitter may be configured to receive incoming messages from proximity broadcast receivers based on clock timing (or clock signals), detected inputs from a user (e.g., a detected button press), or information within a previously received signal (e.g., a received message from a proximity broadcast receiver may instruct the wireless identity transmitter to become available for subsequent messages at a particular future time).

[0141] FIG. 5 illustrates an embodiment method 550 for a wireless identity transmitter performing two-way wireless communications with a proximity broadcast receiver. As described above, wireless identity transmitters may typically be used for one-way signaling, such as transmitting broadcast messages for receipt, use, and relay by proximity broadcast receivers. However, wireless identity transmitters may be configured to conduct two-way communications in order to receive firmware, software instructions or trigger signals directing the transmitter to perform certain operations (e.g., activate sensors), configuration data, and other information the wireless identity transmitter may use to transmit

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broadcast messages. Such two-way communications may be available to wireless identity transmitters that include short-range radio transceivers, such as Bluetooth® radios. However, wireless identity transmitters may be configured to selectively engage in two-way communications with proximity broadcast receivers to minimize power consumption and maximize battery service life. In an embodiment, the wireless identity transmitter may broadcast messages indicating to proximity broadcast receivers a period of time when the wireless identity transmitter may be available for receiving messages from proximity broadcast receivers, and may receive messages for a limited or predefined period of time.

[0142] In block 552, the wireless identity transmitter may reset a counter, such as a counter variable to indicate the beginning (or initialization) of a period during which the wireless identity transmitter may not receive messages. The counter may be reset to a zero value and may be incremented up to a predefined number during the operations of the method 550. Alternatively, the counter may be reset or initialized at a predefined number and decremented down to a zero value. The use of a counter variable is merely a non-limiting example technique for the wireless identity transmitter determining when to configure itself for receiving messages. In alternate embodiments, the wireless identity transmitter may instead determine when to be available for receiving incoming messages based on clock timing (or clock signals), detected inputs from a user (e.g., a detected button press), information within a previously received signal (e.g., a received message from a proximity broadcast receiver may instruct the wireless identity transmitter to become available for subsequent messages at a particular future time), or power-cycling (e.g., one such time might be for the sixty seconds after initial boot-up or reboot of the wireless identity transmitter).

[0143] In an embodiment, the wireless identity transmitter may be roughly in clock synchronization with or maintain the counter variable that it is known and roughly tracked by various proximity broadcast receivers (e.g., smartphones, listening radios throughout a place, etc.) and/or a central server. For example,

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when the wireless identity transmitter is activated (e.g., turned on, initialized by inserting a battery, etc.), a user may register the wireless identity transmitter with a central server that stores the wireless identity transmitter identification along with information that enables the central server to estimate a counter value or clock timing within the wireless identity transmitter. In an embodiment, such a counter variable or clock synchronization may be used to disambiguate wireless identity transmitter identities and/or be used as a decryption key for obfuscated or encoded messages. Such registration and synchronization operations are described further below.

[0144] In block 554, the wireless identity transmitter may generate a message including identification information, counter, and time of availability for receiving messages. The generated message may include information about the wireless identity transmitter's identity (e.g., a serial code/number, a username, or a rolling identifier). In an embodiment, the generated message may be encrypted, encoded, or otherwise obscured to prevent proximity broadcast receivers from determining the identity of the wireless identity transmitter and/or the user thereof. For example, the generated message may employ a rolling identifier or code known only to the wireless identity transmitter and a central server but not proximity broadcast receivers.

[0145] The generated message may also include information indicating a time or condition when the wireless identity transmitter may be available for accepting communications for proximity broadcast receivers. For example, the message may describe the current value of the counter or indicate a count-down timer showing when the wireless identity transmitter may be available. In another embodiment, the generated message may include instructions for proximity broadcast receivers to enable successful transmissions to the wireless identity transmitter. For example, the generated message may contain specifications (e.g., required codes, content, delivery time, etc.) for any messages transmitted by proximity broadcast receivers to the wireless identity transmitter.

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[0146] In block 556, the transmitter may broadcast the generated message via short-range wireless transmissions, such as Bluetooth® LE packets. If within the range of the short-range broadcasts, a proximity broadcast receiver may receive and process the broadcasts as described below.

[0147] The wireless identity transmitter may periodically broadcast the same generated message multiple times for each counter time period. In other words, the wireless identity transmitter may broadcast the generated message more than once before modifying the counter variable value. In determination block 558, the wireless identity transmitter may determine whether the predetermined counter time period has expired. If the counter time period has not expired (i.e., determination block 558 = "No"), the wireless identity transmitter may continue to broadcast the generated message periodically in block 556.

[0148] If the counter time period has expired (i.e., determination block 558 = "Yes"), in block 560 the wireless identity transmitter may increment the counter and, in determination block 562, determine whether the wireless identity transmitter has become available for receiving messages based on the counter value. For example, the wireless identity transmitter may compare the current counter variable value to a predefined maximum (or minimum) counter value. As stated above, in various other embodiments, the wireless identity transmitter may determine availability for receiving messages based on other evaluations of time or instructions stored within the wireless identity transmitter.

[0149] If it is not available to receive messages (i.e., determination block 562 = "No"), the wireless identity transmitter may continue with the operations in block 554 to generate a new message to broadcast. If the wireless identity transmitter is available to receive messages (i.e., determination block 562 = "Yes"), in block 564 the wireless identity transmitter may listen for incoming messages, such as by monitoring a receiver circuit for incoming short-range radio transmissions, and in block 566 the wireless identity transmitter may process any received

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incoming messages, such as with software or operations running on a processor or wireless modem within the wireless identity transmitter.

[0150] In determination block 568, the wireless identity transmitter may determine whether the receiving time period has expired. In other words, the wireless identity transmitter may determine whether incoming messages may still be received. The time period for receiving incoming messages may be based on a counter variable maintained by the wireless identity transmitter, a clock signal indication, or information within a received message. If the receiving time period has not expired (i.e., determination block 568 = "No"), the wireless identity transmitter may continue to listen for incoming messages in block 564. However, if the receiving time period has expired (i.e., determination block 568 = "Yes"), the wireless identity transmitter may repeat the process by returning to block 552.

[0151] FIG. 6 illustrates various modules within a mobile proximity broadcast receiver 138. As described above, proximity broadcast receivers may include stationary proximity broadcast receivers, such as dedicated devices placed around a building, and mobile proximity broadcast receivers 138, such as mobile devices that are configured to perform operations to receive broadcast messages from wireless identity transmitters 110 and transmit sighting messages over the Internet 103 to a central server 120 via long-range communications (e.g., via WiFi or a cellular network). The various modules and components are described below in the context of elements within a mobile proximity broadcast receiver 138, however in various embodiments, any proximity broadcast receiver, such as a stationary proximity broadcast receiver, may include similar modules and/or components.

[0152] The mobile proximity broadcast receiver 138 may include a core client module 115 that may be software, instructions, routines, applications, operations, or other circuitry utilized to process received broadcast messages from proximate wireless identity transmitters 110. The core client module 115 may also handle

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communications between the proximity broadcast receivers 142, 138 and the central server 120, such as transmitting sighting messages and receiving return messages from the central server 120. For example, the core client module 115 may operate as a background service that performs operations, such as uploading or transmitting sighting messages, without interaction from a user.

[0153] The core client module 115 may include an API component 606 that corresponds to application programming interface data, code, or other commands related to broadcast messages and/or sighting messages. For example, the API component 606 may be utilized by a proximity broadcast receiver when listening for Bluetooth® LE advertising packets received from the wireless identity transmitter 110. As another example, the API component 606 may be utilized to register the mobile proximity broadcast receiver 138 to receive notifications, alerts, or other communications corresponding to wireless identity transmitters 110. The core client module 115 may also include an authorization system component 608 for processing received broadcast messages. For example, the mobile proximity broadcast receiver 138 may support oAuth for authorization requests and xAuth for approved communication partners. The core client module 115 may also include a radio specific sightings receiver component 610 (e.g., a component for handling Bluetooth® LE, LTE-D, WiFi, and other communications), an operations, administration, and management module 612, a wireless identity transmitter network manager component 614, an event registration component 616 that relates to stored look-ahead identifiers, and a sightings manager component 618. In an embodiment, the event registration component 616 may store numerous rolling identifiers downloaded from the central server 120 and corresponding to a particular wireless identity transmitter 110, such as a set of rolling identifiers that may match possible rolling identifiers broadcast by the wireless identity transmitter 110 during a certain time window.

[0154] Like many modern mobile devices, the mobile proximity broadcast receiver 138 may be configured to execute third-party applications (or "apps"), and thus may include a third-party applications module 116 that may execute,

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manage, and otherwise perform software instructions and routines related to applications provided by various third-parties (e.g., merchants). For example, the third-party applications module 116 may receive various data from the core client module 115 to be used by various third-party applications. For illustration purposes, a third-party application related to a department store that is registered with the central server 120 may be configured to receive notifications from the core client module 115 when the user of the mobile proximity broadcast receiver 138 enters, remains, and/or leaves the department store (e.g., a geofence of the store). In an embodiment, for optimization purposes, applications or apps executing via the third-party applications module 116 may register or otherwise be configured to received notifications from the core client module 115 when particular wireless identity transmitters are within proximity, or alternatively, leave proximity. For example, applications may register in advance with the core client module 115 to receive event notifications that indicate whether a particular wireless identity transmitter enters proximity, stays within proximity (e.g., standing nearby and not moving), or leaves proximity of a proximity broadcast receiver.

[0155] The mobile proximity broadcast receiver 138 may also include an operating system and platform module 620 for performing various operations and managing circuitry, such as short-range signal receiver circuitry. In particular, the operating system and platform module 620 may include a Bluetooth® Low Energy module 624 for processing communications utilizing Bluetooth® LE protocols, a cellular network module 626 for processing communications corresponding to various cellular and similar long-range wireless networks (e.g., LTE-D, etc.). The operating system and platform module 620 may also include a time services component 628 that may track time and generate timestamp data, a location services component 630 that may maintain low-precision location data or alternatively more precise GPS (or A-GPS) location data, a storage component 632, and a wireless wide area network/ wireless local area network component 622 for enabling communications via WiFi or other wireless networks.

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[0156] In an embodiment, the core client module 115 may request from the central server sets of wireless identity transmitter identifiers (e.g., rolling identifiers of all transmitters on an interested list, identifiers for all transmitters owned by a user, etc.). Such sets may correspond to wireless identity transmitters that are currently in use and are expected to be in use for some period of time.

[0157] FIG. 7 illustrates an embodiment method 700 that may be implemented on a proximity broadcast receiver, such as a stationary proximity broadcast receiver or a mobile proximity broadcast receiver. In determination block 702, the proximity broadcast receiver may determine whether a broadcast message is received. For example, the proximity broadcast receiver may begin listening for broadcast advertisement packets or pairing attempts by wireless identity transmitters. As discussed above, in the passive mode/embodiment, the proximity broadcast receiver may continuously be in a monitoring mode, or begin listening for particular identifiers in response to an alert (or search activation message) received from a central server. In embodiments in which pairing takes place, the pairing may be established automatically if the proximity broadcast receiver is set to pair with any wireless identity transmitter without using a key, by using a key saved from a previous pairing with the wireless identity transmitter, or by using a key received from a central server. If the proximity broadcast receiver does not receive a broadcast message (i.e., determination block 702 = "No"), the proximity broadcast receiver may continue with the operations in determination block 702.

[0158] If the proximity broadcast receiver receives a broadcast message (i.e., determination block 702 = "Yes"), in block 704 the proximity broadcast receiver may generate a sighting message based on information from the received broadcast message and other associated data. In particular, the sighting message may include an identifier specific to the wireless identity transmitter that transmitted the received broadcast message, such as a rolling identifier (i.e., an encoded device identifier), MAC address, or other unique code that may be used

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to identify the particular wireless identity transmitter. In alternate embodiments, the wireless identity transmitter's identifier may be received as part of a pairing process. The other associated data may include various information related to the receipt of the broadcast message, such as the time the proximity broadcast receiver received the broadcast message, location information, the proximity broadcast receiver's identification information, related services (e.g., associated merchants), and signal strength information. In other words, the proximity broadcast receiver may associate data about present conditions (e.g., a timestamp, GPS coordinates, Cell ID of the closest base station, etc.) with the broadcast message and/or the wireless identity transmitter's identifier. This data may be stored in any of various types of data structures, such as an array with one or more identifiers associated with timestamps and GPS coordinates from when the sighting corresponding to each identifier occurred. In an embodiment, the sighting message may include authentication data, such as a digital certificate or code, that may be used by a central server to confirm the identity of the proximity broadcast receiver. For example, within the metadata of the sighting message, the proximity broadcast receiver may include a special hash code known only to the proximity broadcast receiver and the central server.

[0159] In block 706, the proximity broadcast receiver may transmit the sighting message to a central server, such as via a cellular (e.g., an LTE, 3G, or 4G network) or other network and the Internet as discussed above with reference to FIGS. 2A-2B. Upon reporting a contact event by transmitting the sighting message, the proximity broadcast receiver may promptly return to perform the operations in determination block 702 and await further broadcasts from wireless identity transmitters. This enables the proximity broadcast receiver to continuously report contact events to the central server.

[0160] FIG. 8 is a call flow diagram 800 illustrating communications during various embodiments. A wireless identity transmitter 110 may transmit a short range broadcast message 802 (e.g., a Bluetooth® LE signal) to a proximity broadcast receiver, such as a mobile proximity broadcast receiver (e.g., a mobile

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device, cellular phone, etc.) or various other proximity broadcast receivers as discussed above. The broadcast message 802 may contain an identifier for the wireless identity transmitter. The proximity broadcast receiver may transmit (or upload) the wireless identity transmitter's identifier along with any associated data (e.g., timestamp, GPS coordinates, Cell ID, etc.) as a sighting message 804 to a central server 120. The central server 120 may receive the sighting message 804 and store many different identifiers from one or more proximity broadcast receivers.

[0161] In some embodiments, identifiers and the associated data may be transmitted (or uploaded) to the central server without any of a user's personal data to protect privacy. In the various embodiments attempting to leverage personal mobile phones, the phone users may opt-in as mobile proximity broadcast receivers. However, these phone users may refuse to opt-in if they fear that personally identifiable data will also be transmitted to the central server. Therefore, an application for uploading received identifiers installed on these personal mobile devices (i.e., mobile proximity broadcast receivers) may prohibit transmission of personal data or other data that may identify the mobile proximity broadcast receivers.

[0162] The central server 120 may receive a user request 806 from a user device, such as a terminal 124 or a mobile device, requesting the location of a wireless identity transmitter. This request may be sent by a user after logging into an account associated with a particular wireless identity transmitter. For example, each wireless identity transmitter may be registered with an authenticated user such that a request 806 for the registered wireless identity transmitter's location can only be transmitted after the authenticated user logs into a secure account.

[0163] After receiving a user request 806, the central server 120 may search through the previously reported wireless identity transmitter identifiers that are received via sighting messages to find any matches with the identifier of the

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requested wireless identity transmitter. Any matches could be reported to the user in a response 808. The response 808 may also include associated data (e.g. timestamp, GPS coordinates, Cell ID) within the sighting message 804. A user may use this associated data to help locate or track the wireless identity transmitter (e.g., a mother could look for a lost child at the latest location reported for the child's wireless identity transmitter).

[0164] FIG. 9 illustrates an embodiment method 900 for including a type or command segment. In block 902, a proximity broadcast receiver may receive a broadcast message, such as a broadcast advertising packet, from a wireless identity transmitter (referred to as "WIT" in FIG. 9). In alternate embodiments, this message may be sent over a connection established by pairing or as part of the pairing procedure. The broadcast message may contain an identifier segment, as well as an additional segment or code, such as a type segment or command segment. The proximity broadcast receiver may perform an action based on this code in the received broadcast message in block 904. In various embodiments, this action may include any operation the proximity broadcast receiver is capable of performing. For example, the proximity broadcast receiver may assign different levels of priority to messages or identifiers based on a type segment or command segment (e.g., child safety devices have higher priority than security tags from stores). Received messages or identifiers with higher priority may be transmitted to a central server first or deleted last from a proximity broadcast receiver's local log.

[0165] A proximity broadcast receiver may handle the broadcast message or identifier differently based on a type or command segment. For example, the message may be stored locally for a certain time (e.g., various times depending on the value of the segment) prior to being transmitted to a central server. Alternatively, the message or identifier, along with any associated data such as timestamps and GPS coordinates, may be transmitted to multiple locations.

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[0166] As another example, a proximity broadcast receiver may initiate various communications based on the type and/or command segments. The proximity broadcast receiver may report to particular URLs, transmit an SMS message, initiate a phone call, or establish new network connections. In various embodiments, some of these actions may be optionally disabled to protect user privacy.

[0167] In further embodiments, the proximity broadcast receiver may be configured to transmit the additional segment or other message to another network device for the other network device to take some action. For example, the proximity broadcast receiver may forward the message along with associated data to the central server. The central server may perform an action based on the additional segment in the message, such as automatically sending a message to a user without waiting for a user request.

[0168] FIG. 10 illustrates an embodiment method 1000 for providing content based on proximity to a wireless identity transmitter. A proximity broadcast receiver may receive a broadcast message from a wireless identity transmitter (referred to as "WIT" in FIG. 10) containing an identification code and/or second segment in block 1002. The proximity broadcast receiver may determine whether an action associated with the identification code and/or second segment is stored locally (e.g., in the proximity broadcast receiver's memory) in determination block 1005. If an associated action is found locally (i.e., determination block 1005 = Yes), the action may be performed by the proximity broadcast receiver in block 1008.

[0169] If an associated action is not found locally (i.e., determination block 1005 = No), the proximity broadcast receiver may transmit a sighting message with the identifier and/or second segment to a central server in block 1010. In an embodiment, the proximity broadcast receiver may transmit a message to another device, such as a user device. The proximity broadcast receiver may receive an instruction message in block 1012. This instruction may be sent by the central

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server or other device in response to the sighting message with the identifier and/or second segment. In block 1014, the proximity broadcast receiver may perform an action based on the received instruction message, such as access content by going to a web page or other online resource. In alternate embodiments, the proximity broadcast receiver may skip the determination block 1005 and automatically proceed to either transmit a sighting message in block 1010 or attempt to perform an action stored locally.

[0170] A proximity-based content publishing system may be used for a wide range of activities. For example, teens may carry a wireless identity transmitter with them that they point to their social networking pages (e.g., Facebook®). When they are proximate to friends, the pages can be quickly accessed on proximity broadcast receivers (i.e., mobile phones configured to operate as mobile proximity broadcast receivers). Realtors may setup a web page for a home and affix to the home's signpost a wireless identity transmitter pointing to the web page so that anyone driving by the home can access that information. Stores may include wireless identity transmitters with products to provide dynamic displays such as links to coupons, customer reports, or additional nutritional information. If a lost dog has a wireless identity transmitter on its collar, instead of trying to wrestle the dog for access to his collar, a proximity broadcast receiver may simply access the wireless identity transmitter and send a message or call the owner.

[0171] The various features and alternative actions may enable the system to have flexible and extensible functionality. The functionality could be added later as the actions taken are controlled by applications that may be updated in proximity broadcast receivers over time.

[0172] FIG. 11 illustrates an embodiment method 1100 for a proximity broadcast receiver relaying a broadcast message to and receiving a return message from a central server. Proximity broadcast receivers may be connected to facilities, such as houses, stores, gyms, schools, etc., and may be configured to

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execute various operations relating to those facilities. For example, a proximity broadcast receiver may be contained within equipment that executes software routines. Such proximity broadcast receivers may be configured to execute particular routines in response to receiving broadcast messages from a wireless identity transmitter (referred to as "WIT" in FIG. 11). For example, the proximity broadcast receiver may modify the execution of operations to suit preferences of the user of the wireless identity transmitter.

[0173] However, as discussed above, the wireless identity transmitter may obscure, encode, or encrypt data within broadcast messages to protect the privacy and identity of the wireless identity transmitter user. For example, the broadcast messages may not transmit the user's identity in the clear. To determine the identity information related to received broadcast messages, the proximity broadcast receiver may relay the broadcast messages to the central server, which may identify the wireless identity transmitter and its user based on information in the messages (e.g., a disguised, rolled, or encrypted device ID). As discussed above, the central server may store a secret to decrypt messages transmitted by the wireless identity transmitter. In response to receiving a sighting message, the central server may transmit a return message to the proximity broadcast receiver including identification information of the wireless identity transmitter.

[0174] In an embodiment, the central server may also store additional information relevant to the operations of the facility associated with the proximity broadcast receiver. For example, the central server may be an information hub that stores proprietary information related to the operations of the facility the proximity broadcast receiver is within. As another example, the central server may contain instructions for the proximity broadcast receiver to perform based on the identity of the wireless identity transmitter. Accordingly, the central server may transmit a return message that may not identify the wireless identity transmitter (or its user) related to a sighting message, but may instead includes data relevant to the wireless identity transmitter. In various embodiments, return messages may include or not include either data or

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identification information based on the preferences of the user of the wireless identity transmitter and/or the services associated with the proximity broadcast receiver. For example, the proximity broadcast receiver may be registered as relating to a trusted service for the user of the wireless identity transmitter, and therefore the central server may transmit return messages that identify the user. As another example, the user of the wireless identity transmitter may have set privacy permissions (or settings) during a registration procedure with the central server that enable anonymous data to be distributed to proximity broadcast receivers. Privacy permissions are further discussed below.

[0175] In determination block 702, the proximity broadcast receiver may determine whether a broadcast message is received, such as from a wireless identity transmitter. If no broadcast message is received (i.e., determination block 702 = "No"), the proximity broadcast receiver may continue with the operations in determination block 702. If a broadcast message is received (i.e., determination block 702 = "Yes"), in block 706 the proximity broadcast receiver may transmit a sighting message to a central server. For example, the sighting message may include identification information of the wireless identity transmitter as well as associated data, such as the location of the proximity broadcast receiver and a timestamp. In determination block 1101, the proximity broadcast receiver may determine whether a return message from the central server is received. In an embodiment, the proximity broadcast receiver may record identification information about the sighting message and may compare that information to received messages to find a match. If no return message is received (i.e., determination block 1101 = "No"), the proximity broadcast receiver may continue with the operations in determination block 702. Alternatively, if no return message is received (i.e., determination block 1101 = "No"), the proximity broadcast receiver may optionally re-transmit the sighting message to the central server in block 706. In an embodiment, the proximity broadcast receiver may retransmit sighting messages a predefined number of times over a period of time when no return message is received.

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[0176] When a return message is received (i.e., determination block 1101 = "Yes"), in determination block 1102 the proximity broadcast receiver may determine whether the return message includes wireless identity transmitter identification information. For example, identification information may include user names, addresses, sensitive information (e.g., social security number, banking information, passwords, etc.), and other data describing the wireless identity transmitter and/or the user of the wireless identity transmitter. If the return message does contain identification information (i.e., determination block 1102 = "Yes"), in optional block 1104 the proximity broadcast receiver may transmit a message to a local device, such as a local server, for processing. In other words, the proximity broadcast receiver may relay the identification information in the return message to a local device associated with proximity broadcast receiver and/or the facility in which the proximity broadcast receiver is located. For example, the proximity broadcast receiver may transmit the identification information of the wireless identity transmitter to a local computing device of a gym, retail store, a school, or other third-party that may in turn determine instructions for the proximity broadcast receiver based on the identification information. In an embodiment, the local device may store the identification information and/or relate the information to database data for further use with the various related devices of the facility.

[0177] If the return message does not include identification information (i.e., determination block 1102 = "No") or the proximity broadcast receiver transmits a message to the local device in optional block 1104, the proximity broadcast receiver may determine whether the return message includes other data for use, such as by the proximity broadcast receiver or other devices associated with the proximity broadcast receiver in determination block 1106. For example, the return message may include commands or instructions for the proximity broadcast receiver to perform. Additionally, the data may contain configuration data (or configuration information) that may be used by various devices to accommodate the wireless identity transmitter and/or the preferences of the

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wireless identity transmitter's user. For example, the return message may contain software instructions for the proximity broadcast receiver to use or transfer to the local device, the wireless identity transmitter, or various other associated devices. If the return message includes data for use (i.e., determination block 1106 = "Yes"), in block 1108 the proximity broadcast receiver may use the data within the return message. For example, the proximity broadcast receiver may execute operations to utilize configuration data from the return message (e.g., set equipment to suit the user's preferences). If the return message does not contain data for use by the proximity broadcast receiver (i.e., determination block 1106 = "No"), the proximity broadcast receiver may continue with the operations in determination block 702.

[0178] As a non-limiting, illustrative example: the proximity broadcast receiver may be connected to a piece of exercise equipment within a fitness facility that is registered with a central server (i.e., the facility relates to a registered service). When the proximity broadcast receiver receives a broadcast message from the wireless identity transmitter carried by a user intending to work-out on the exercise equipment, the proximity broadcast receiver may transmit a sighting message to the central server. The proximity broadcast receiver may receive a return message from the central server that includes data which may be used to configure the exercise equipment to suit the anatomical dimensions and preferences of the user of the wireless identity transmitter without necessarily sharing the user's identity. For example, the proximity broadcast receiver may use the data to adjust the height of the equipment's seat or pedals. As another example, the data may define a workout routine to be executed on the exercise equipment. Alternatively, the return message may include the user's fitness facility identification, which the proximity broadcast receiver may transmit to a local server (e.g., a gym administrative server). The local server may compare the user's fitness facility identification to a local database and in response to the comparison, may transmit personalized configuration instructions to the proximity broadcast receiver and exercise equipment. Other non-limiting but

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illustrative applications of return message data may include configuring rental cars (e.g., seat positions, settings, etc.) and computer components (e.g., mouse, keyboards, etc.) for personalized use by the user of the wireless identity transmitter.

[0179] In an embodiment, return messages may include identification information such as photographic imagery useful to identify the user of the wireless identity transmitter. For example, in response to receiving a return message identifying the user of the wireless identity transmitter, the proximity broadcast receiver may display an image of the user or a sample of the user's handwriting (e.g., a signature). This functionality may be used by emergency personnel, citizens on alert, or merchants when attempting to quickly verify the identity of a person (e.g., a missing child, customer, etc.) equipped with a wireless identity transmitter. In another embodiment, a merchant's proximity broadcast receiver engaged in a business transaction (e.g., a point-of-sale device with an embedded proximity broadcast receiver) may transmit a sighting message including information broadcast by a proximate user's wireless identity transmitter. The resulting return message may include confirmation that the identities of the registered user of the wireless identity transmitter and the user match (i.e., the in-store person matches the user indicated in the central server as relating to the wireless identity transmitter). Additionally, if the identities are the same, the return message may include additional information to assist in the transactions, such as payment information, credit card numbers, or contact information for follow-up communications.

[0180] In another embodiment, the return message from the central server may include software instructions and/or data that may cause the proximity broadcast receiver to modify, adjust, remove, activate, or disable components, sensors, features, software, and/or functions of the proximity broadcast receiver. For example, the return message may include software instructions that the proximity broadcast receiver executes upon receiving the return message, or triggers the proximity broadcast receiver to execute a pre-loaded routine or enter a particular

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operating mode. Such software instructions may define operations the proximity broadcast receiver may execute that configure the proximity broadcast receiver, such as activating (or de-activating) a camera component, a cellular network modem, speaker systems, WiFi transceivers, etc. As another example, the return message may instruct the proximity broadcast receiver, such as a smartphone configured to operate as a mobile proximity broadcast receiver, to execute an application, transmit a message (e.g., email, SMS, short-range radio signal, etc.), or turn itself off. Software instructions within such return messages may include timing information that indicates when affected components, sensors, features, software, and/or functions may be configured and/or re-configured. For example, the return message may include instructions that cause the proximity broadcast receiver to disable a microphone for a certain period of time. In an embodiment, the proximity broadcast receiver may be configured to reverse any modifications, adjustments, operating mode selections, or other configurations identified in return message software instructions after a period of time and/or when the proximity broadcast receiver no longer receives broadcast messages from wireless identity transmitters related to the return message. For example, the proximity broadcast receiver may disable the speakers on the proximity broadcast receiver so long as the proximity broadcast receiver receives broadcast messages from the wireless identity transmitter. In another embodiment, the proximity broadcast receiver may modify, adjust, remove, activate, or disable components, sensors, features, software, and/or functions of the proximity broadcast receiver based on information within received broadcast messages. For example, the proximity broadcast receiver may process a received broadcast message and execute detected software instructions that direct the proximity broadcast receiver to disable a sensor, such as a camera.

[0181] FIG. 12 illustrates a diagram 1200 of various modules within a central server 120. The various modules and components are described below in the context of modules, components, and/or elements within a central server 120. However, in various embodiments, the central server 120 may include or be

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connected to individual computing devices, server blades, or other units that may perform the operations associated with the various modules and/or components described below.

[0182] As described above with reference to FIG. 1, the central server 120 may be configured to receive, store, and otherwise process data corresponding to wireless identity transmitters. For example, the central server 120 may be configured to exchange communications with various devices via the Internet 103, such as proximity broadcast receivers 142 and mobile proximity broadcast receivers 138 communicating via a cellular network 121, third-party systems 101, and other support systems and/or services 102.

[0183] The central server 120 may include several components 104-109 to perform various operations to process data, such as received from proximity broadcast receivers 142, 138, third-party systems 101, or other support systems and/or services 102. In particular, the central server 120 may include a core component 108 that may process sighting messages, execute an alert or notice engine module, handle application programming interface (API) commands, and exchange data with other components within the central server 120. The core component 108 may include a data layer module 1202 that may include units for storing short-term data and third-party specific data. The core component 108 may also include an alert engine module 1204 for generating alert messages for transmissions to proximity broadcast receivers and initiating searches of various target wireless identity transmitters. The core component 108 may further include a data anonimizer module 1206 that may generate generic, anonymous, or otherwise processed data based on privacy policies or profile preferences of users. For example, the data anonimizer module 1206 may strip personal information from return messages transmitted to a proximity broadcast receiver associated with a store so that a customer user of a wireless identity transmitter is not identified to the store, but the fact that the user is within the store is still reported to the store. The core component 108 may also include a privacy manager module 1208 that may maintain privacy permission information for

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various users. For example, the privacy manager module 1208 may include a database of privacy parameters provided by users at registration. In an embodiment, the data anonimizer module 1206 and/or the privacy manager module 1208 may utilize the permissions described below.

[0184] The core component 108 may also include a search manager module 1210 for assisting in organizing and administering searches and an authorization system module 1212. The core component 108 may further include a sightings resolver module 1214 that may be utilized by the central server 120 for identifying wireless identity transmitters associated with broadcast messages reported within received sighting messages from proximity broadcast receivers 142, 138. The core component 108 may include an API module 1216 that may include functions and interfaces for initiating operations, a sightings aggregator module 1218 for compounding various sighting messages over a period for transmissions in consolidated form to merchants, third-parties, and other services. The core component 108 may also include a network module 1220 for transmitting and receiving various communications with devices, such as proximity broadcast receivers 142, 138 and third-party systems 101 via the Internet.

[0185] The central server 120 may also include a data warehouse component 104 that may store long-term data (e.g., archived user data, past location information, etc.). The data warehouse component 104 may include various databases for storing information pertinent to users of wireless identity transmitters, such as profile information provided by users via registration websites. The data warehouse component 104 may be configured to exchange data with the data layer module 1202 of the core component 108. The central server 120 may also include an operations, administration, and management component 105 that may process and/or store software associated with user portal accesses, scripts, and tools (e.g., software utilities, routines, etc.). The operations, administration, and management component 105 may be configured to exchange data with the core component 108.

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[0186] The central server 120 may also include a developer portal component 106 that may store developer account data and perform registration, account management, and alert (or notice) management routines associated with developers, such as vendors or merchants that register to interact with users of wireless identity transmitters 110. The central server 120 may also include a user portal component 109 that may store user account data and perform registration, account management, and search routines associated with users, such as persons associated with wireless identity transmitters. The user portal component 109 and developer portal component 106 may be configured to exchange data with the authorization system module 1212 of the core component 108. The central server 120 may also include a rolling identifier (or ID) resolver component 107 that may store factory keys associated with wireless identity transmitters 110 as well as perform operations, software, or routines to match encrypted, encoded, rolling, or otherwise obfuscated identification information within received sighting messages with affiliated user data. The rolling identifier (or ID) resolver component 107 may be configured to exchange data with the sightings resolver module 1214 of the core component 108.

[0187] In various embodiments, the modules and components described with reference to FIG. 12, such as the rolling ID resolver component 107, may be performed or otherwise enabled by software instructions, applications, routines, threads, circuitry, or hardware units.

[0188] FIG. 13 illustrates a wireless identity transmitter registration process for use in various embodiments. In general, before broadcast messages may be processed by a central server, the central server may require that wireless identity transmitters and their users be registered with the central server. For example, before any tracking, searching, or other location-based activities related to a wireless identity transmitter can be initiated, the central server must be able to determine the users associated with the various wireless identity transmitters circulating in the world. Registration may create links between identifiers transmitted by wireless identity transmitters in broadcast messages, the wireless

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identity transmitters, and their users. For example, in order to transmit a notification to a missing child's parents that the child has been found, relayed obfuscated (or encoded) identifiers must be matched to account information that indicates the parents' cell phone numbers as stored in relation to a registered user account.

[0189] In particular, through registration, a timing mechanism may be synchronized between each wireless identity transmitter and the central server (i.e., a counter). With such a counter, a wireless identity transmitter and the central server may encode (or roll) and decode identifiers respectively, keeping the identity associated with the wireless identity transmitter (and its users) concealed and private. The most appropriate time to synchronize such a timing mechanism or counter may be during a device registration and/or account creation process as described below. For the purpose of FIG. 13, a mobile device, such as a smartphone, is described as being used by a user to perform account creation and registration operations (e.g., the mobile device accesses a web portal to register with the central server, etc.). However, any computing device connected to the Internet and capable of exchanging communications with the central server via a registration web portal or website may be relevant.

[0190] In block 1302, a user's mobile device (e.g., an iPhone, Android, tablet device, etc.) may install an application for use with wireless identity transmitters. Such an application (or "app") may execute on the mobile device's processor as a background service or alternatively may be activated for selective use by the user. As described throughout this disclosure, such an application may enable the mobile device to process short-range broadcast messages from proximate wireless identity transmitters, such as by identifying received signals as broadcast messages and relaying sighting messages having location information to the central server in response. In block 1304, the mobile device may transmit a registration request with user information (e.g., a device identity or "deviceID"). The registration request may be sent to the central server via Internet communications with a web portal, web site, or web server controlled or

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otherwise accessible by the central server. In other words, the mobile device may invoke the registration process or by providing user information (e.g., device ID) through the installed app by providing the device ID (deviceID) and other information the central server may utilize to bind the registration request to an account. For example, the user's mobile device may access a registration website, receive inputs from the user, and transmit the user input as data to the registration website for use by the central server as described above with reference to FIG. 12. In an embodiment, the user information may include personal information about the user, such as name, address, contact information (e.g., social network sites, cell phone number, email address, telephone number, etc.) age, and other demographic information, as well as identifying information about wireless identity transmitters and/or proximity broadcast receivers that may be associated with the user's account. For example, the user information transmitted to the central server may include the serial number on a wireless identity transmitter and/or a confirmation code produced by the mobile device in response to installing the application with the operations in block 1302. The user information may also include preference information, such as the user's preferred retails stores, product lines, and areas to eat or consume. The user information may further include privacy permissions that indicate how personal information may be distributed or used by the central server, such as discussed below. In an embodiment, users may register as anonymous users, such that the central server does not store any identifying information about the users. For example, an account may be registered that is linked to a non-descript post office box, a disposable cellular telephone number, or other contact information that does not directly identify the user or the holder of the account. This may be important for those who may choose to utilize services provided by the central server, but who are concerned about leaked private or identifying information. In block 1312, the user's mobile device may store account information, such as authentication information (e.g., codes, messages) from the central server or device ID associated with an owned wireless identity transmitter.

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[0191] In block 1306, the central server may receive the user information for account registration. In block 1308, the central server may register an account for the user. For example, the central server may store the user's information, including provided device identifications, in a database of all registered users. In block 1310 the central server may provide account creation information to the user. The account creation information may include an authentication code or other information the user's mobile device may store for future use. For example, the central server may display confirmation of account creation on a website accessible by the user's mobile device or alternatively may transmit a confirmation signal, text message, email, or other communication to the user's mobile device.

[0192] In block 402, the wireless identity transmitter boots-up, such as in response to the user inserting a battery. When the wireless identity transmitter boots, a counter value may be initialized. For example, the wireless identity transmitter may begin to increment a value that represents the passage of time, starting from a zero value. In block 1313, the wireless identity transmitter may broadcast a message (i.e., a broadcast message) that includes an encoded (or rolling) identifier. For example, the wireless identity transmitter may begin transmitting broadcast messages every few seconds. The wireless identity transmitter may generate rolling identifiers with the embodiment methods described below. In general, the broadcast message may include a payload that includes data generated by performing a pseudo-random function. For example, the wireless identity transmitter may perform a pseudo-random function to generate encoded data based on input values of the wireless identity transmitter's device ID, a counter value, and a secret key, seed, or other value known only to the wireless identity transmitter and the central server. In an embodiment, the pseudo-random function may be a polynomial time computable function that may utilize a randomly selected seed value only known to the wireless identity transmitter and the central server, such that the pseudo-random function may be computationally indistinguishable from a random function defined on the same

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domain with output to the same range as the pseudo-random function. In an embodiment, the keyed–hash Message Authentication Code (HMAC) or the cipher–based Message authentication Code (CMAC) may be used as the pseudo-random function.

[0193] In an embodiment, the wireless identity transmitter may be required to be activated within a predefined number of seconds within the time the mobile device begins the registration process with the operations in block 1304. In other words, once the wireless identity transmitter begins incrementing its counter value, the user must register with the central server within a certain period. This enables the central server to try at only a certain number of values when trying to determine the counter value at the wireless identity transmitter during registration.

[0194] In an embodiment, the wireless identity transmitter may indicate an initial broadcast by adjusting data within a broadcast message's payload. For example, the wireless identity transmitter may change a bit within a broadcast message that the central server may recognize as indicating an initialization time period for the wireless identity transmitter. If there are initialization indicators within payloads, the central server may expedite comparisons between received payloads and stored payloads by avoiding comparisons to payloads corresponding to already registered (or recognized) wireless identity transmitters within a central server lookup data table.

[0195] In block 1314, the user's mobile device may receive the broadcast message. In other words, based on the installed application (or app), the mobile device may function as a mobile proximity broadcast receiver. An installed application may, such as the app installed with the operations in block 1302, may be waiting to receive such a broadcast message in response to initiating registration operations with the central server via the registration request. In block 1316, the mobile device may transmit the wireless identity transmitter's rolling identifier and other information, such as the stored device ID and

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authentication information. In an embodiment, the mobile device may extract encoded information from the received broadcast message, such as by using text comparison and/or parsing operations. For example, the mobile device may perform a most-significant bit operation.

[0196] In block 1318, the central server may receive the message with the encoded information, as well as the authentication information and the device ID. In block 1320, the central server may validate authentication information, such as in the received message from the mobile device. In particular, the central server may compare the authentication information to information generated in the operations in blocks 1308-1310. In block 1322, the central server may generate a set of rolling identifiers using the device ID and possible counter values. The central server may compare the encoded identifiers of the set with the rolling identifier received from the mobile device. In an embodiment, the central server may compute a set of encoded data by using a pseudo-random function, such as described above, along with the device ID and a number of counter values. For example, the central server may execute the pseudo-random function with a seed shared with wireless identity transmitters, the device ID indicated by the mobile device, and many counter values, starting with 0. In block 1324, when the central server matches the received rolling identifier to one of the rolling identifiers in the generated set, the central server may store relevant counter value and time in relation to the WIT. The central server may use the counter value used to generate the matching rolling identifier to sync with the counter running on the wireless identity transmitter. In an embodiment, the central server may store an indicator that describes the wireless identity transmitter as having been successfully registered and/or synced. In optional block 1326, the central server may then transmit a registration result message to the user, such as by transmitting a message to the mobile device. The registration result message may indicate whether or not the central server was able to match the received encoded identifier with a generated identifier. In optional block 1328, the mobile device may receive the registration result message. In an embodiment, the

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registration result message indicates that the registration process failed (e.g., the received broadcast message received by the mobile device did not correspond to the user's wireless identity transmitter), the mobile device may re-attempt the registration by receiving and relaying another broadcast message.

[0197] The operations described above, particularly within blocks 1313-1324, assume that message processing operations performed by the various devices, as well as any propagation delay, may be much smaller than the time required to increment (or update) the counter value at the wireless identity transmitter. This ensures that the counter values at the wireless identity transmitter and central server do not differ by more than 1.

[0198] FIG. 14A illustrates an embodiment method 1400 for a central server to process sighting messages received from proximity broadcast receivers. As described above, the central server may be configured to utilize various modules, components, circuitry, and software to process sighting messages. In determination block 1402, the central server may determine whether a sighting message is received. The central server may evaluate a receiving circuit, buffer, queue or other indicator to determine when messages are received from various devices, such as proximity broadcast receivers. In an embodiment, the central server may utilize a network module as described above to determine whether a sighting message is received. In general, sighting messages may be received via long-range communications, such as packets transmitted via a cellular network over the Internet. If the central server does not receive a sighting message (i.e., determination block 1402 = "No"), the central server may continue with the operations in determination block 1402.

[0199] If the central server receives a sighting message (i.e., determination block 1402 = "Yes"), in block 1404 the central server may identify wireless identity transmitter information, proximity broadcast receiver information, and associated data based on the sighting message. The central server may evaluate, parse, and otherwise make accessible various data and information segments

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within the received sighting message. For example, the central server may parse the sighting message to identify an included broadcast message from the wireless identity transmitter. As another example, the central server may identity encoded data corresponding to a wireless identity transmitter identity (i.e., rolling identifier), proximity broadcast receiver identification information (e.g., a receiver ID), location information, timestamp information, sensor data (e.g., accelerometer sensor data, etc.), identifiers of applications (or apps) associated with a proximity broadcast receiver (e.g., a list of installed applications, an identifier for a relevant app executing on the proximity broadcast receiver, etc.). In an embodiment, the central server may perform the operations of block 1404 with a sightings resolver module as described above.

[0200] In block 1406, the central server may obtain the wireless identity transmitter identity based on the rolling identifier within the sighting message. The central server may perform operations to decode, descramble, decrypt, or otherwise make accessible the rolling identifier. For example, the central server may perform operations to apply a secret key or decoding algorithm to obtain the identity of the wireless identity transmitter. In an embodiment, the operations of block 1406 may be performed by the central server by way of a rolling ID resolver component as described above. For example, the central server may cause a sightings resolver module to exchange data with the rolling ID resolver component to obtain a decoded wireless identity transmitter identifier. Embodiment operations to identity the wireless identity transmitter based on a sighting message that includes a rolling identifier are described below.

[0201] In block 1408, the central server may retrieve the wireless identity transmitter user information based on the obtained wireless identity transmitter identity. For example, the central server may retrieve user account information related to the wireless identity transmitter, such as demographics information, stored data indicating previous behaviors (e.g., travel paths, location history, etc.). In an embodiment, the operations of block 1408 may be performed by the central server by way of an authorization system module as described above. For

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example, the central server may cause the authorization system module to exchange wireless identity transmitter identity information with a user portal component to obtain user information as saved within user registration databases.

[0202] In block 1410, the central server may retrieve proximity broadcast receiver identification information, such as proximity broadcast receiver user information and related services, based on the identified proximity broadcast receiver information. For example, the central server may retrieve the merchant identity associated with the proximity broadcast receiver that transmitted the received sighting message, the tracking services the proximity broadcast receiver is registered to participate in, as well as any other relevant information to the proximity broadcast receiver. The central server may retrieve email addresses, MAC addresses, phone numbers, and other contact information related to a user of related proximity broadcast receiver based on the information within the sighting message. For example, the central server may determine the user contact information associated with a proximity broadcast receiver that may be used for subsequent transmissions from the central server, such as emails or SMS text messages that indicate proximity to an item of interest. In an embodiment, the central server may determine the identity of a user of a smartphone that is configured to perform operations of a mobile proximity broadcast receiver. In an embodiment, the operations of block 1410 may be performed by the central server by way of an authorization system module as described above. For example, the central server may cause the authorization system module to exchange proximity broadcast receiver information with a developer (or user) portal component to obtain information about related registered services (e.g., merchants, stores, vendors, services, etc.) as saved within developer registration databases.

[0203] In optional block 1411, the central server may authenticate the sighting message. Based on authentication information within the received sighting message, the central server may perform authentication operations that confirm the legitimacy of the sighting message as coming from a known or otherwise

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valid proximity broadcast receiver. As described above, sighting messages may include data, such as secret codes, certificates, or hash data, that can be used to confirm the identities of valid proximity broadcast receivers. As third-parties may attempt to spoof proximity broadcast receivers associated with registered services (e.g., a nefarious spammer may attempt to imitate a merchant's store proximity broadcast receiver by sending a fraudulent sighting message), the central server may check for authentication information that confirms the information within the sighting message is useful and related to a registered service (e.g., a registered merchant, a valid developer, or other party that deploys legitimate proximity broadcast receivers). For example, the central server may detect obscured header information within the sighting message that relates to a merchant established within the central server as a registered developer. When the sighting message does not include authentication information expected by the central server, such as a special code that all proximity broadcast receivers within a certain building possess, or does include authentication information that does not match information stored in the central server, the central server may disregard the sighting message and all included information. For example, a sighting message with out-of-date or incomplete authentication information may be disregarded by the central server, or alternatively stored in a list for potentially fraudulent proximity broadcast receivers.

[0204] In optional block 1412, the central server may generate hashed data based on the obtained and/or retrieve data. In an embodiment, the operations of optional block 1412 may be performed by the central server by way of a data anonimizer module as described above. In block 1414, the central server may store data based on the sighting message in relation to the wireless identity transmitter identity. For example, the central server may store identified associated data from the sighting message in a database in relation to the wireless identity transmitter's decoded identity. In an embodiment, the operations of block 1414 may be performed by the central server by way of a data layer module as described above.

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[0205] FIG. 14B illustrates an embodiment method 1450 for a central server to process sighting messages received from proximity broadcast receivers. The method 1450 is similar to the method 1400 described above, except that the central server may perform the method 1450 to transmit messages for use by a third-party application executing on mobile device carried by a user. As described above, various messages, such as return messages, alerts (or search activation messages), may be transmitted by the central server to various recipients, such as mobile devices associated with a user. For example, the central server may transmit messages to a user's tablet, smartphone, mobile proximity broadcast receiver, or other computing device. A recipient may also include an application or app executing on a mobile device. In an embodiment, the central server may also transmit messages to other third-party recipients or devices, such registered services that may include emergency medical technicians (EMTs), fire, local police, retail store, merchant computing devices, and ad servers.

[0206] Messages transmitted by the central server in response to receiving sighting messages may be transmitted to inform devices, such as a mobile phone or mobile proximity broadcast receiver carried by a user, of the location of proximity of known wireless identity transmitters. For example, when a proximity broadcast receiver, such as a stationary proximity broadcast receiver within a retail store, relays a broadcast message from a wireless identity transmitter associated with a user, the central server may respond by transmitting a message back to a mobile device of the user indicating the user is near the store's proximity broadcast receiver. Further, a third-party application running on the user's device may use information within the message. For example, a retail store app running on a user's smartphone may receive a notice that the user has moved within proximity of a display area within proximity of a retail store building. In various other embodiments, the third-party applications may be utilized to track owned items associated with wireless identity transmitters. For

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example, a particular third-party application may perform a ring tone when the user is within proximity of a searched for missing child.

[0207] In determination block 1402, the central server may determine whether a sighting message is received. If the central server does not receive a sighting message (i.e., determination block 1402 = "No"), the central server may continue with the operations in determination block 1402. If the central server receives a sighting message (i.e., determination block 1402 = "Yes"), in block 1404 the central server may identify wireless identity transmitter information, proximity broadcast receiver information, and associated data based on the sighting message. In block 1406, the central server may obtain the wireless identity transmitter identity based on the rolling identifier within the sighting message. In block 1408, the central server may retrieve the wireless identity transmitter user information based on the obtained wireless identity transmitter identity. In block 1410, the central server may retrieve proximity broadcast receiver identification information, such as proximity broadcast receiver user information and related services, based on the identified proximity broadcast receiver information. In optional block 1412, the central server may generate hashed data based on the obtained and/or retrieve data. In block 1414, the central server may store data based on the sighting message in relation to the wireless identity transmitter identity.

[0208] In determination block 1452, the central server may determine whether a third-party application (or app) is allowed to have obtained proximity broadcast receiver information. In other words, based on data stored in the central server that is associated with the user of the wireless identity transmitter, the central server may detect any registered services or third-party applications that are associated with the user's devices. For example, the central server may evaluate database information to identify the user has installed a third-party application on his/her smartphone that corresponds to a retail store. The proximity broadcast receiver information may include proximity broadcast receiver identification (e.g., an ID code or identifier) and the user identity of the proximity broadcast

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receiver. In an embodiment, the central server may identify whether third-party applications are allowed such information based on the third-party's developer rights, such as indicated when the third-party registered as a developer or registered service, or alternatively based on the user's permission settings, as described below. In an embodiment, the central server may use application identification information provided within the received sighting message to determine whether the third-party applications on the user's device may receive proximity broadcast receiver information. For example, the sighting message may contain indicators of applications (e.g., app IDs) that correspond to the sighting message and thus are allowed to receive any proximity broadcast receiver information from the central server.

[0209] If the third-party app is not allowed to have the obtained proximity broadcast receiver information (i.e., determination block 1452 = "No"), in block 1456 the central server may transmit a message to the user's device that includes only wireless identity transmitter identification information and associated data from the sighting message. For example, the message transmitted by the central server may include the obtained wireless identity transmitter identity, user information, timestamp data, and location information from the sighting message. If the third-party app is allowed to have the obtained proximity broadcast receiver information (i.e., determination block 1452 = "Yes"), in block 1454 the central server may transmit a message to the user's device that includes wireless identity transmitter identification information, proximity broadcast receiver information, and associated data from the sighting message. For example, the message transmitted by the central server to the user's smartphone may include indicators of the obtained proximity broadcast receiver identification (e.g., serial code, group affiliation, merchant category, etc.). The central server may then continue with the operations in determination block 1402. In an embodiment, the central server may utilize an alert engine module, such as described above with reference to FIG. 12, to transmit and/or generate messages for transmission to various devices.

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[0210] FIG. 15A illustrates an embodiment call flow diagram 1500 illustrating communications between a wireless identity transmitter, a proximity broadcast receiver, and a central server. As described above, the wireless identity transmitter may periodically transmit a short-range broadcast message 802 via a short-range radio. When within signal range of the broadcast message 802, the proximity broadcast receiver may receive the broadcast message 802 using a similar short-range radio. The broadcast message 802 may be processed by the proximity broadcast receiver and related data may be relayed to the central server as a sighting message 804. In an embodiment, the sighting message 804 may include the broadcast message, identification information of the proximity broadcast receiver and/or the wireless identity transmitter, encrypted information the proximity broadcast receiver is incapable of decoding, and other information related to the reception of the broadcast message 802. In an embodiment, the sighting message 804 may be transmitted over various wireless or wired networks that may be configured to communicate via Internet protocols.

[0211] The central server may receive and process the sighting message 804. When the central server determines that the sighting message 804 requires a response based on the information in the sighting messages (e.g., metadata requesting a response, the sighting message relates to a wireless identity transmitter that needs to receive upgraded firmware, etc.), the central server may generate and transmit a return message 1502 to the proximity broadcast receiver. In various embodiments, the return message 1502 may contain configuration information, identification information describing the wireless identity transmitter, or other data as described above. The proximity broadcast receiver may receive and process the return message 1502. Based on the data within the return message 1502, the proximity broadcast receiver may optionally transmit a message 1504 to the wireless identity transmitter that may contain configuration information and other data from the central server. The wireless identity transmitter may selectively accept transmissions such as the message 1504 using operations as described above with reference to FIGs. 4.

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[0212] As another option, the proximity broadcast receiver may transmit a message 1506 to a local server based on the return message 1502. The message 1506 may contain wireless identity transmitter identification information, configuration information, software routines, and various other data from the return message 1502 for storage, processing, and otherwise additional use by the local server. Based on the message 1506, the local server may in turn transmit an optional response message 1508 to the proximity broadcast receiver that may include software instructions, configuration data, or other data generated in response to receiving the message 1506.

[0213] In an embodiment, the central server may also transmit messages directly to the local server (not shown) that include configuration information and other data. For example, the sighting message 804 from the proximity broadcast receiver may provide the contact information for the local server which the central server may utilize for subsequent communications.

[0214] FIG. 15B illustrates an embodiment call flow diagram 1550 illustrating communications between a wireless identity transmitter, a proximity broadcast receiver, a local computing device, and a central server. The local computing device may be a local server, such as within a retail store, or alternatively, a device configured to perform operations of a point-of-sale device (e.g., a cash register). The proximity broadcast receiver may be a stationary receiver device associated with and communicates information to the local computing device. For example, the local computing device and the proximity broadcast receiver may both be associated with a merchant and/or both communicate over a common local area network, such as via a WiFi router. For example, the stationary proximity broadcast receiver may be placed at the cash register of the retail store and may receive transmissions from wireless identity transmitters when customers walk within proximity of the cash register.

[0215] As described above, the wireless identity transmitter 110 may periodically transmit a broadcast message 802 via short-range wireless signals

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(e.g., Bluetooth® LE radio signals). When within signal range of the broadcast message 802, the proximity broadcast receiver may receive the broadcast message 802 using a similar transceiver. The broadcast message 802 may be processed by the proximity broadcast receiver and transmitted to the local computing device as a first sighting message 804' for processing. The local computing device may in turn transmit a second sighting message 1552 to the central server. The second sighting message 1552 may be identical to the first sighting message 804' or alternatively a new or modified version of the first sighting message 840'. For example, the second sighting message 1552 may include identification information of the local computing device in addition to a representation of the broadcast message 802.

[0216] The central server may receive and process the second sighting message 1552, as described above, and may generate and transmit a return message 1554 to the local computing device. In an embodiment, the local computing device may be configured to act as a message router and may transmit a message 1556 to the proximity broadcast receiver. The message 1556 may be similar to the return message 1554 or alternatively may include only portions of the return message 1554. For example, the message 1556 may contain information (e.g., marketing information, payment authentication information, etc.) to be rendered or otherwise used by the proximity broadcast receiver. In an embodiment, the message 1556 may include instructions for presenting marketing information, such as software instructions for rendering an advertising video.

[0217] In an embodiment, the central server may transmit a return message 1502 to the proximity broadcast receiver, which may in turn transmit a message 1560 to the local computing device that reports various information (e.g., the identification information of the wireless identity transmitter). In an embodiment, the proximity broadcast receiver may process the return message 1502 and the message 1556 and may store, utilize, and/or evaluate data of the return message 1502. For example, the stationary proximity broadcast receiver may detect software instructions within the return message 1502 or the message

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1556, such as an instruction to re-calibrate a radio within the proximity broadcast receiver, and may perform operations in response to detecting the software instructions. As another example, the proximity broadcast receiver may store a list of wireless identity transmitter identities based on the return message 1502 or the message 1556. In an embodiment, the return message 1502, 1554 may not include identification information of the wireless identity transmitter, but may instead include an indicator of whether the wireless identity transmitter is related to an authorized user.

[0218] FIG. 16 illustrates an embodiment method 1600 for a central server to process sighting messages received from a proximity broadcast receiver. In general, based on the information within sighting messages, the central server may identify a wireless identity transmitter (and related user), determine whether there is a relationship between the proximity broadcast receiver and the wireless identity transmitter (i.e., related to a registered service), and transmit return messages with various data and/or information based on the sighting messages. Accordingly, return messages may be provided to proximity broadcast receivers such that no identifying information about the wireless identity transmitter is included. This may enable the proximity broadcast receiver to anonymously personalize equipment, devices, or other facilities, as described above, to benefit the user of the wireless identity transmitter without disclosing his/her identity. For example, a return message from the central server may include a user's configuration data for a piece of equipment but not the user's identity. In an embodiment, the method 1600 may be performed by the central server in connection with the proximity broadcast receiver performing the operations of the method 1100 as described above with reference to FIG. 11. In various embodiments, such return messages may be transmitted to any devices related to received sighting messages and/or the related wireless identity transmitter, such as third-parties (e.g., emergency services, retailers, etc.) or user devices associated with the sighting message.

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[0219] In determination block 1402, the central server may determine whether a sighting message is received. If no sighting message is received (i.e., determination block 1402 = "No"), the central server may continue with the operations in determination block 1402. If a sighting message is received (i.e., determination block 1402 = "Yes"), in determination block 1602 the central server may determine whether the wireless identity transmitter identity is known. In other words, the central server may perform the operations in block 1404-1410 as described above with reference to FIG. 14A in order to evaluate, decode, decrypt, and otherwise access the data within the received sighting message to determine whether it includes a wireless identity transmitter identity (or identifier) that is associated with a user registered with the central server. For example, the central server may decrypt a rolling identifier within the received sighting message to identify a device identifier of a wireless identity transmitter and may match that identifier to stored information representing all registered users and/or devices. If the wireless identity transmitter is not known (i.e., determination block 1602 = "No"), in block 1603 the central server may ignore the sighting message and continue to perform the operations in determination block 1402. If the wireless identity transmitter is known (i.e., determination block 1602 = "Yes"), in block 1414 the central server may store data based on the sighting message in relation to the wireless identity transmitter identity, such as storing location data within the sighting message in a database in relation to the user of the wireless identity transmitter.

[0220] In determination block 1604, the central server may determine whether the received sighting message relates to a registered service. In other words, the central server may compare information obtained from the sighting message to lists of registered services to determine whether the sighting message is valid (or authenticated) and corresponding to a third-party, merchant, or other service registered with the central server. To make the determination, the central server may analyze the received sighting message and evaluate any metadata or header information that identifies the proximity broadcast receiver, the subject matter of

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the sighting message, or other descriptive information regarding the proximity broadcast receiver and/or the wireless identity transmitter that transmitted the broadcast message reported by the sighting message. For example, the sighting message may contain metadata that indicates the sighting message was sent by a proximity broadcast receiver in response to an active alert. Alternatively, the sighting message may contain header information that indicates relevance to a particular vendor facility or service. For example, the sighting message may contain metadata that indicates the proximity broadcast receiver is associated with a particular third-party application (e.g., a retail store app ID). As another example, the central server may evaluate metadata within the sighting message to detect a code that identifies a registered merchant or retail store that is associated with a marketing service or data collection scheme. A sighting message may not relate to a registered service if the transmitting proximity broadcast receiver is not registered, authenticated, or otherwise known to the central server.

[0221] If the sighting message is not related to a registered service (i.e., determination block 1604 = "No"), the central server may continue with the operations in determination block 1402. If the sighting message does relate to a registered service, such as a valid vendor service or an active alert (i.e., determination block 1604 = "Yes"), in block 1606 the central server may generate a return message. The return message may include information that indicates the sighting message, the proximity broadcast receiver, related services, time of receipt of the sighting message, and other informational data. In determination block 1608, the central server may determine whether the proximity broadcast receiver is allowed to receive identification info. In other words, the central server may determine whether the proximity broadcast receiver has permission or is authorized to receive identification information of the wireless identity transmitter. For example, based on metadata within the sighting message indicating that the proximity broadcast receiver is associated with a vendor or a registered service, the central server may determine that the identification of the wireless identity transmitter (or its user) may not be included

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within the return message. In an embodiment, the central server may evaluate a stored database that describes information permissions based on the identity of the proximity broadcast receiver and its associated services. For example, the database may indicate that the proximity broadcast receiver is associated with a service that is allowed to receive identification information about the wireless identity transmitter. Such permissions or privacy settings are described below with reference to FIGS. 31-32. For example, using user identification information obtained based on the sighting message, the central server may look-up user permissions to identify whether the user authorized user data to be shared with registered services.

[0222] If the proximity broadcast receiver is allowed to receive identification information (i.e., determination block 1608 = "Yes"), in block 1610 the central server may append identification information to the return message. For example, the return message may include the username, customer ID, address and/or name of the user of the wireless identity transmitter. If the proximity broadcast receiver is not allowed to receive identification information (i.e., determination block 1608 = "No") or if the central server appended identification information to the return message in block 1610, the central server may determine whether there is stored data related to the wireless identity transmitter and the registered service in determination block 1612. The central server may evaluate a database and identify whether the proximity broadcast receiver, its associated devices or services (e.g., a local server), and/or the wireless identity transmitter require data based on the sighting message. Examples of such data may include firmware, software instructions, configuration information, proprietary information (e.g., customer ID), activity information (e.g., information describing recent wireless identity transmitter activities related to the proximity broadcast receiver), or any other relevant information. The central server may query the database using the wireless identity transmitter identification information in combination with the proximity broadcast receiver identification information to detect data within the database that may be included

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in the return message. For example, the return message may contain personalization information for the user of the wireless identity transmitter to be used by the proximity broadcast receiver. In an embodiment, the database may indicate that the proximity broadcast receiver is associated with a service (e.g., vendor, merchant, etc.) that stores proprietary data within the central server database.

[0223] If there is stored data related to the wireless identity transmitter and the registered service (i.e., determination block 1612 = "Yes"), in block 1614 the central server may append the data regarding registered service and the wireless identity transmitter to the return message. If there is no stored data related to the wireless identity transmitter and the registered service (i.e., determination block 1612 = "No"), or if data is already appended, in block 1616 the central server may transmit the return message, such as to the proximity broadcast receiver. The central server may then continue to perform the operations in determination block 1402.

[0224] FIG. 17 illustrates an embodiment method 1700 for a central server determining whether a proximity broadcast receiver has lost a wireless identity transmitter. In the central server, the proximity broadcast receiver may be associated with the wireless identity transmitter. For example, the proximity broadcast receiver may be a user's smartphone that is associated with the wireless identity transmitter within an asset (e.g., wallet, purse, luggage, medicine bag, clothing, etc.). In response to failing to receive sighting messages from a proximity broadcast receiver associated with a particular wireless identity transmitter, the central server may be configured to transmit messages, such as warnings, indicating that the wireless identity transmitter (and the object it is connected to) is lost, absent, forgotten, or otherwise non-proximate to the proximity broadcast receiver. This embodiment method 1700 may be useful for leashing certain assets, such as possessions, pets, and children. For example, when a child runs from a parent, broadcast messages from the child's wireless identity transmitter may no longer be received by the parent's proximity

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broadcast receiver. As a result, the parent's proximity broadcast receiver may not transmit sighting messages to the central server and the central server may determine the child has been lost or run away.

[0225] In block 1702, the central server may register a relationship between the proximity broadcast receiver and the wireless identity transmitter, such as by storing information within a database. In various embodiments, each proximity broadcast receiver and wireless identity transmitter may be involved in numerous relationships. Additionally, the relationship information may be stored based on user input data to the central server via a registration web portal (e.g., the user may access a website and indicate all of his/her wireless identity transmitters). During such a registration, the central server may prompt the user to provide conditions under which the central server should transmit messages when wireless identity transmitters are lost or otherwise outside of the proximity of the proximity broadcast receiver. For example, the user may enter configuration data stored by the central server that indicates that if the proximity broadcast receiver does not receive broadcast messages from the wireless identity transmitter between certain hours of the day, the central server should transmit a warning message.

[0226] In determination block 1704, the central server may determine whether a sighting message has been received from the proximity broadcast receiver related to the wireless identity transmitter. In other words, based on whether or not such a sighting message is received, the central server may detect if the wireless identity transmitter is close to the proximity broadcast receiver. The central server may also evaluate sighting messages received over a period to determine whether the wireless identity transmitter is (or has recently been) within proximity of the proximity broadcast receiver. In an embodiment, the central server may determine whether it receives a sighting message for each wireless identity transmitter registered in the relationship. For example, if the registered relationship includes multiple wireless identity transmitters, the central server may expect to receive sighting messages from the proximity broadcast receiver

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regarding all the wireless identity transmitters. If the central server receives a sighting message related to the wireless identity transmitter (i.e., determination block 1704 = "Yes"), in optional block 1705 the central server may wait a period and may continue with the operations in determination block 1704. In various embodiments, the central server may perform the operations in determination block 1704 periodically, such as every few seconds, minutes, or hours.

[0227] If the central server does not receive a sighting message related to the wireless identity transmitter (i.e., determination block 1704 = "No"), in block 1706 the central server may transmit a message indicating the wireless identity transmitter is lost. In various embodiments, the central server may transmit such a message to the proximity broadcast receiver, other devices associated with the user of the proximity broadcast receiver (e.g., a smartphone, tablet), and/or any other device relevant to the wireless identity transmitter. For example, the central server may transmit a warning message to a police server when the wireless identity transmitter is lost and associated with a child.

[0228] FIG. 18A illustrates two proximity broadcast receivers 138, 138' receiving short-range broadcast messages from a wireless identity transmitter 110. In various embodiments, the communication system may provide increased location or proximity granularity when multiple proximity broadcast receivers (e.g., mobile proximity broadcast receivers) are able to successfully communicate with a wireless identity transmitter. As previously discussed, since the wireless identity transmitter relies on a short-range radio to broadcast its identifier to proximity broadcast receivers, the location of a proximity broadcast receiver receiving such a short-range broadcast message provides an approximate location for the wireless identity transmitter (i.e., the proximity broadcast receiver and wireless identity transmitter are within proximity of each other when a broadcast message is received). However, if multiple proximity broadcast receivers receive the broadcast message from the wireless identity transmitter, the location of the wireless identity transmitter may be more precisely approximated.

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[0229] In particular, two proximity broadcast receivers 138, 138' may receive broadcast messages from a wireless identity transmitter 110. Since the reception range of signals transmitted by wireless identity transmitters 110 is limited, proximity broadcast receivers 138, 138' may receive the broadcast messages only if the wireless identity transmitter 110 is within that reception range 1801, 1801'. Thus, if both proximity broadcast receivers 138, 138' receive the same broadcast message from the wireless identity transmitter 110, then the wireless identity transmitter 110 must be located in the overlapping region that is within the reception range 1801, 1801' of both of the two proximity broadcast receivers 138, 138'. Since the reception range 1801, 1801' will depend upon signal attenuators (e.g., structures and vegetation) along the transmission path and the sensitivity of proximity broadcast receivers 138, 138', this variability may be taken into account by a central server, such as by treating the reception range 1801, 1801' as a statistical parameter (e.g., average range with standard deviations, which may be determined through field testing). In such an embodiment, the central server may assign probabilities to different overlapping region sizes, which may help searchers focus initial search efforts.

[0230] FIG. 18B illustrates an embodiment method 1820 for a central server providing a finer grained location for a wireless identity transmitter. The central server may receive multiple sighting messages from proximity broadcast receivers in block 1822. The central server may determine whether any of the received sighting messages are concurrent in determination block 1825 (i.e., whether broadcast messages from the same wireless identity transmitter are reported as being received at approximately the same time from two different proximity broadcast receivers). The central server may not consider sighting messages concurrent unless they are associated with the same wireless identity transmitter (i.e., include the same identifier or corresponding rolling identifiers) and come from different proximity broadcast receivers. Further, the central server may determine whether sighting messages are concurrent based on the contents of the messages, such as by comparing and matching timestamps in the

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received sighting messages (i.e., the time the proximity broadcast receivers received broadcast messages from the same wireless identity transmitter). The timestamps may be matched without being exactly the same in order to accommodate differences due to unsynchronized clocks within the proximity broadcast receivers, transmission delays, etc. In some cases, such as if the wireless identity transmitter is assumed or determined to be stationary, received sighting messages may be matched for purposes of refining the position despite the messages being received at different times. The acceptable time range for matching may be adjustable. Alternately, if the wireless identity transmitter is using a rolling identifier that shifts with each broadcast message, the central server may match received sighting messages based on the rolling identifier rather than on timestamps. If none of the sighting messages are determined to be concurrent (i.e., determination block 1825 = "No"), the central server may continue with the operations in block 1822.

[0231] If the central server determines that two or more sighting messages are concurrent (i.e., determination block 1825 = "Yes"), the central server may compute the location and area of an overlapping region related to the concurrent sighting messages in block 1828. For example, based on the locations of each of the proximity broadcast receivers associated with the concurrent sighting messages and the known transmission range of the wireless identity transmitter, the central server may compute the reception radius of each proximity broadcast receiver to determine the overlapping region. The location of each proximity broadcast receiver may be included in sighting messages transmitted by each proximity broadcast receiver.

[0232] In block 1830, the central server may associate the overlapping region (i.e., the computed location and area of the overlapping region) with the wireless identity transmitter. In other words, the central server may associate a finer grained location of the wireless identity transmitter by calculating multiple reception radii for each of the proximity broadcast receivers and identifying an overlapping region that falls within the reception range of each proximity

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broadcast receiver. This finer grained location may also be associated with the contents of one or more of the proximity broadcast receiver sighting messages (e.g., timestamp, sensor data, etc.). Also as part of block 1830, the central server may identify a number of overlapping area boundaries and assign a probability value to each based on the average and variability of the transmission range.

[0233] Embodiment method 1820 may be applied to many concurrent sighting messages received from several proximity broadcast receivers, which may enable the overlapping area to be more narrowly defined. For example, the central server may compute the overlapping region between several proximity broadcast receiver listening ranges or refine a previously computed overlapping region based on another overlapping report (i.e., compute the overlapping region shared by a previous overlapping region and another proximity broadcast receiver listening area). For example, as searchers close in on the wireless identity transmitter, each of their respective mobile proximity broadcast receivers will begin to transmit sighting messages related to the wireless identity transmitter, which the central server may combine to further narrow the search area as searchers approach from different directions. This capability may be further leveraged by having some searchers move away from a suspected location of the wireless identity transmitter until their mobile proximity broadcast receivers are transmitting sighting messages only intermittently, indicating they are on the edge of the transmission range. With multiple proximity broadcast receivers positioned near the apparent maximum transmission range, the overlapping area computed by the central server can be minimized, thereby helping to further pinpoint the location of the wireless identity transmitter.

[0234] Further embodiments may provide increased location granularity by considering the power level of the broadcast messages received by multiple proximity broadcast receivers. As is well known, the signal strength of a radio transmission from a point transmitter decreases with distance by a factor proportional to the inverse of the square of the distance (i.e., $1/R^2$), with any intervening structure or vegetation causing further attenuation. Thus, proximity

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broadcast receivers located at different distances from a wireless identity transmitter will typically receive the broadcast messages with different signal strengths. For, example, FIG. 18C illustrates a wireless identity transmitter 110 whose transmissions (i.e., broadcast messages) are being received by two proximity broadcast receivers 138, 138' at different ranges. Due to the attenuation of radio signals with distance, the proximity broadcast receiver 138' at distance 1852 from the wireless identity transmitter 110 may typically receive the transmissions with a higher signal strength than a more distant proximity broadcast receiver, such as the proximity broadcast receiver 138 at distance 1850. Thus, by including the signal strength of received transmissions in sighting messages transmitted by proximity broadcast receivers 138, 138' to a central server, the central server may be able to further refine the location of a wireless identity transmitter 110.

[0235] A proximity broadcast receiver's distance to the wireless identity transmitter 110 may be estimated as inversely proportional to the power level. Distance estimations may also account for channel conditions such as intervening signal attenuators (e.g., vegetation, buildings, etc.), echoes (i.e., multipath reception) or other interferences. The distance may be estimated locally on the proximity broadcast receiver 138,138' or alternately by the central server if the proximity broadcast receiver 138, 138' includes the power level in a sighting message. Each proximity broadcast receiver's own location and estimated distance from the wireless identity transmitter 110 may be used to triangulate the approximate location of the wireless identity transmitter 110. For example, as searchers close in on the wireless identity transmitter, the signal strength of received broadcast messages from the wireless identity transmitter may increase, enabling the central server to further narrow the search area as searchers approach from different directions. Thus, when proximity broadcast receivers 138, 138' include signal strength data in sighting messages, the central server can reduce the overlap area for searching as multiple searchers approach the wireless identity transmitter 110 (which would not be the case in the circumstances

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similar to illustrated above with reference to FIGs. 18A and 18B as the overlap area was determined solely upon the maximum reception range).

[0236] FIG. 18D illustrates an embodiment method 1860 for a central server providing a finer grained location for a wireless identity transmitter based on the power level of broadcast messages received by proximity broadcast receivers. The central server may receive multiple sighting messages from proximity broadcast receivers in block 1822. The sighting messages may include the power level of a broadcast messages received by the reporting proximity broadcast receivers, or an estimated distance from the proximity broadcast receiver to the wireless identity transmitter determined based on the received signal strength. The central server may determine whether any of the sighting messages are concurrent in determination block 1825. The central server may not consider sighting messages concurrent unless they are associated with the same wireless identity transmitter (i.e., include the same identifier or corresponding rolling identifiers) and are received from different proximity broadcast receivers. Further, the central server may determine whether sighting messages are concurrent based on the contents of the sighting messages as described above with reference to FIG. 18B. If none of the sighting messages are concurrent (i.e., determination block 1825 = "No"), the central server may continue with the operations in block 1822.

[0237] If the central server determines that two or more sighting messages are concurrent (i.e., determination block 1825 = "Yes"), the central server may compute a finer grained location of the wireless identity transmitter based on the received signal power levels and the locations of proximity broadcast receivers transmitting the concurrent sighting messages in block 1868. The central server may estimate the distance between the proximity broadcast receivers and the wireless identity transmitter or may receive an estimated distance in the sighting messages as discussed above. Each proximity broadcast receiver's location and estimated distance from the wireless identity transmitter may be used to triangulate the finer grained location. Triangulation based on information within

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sighting messages received from only two proximity broadcast receivers may result in two possible locations for the wireless identity transmitter. However, information in sighting messages from three or more proximity broadcast receivers may be used to better approximate the wireless identity transmitter's location. The central server may associate the finer grained location (i.e., the triangulated location) with the wireless identity transmitter in block 1870. This finer grained location may also be associated with the contents of one or more of the proximity broadcast receiver sighting messages (e.g., timestamp, sensor data, etc.).

[0238] In optional block 1872, the central server may transmit a return message to a proximity broadcast receiver that is closest to the wireless identity transmitter based on signal power information reported in received sighting messages. In other words, the central server may determine the closest proximity broadcast receiver to the wireless identity transmitter among the plurality of proximity broadcast receivers that transmitted the concurrent sighting messages. Often, a user of a wireless identity transmitter may intend to use a device associated with a single proximity broadcast receiver within a plurality of proximity broadcast receivers (e.g., a point-of-sale device in a line of point-of-sale devices each connected to proximity broadcast receivers). The central server may use signal strength or signal power indicators within concurrent sighting messages, as well as any other relevant data (e.g., location information, direction of the wireless identity transmitter based on previous sighting messages, etc.) to determine the single proximity broadcast receiver the user of the wireless identity transmitter likely intends to interface. The return message may indicate to the proximity broadcast receiver that the wireless identity transmitter is likely intending to interface with that proximity broadcast receiver, and may additionally include instructions, data, or other information for the proximity broadcast receiver. For example, the return message may include a message indicating the user of the wireless identity transmitter is near, or alternatively instructions on how to handle the user.

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[0239] In an embodiment, the return message may indicate information describing the certainty of the determination that the recipient proximity broadcast receiver is the closest to the wireless identity transmitter. Additionally, the return message may request a confirmation of proximity to the wireless identity transmitter. For example, the closest proximity broadcast receiver may confirm that it is the closest proximity broadcast receiver based on subsequent input data related to the user of the wireless identity transmitter (e.g., the user of the wireless identity transmitter pressed a 'confirm' button on the proximity broadcast receiver). In another embodiment, the central server may transmit messages to the proximity broadcast receivers determined to not be the closest proximity broadcast receiver, indicating that these proximity broadcast receivers are not closest and/or the identity of the determined closest proximity broadcast receiver. In response, the proximity broadcast receivers that are not the closest may modify their subsequent transmission of sighting messages regarding the wireless identity transmitter. For example, the proximity broadcast receivers may adjust (i.e., increase or decrease) the frequency of transmitting sighting messages regarding the wireless identity transmitter (i.e., adjust receiver thresholds) or alternatively may ignore future broadcast messages from the wireless identity transmitter for a period of time.

[0240] FIG. 19 illustrates an embodiment method 1900 that may be implemented within a central server. The method 1900 may be performed by the central server in response to receiving a sighting message from a proximity broadcast receiver that includes encoded, rolling, or otherwise protected data originally broadcast by a wireless identity transmitter. Privacy of users of wireless identity transmitters may be protected by using a rolling or randomly varying identifier for each wireless identity transmitter so the identifier changes with time. New identifiers may be generated periodically or based on certain events, such when a wireless identity transmitter broadcasts an identifier a certain number of times or for a certain time period (e.g., an hour), or after one or more pairings. This rolling of identifiers may be coordinated with the central server so

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that the wireless identity transmitter may still be tracked. For example, the wireless identity transmitter and the central server may each have a cryptographically secure pseudo-random number generator algorithm that is used to generate identifiers on a common time scale so that any given moment, the central server can calculate the identifier being transmitted by a particular wireless identity transmitter.

[0241] Generating rolling identifiers, or other methods of obfuscating identifiers, is important in that it may prevent sniffing attacks from a third party. For example, if the identifier was static, a third party could sniff the identifier, such as by impersonating a proximity broadcast receiver, and then use the identifier to track the wireless identity transmitter. A rolling identifier may hinder such an attack impossible if the third party lacks the pseudo-random number generator or other means of generating the latest rolling identifiers.

[0242] In block 1902, the central server may receive a wireless identity transmitter's rolling identifier in a sighting message from a proximity broadcast receiver. In block 1904, the central server may compare the rolling identifier with code calculated by an algorithm shared with the wireless identity transmitter, such as a pseudo-random function or an encryption algorithm with shared secret keys. The algorithm may be software instructions, routines, algorithms, circuitry, or modules that are utilized by the central server to calculate codes that are expected to align with rolling identifiers generated and broadcast by the wireless identity transmitter over a period. In various embodiments, the central server may compare the received identifier with the next several codes in case some identifiers were missed. If the received identifier matches any codes generated or expected by the central server, in block 1906 the central server may associate the matching identifier and any associated data with a serial code corresponding to the wireless identity transmitter. This way, if the central server later receives a user request with the wireless identity transmitter's serial code, such as a request from a parent to locate the wireless identity transmitter carried by a child, then the central server can find all the prior

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matches and any associated data without having to search for every previous rolling identifier.

[0243] In an embodiment, when initiating a search for a target wireless identity transmitter, the central server may use the shared algorithm and information (e.g., key) to generate a target device ID that is transmitted in an alert message. In this embodiment, alert messages may be retransmitted with an updated target device ID whenever the target wireless identity transmitter is scheduled to roll its identifier. Various algorithms for generating rolling identifiers or other encoded identifiers, as well as other decoding algorithms, are discussed below.

[0244] FIGS. 20-23B illustrate various embodiment methods for synchronizing a counter between a wireless identity transmitter and a central server to enable transmitting and receiving obscured information. The wireless identity transmitter may perform various methods for broadcasting messages that include obscured identifiers and data (i.e., payloads) that identify the wireless identity transmitter to the central server and provide a relative reading on the wireless identity transmitter clock. Likewise, the central server may perform various methods for processing obscured information within received messages corresponding to the wireless identity transmitter. As described above, the broadcast messages from the wireless identity transmitter may be sent to the central server directly or through intermediary devices, such as proximity broadcast receivers transmitting sighting messages.

[0245] Due to privacy concerns regarding unintended tracking of devices described above, the wireless identity transmitter may obscure information within the transmitted messages through obfuscation measures (e.g., encryption or pseudo-random data generation) known only to the central server and wireless identity transmitter. In general, the wireless identity transmitter may maintain a clock or timer mechanism that is represented by a counter value (or a "nonce") and that may begin once the device is operational (e.g., activated through the insertion of a battery). The clock may be relatively low-quality and therefore

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may drift unlike more accurate clocks, such as in the central server (e.g., clocks calibrated by periodic atomic clock readings). The counter (or nonce) may be a non-repeating number generated by the wireless identity transmitter, and may be changed each time wireless identity transmitter encodes its identifier for broadcasting, such as once every hour or even once every broadcast message. In various embodiments, counters (or counter values) may be encrypted or encoded using pseudo-random functions or other encryptions algorithms (e.g., AES). For example, a wireless identity transmitter may encode a counter value with an AES-CTR block cipher to create a nonce for use in generating the payload including a rolling identifier of a broadcast message. As another example, a nonce may be generated by applying a linear feedback shift register (LFSR) to a counter value.

[0246] As described throughout the disclosure, the wireless identity transmitter may also store a unique device identification code or number (i.e., a device identifier or '*deviceID*') and be pre-provisioned with a per-device shared secret key (or *K*) which is associated with the unique identifier at the central server. For example, the central server may store the unique device identifier and the secret key in a database and may maintain a table of *deviceID* and *K* pairs for all wireless identity transmitters registered with the central server. The central server may use the device identifier and secret key, along with other information such as reported counter values, to identify, decrypt and otherwise process obscured messages from the wireless identity transmitter. In an embodiment, the device identifier (or *deviceID*) may be generated sequentially or randomly.

[0247] FIG. 20 illustrates an embodiment method 2000 for a central server to identify a wireless identity transmitter indicated by encrypted data within a message broadcast by the wireless identity transmitter. In block 2002, the wireless identity transmitter may receive a shared secret key (i.e., "*K*"). In other words, the wireless identity transmitter may be pre-provisioned with a per-device shared secret key (*K*), such as during manufacturing. In another embodiment, the wireless identity transmitter may receive the secret key in a messages broadcast

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from a proximate proximity broadcast receiver, such as described above with reference to FIG. 4. The secret key may be associated with the wireless identity transmitter's unique device identifier (i.e., *deviceID*) at the central server. In an embodiment, the secret key may be a 128 bit secret key.

[0248] In block 2004, the wireless identity transmitter may encode the device identifier (*deviceID*), secret key (*K*), and a counter value via a streaming-like encryption algorithm (e.g., AES-CTR encryption) to generate a rolling identifier. "AES-CTR" is one of the confidentiality modes recommended by the National Institute of Standards and Technology for implementations of the Advanced Encryption Standard (AES). In an embodiment, the wireless identity transmitter may include an AES coprocessor that is configured to support the "CTR" mode. In an embodiment, the rolling identifier may be represented by the following equation:

Rolling identifier = (*deviceID* || *bat_stat*) XOR (MSB_N(AES_K(*t*)))

[0249] where *t* is the value of the wireless identity transmitter's counter (e.g., a 20 bit value), '*bat_stat*' is the battery status information of the wireless identity transmitter (e.g., a 4-bit code), '||' means concatenation, `XOR' denotes the bitwise exclusive-or operation, 'AES_K()' is the AES block cipher with key '*K*', and 'MSB_N()' means the 'N' most significant bits (e.g., 60 bits).

[0250] In block 2006, the wireless identity transmitter may then broadcast a message that includes the counter and the rolling identifier. In an embodiment, the broadcast message may be a single packet length Bluetooth® LE® chirp message. In various embodiments, the counter included in the broadcast message may be 20 bits and the rolling identifier may be 60 bits, so that the entire broadcast message is 80 bits.

[0251] In an embodiment, the broadcast message (or the payload of the broadcast message) may be represented by the following equation:

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Payload = t | (*deviceID* || *bat_stat*) XOR (MSB_N(AES_K(t)))

[0252] where t is the value of the wireless identity transmitter's counter (e.g., a 20 bit value), '*bat_stat*' is the battery status information of the blip device (e.g., a 4-bit code), '||' means concatenation, `XOR' denotes the bitwise exclusive-or operation, 'AES_K()' is the AES block cipher with key '*K*', and 'MSB_N()' means the 'N' most significant bits (e.g., 60 bits). In other words, the embodiment broadcast message may include the counter in the clear (i.e., not encrypted) in addition to a rolling identifier that includes a battery level indicator. In another embodiment, the battery level indicator (i.e., *bat_stat*) may not be encrypted.

[0253] In block 2010, the central server may receive the shared secret key (*K*), such as during the account creation operations described above with reference to FIG. 13. For example, the central server may generate the secret key in response to receiving account registration information from the user of the wireless identity transmitter (e.g., *deviceID* and registration request information). In block 2012, the central server may associate the shared secret key (i.e., *K*) with the wireless identity transmitter's device identifier (i.e., *deviceID*). For example, the central server may store the *deviceID* and *K* in a data table of registered devices.

[0254] In block 2014, the central server may receive a message including the counter and the rolling identifier. For example, the received message may be a sighting message from a proximity broadcast receiver that includes the information broadcast by the wireless identity transmitter with the operations in block 2006. In block 2016, the central server may extract the counter from the received message, and in block 2018 may extract the rolling identifier. In block 2019, the central server may select a wireless identity transmitter (i.e., selected wireless identity transmitter) to evaluate. In other words, the central server may obtain a stored *deviceID*, *K*, and counter for a registered wireless identity transmitter known to the central server, such as from the database or data table

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storing such information for all registered wireless identity transmitters. In block 2020, the central server may decode the rolling identifier via the same streaming-like encryption algorithm (e.g., AES-CTR) with the counter and the selected wireless identity transmitter's secret key (*K*) to generate a decoded device identifier (or *M*). For example, the central server may perform a decoding operation based on the AES-CTR algorithm that uses the rolling identifier as input along with the selected wireless identity transmitter's secret key (*K*) and the counter indicated in the received message.

[0255] In an embodiment, the decoded device identifier *(M)* may be represented by the following equation:

$$M = (\text{rolling identifier}) \text{ XOR } (\text{MSB\_}\{\text{N-}a\}(\text{ AES\_K}(t)\text{ })),$$

[0256] where *t* is the value of the wireless identity transmitter's counter (e.g., a 20 bit value), `XOR' denotes the bitwise exclusive-or operation, 'AES_K()' is the AES block cipher with key '*K*', and 'MSB_{N-*a*}' means the 'N-*a*' most significant bits (e.g., 56 bits when *a* is 4 bits and N is 60 bits).

[0257] In determination block 2022, the central server may determine whether the decoded device identifier (*M*) and the *deviceID* match. In other words, the central server may compare the decoded device identifier (*M*) to the *deviceID* for the selected wireless identity transmitter whose secret key (*K*) was used with the AES-CTR algorithm operations to obtain the decoded device identifier (*M*). If *M* and the *deviceID* do match (i.e., determination block 2022 = "Yes"), in block 2024, the central server may identify the broadcast message as originating from the selected wireless identity transmitter. If *M* and the *deviceID* do not match (i.e., determination block 2022 = "No"), in block 2026 the central server may decode the rolling identifier with secret keys associated with other wireless identity transmitters. For example, the central server may select the next registered wireless identity transmitter and use the corresponding stored pair of a secret key (*K*) and corresponding *deviceID*. In this manner, all *K* and *deviceID* pairs stored for all registered wireless identity transmitters and/or users of the

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system may be tried by the central server until a match is found that indentifies the originator of the broadcast message.

[0258] FIG. 21A illustrates the embodiment method 2100 for a wireless identity transmitter generating and broadcasting an encrypted message (i.e., a rolling identifier) for receipt/use by a central server.

[0259] In block 2102, a user of the wireless identity transmitter may register the device with the central server. The services the wireless identity transmitter utilizes may require registrations of all active devices employed by users (e.g., customers, proprietors, etc.). The registration process may include an initial synchronization with the central server by the user of the wireless identity transmitter. For example, the user of the wireless identity transmitter may register the device with the central server through a Web application, in a mobile device or a PC able to receive wireless identity transmitter messages and operated by the user. The wireless identity transmitter may be required to be registered with the central server within a certain time period from activation of the device. For example, the wireless identity transmitter may be required to be registered within the first 24 hours after the device is initiated (e.g., a battery is placed within the wireless identity transmitter). Registration operations are further described above with reference to FIG. 13.

[0260] In block 2104, the wireless identity transmitter may initialize an internal counter, such as by setting the counter to a zero value. The counter initialization may occur due to a triggering event, such as the placement of a battery or power source within the wireless identity transmitter. For example, the counter may begin incrementing once the wireless identity transmitter is activated or powered on. Alternatively, the initialization may occur in response to registration operations described above. The counter may begin with '0' (or any other starting value, such as '1') and may be incremented periodically by the wireless identity transmitter. In an embodiment, when the battery of the wireless identity transmitter is replaced (e.g., due to battery failure) or the wireless identity

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transmitter is otherwise reset/ restarted/ rebooted, the counter may return to the initial value (e.g., '0'). The counter may not repeat the value it represents unless the wireless identity transmitter is reset/ restarted/ rebooted. In an alternative embodiment, during initialization of the counter, the wireless identity transmitter may read from flash memory a predefined initial counter value. For example, the wireless identity transmitter may initialize the counter with a value set at a factory or updated by an installed application.

[0261] In an embodiment, the counter (or nonce) may be initialized and adjusted in a random or pseudo-random fashion using methods well known in the art. The counter may be a pseudo-randomly generated value that can be replicated in both the wireless identity transmitter and the central server. In another embodiment, the counter or nonce may be generated by the wireless identity transmitter using a linear feedback shift register (LFSR) with a proper period configured to create counter values that do not repeat during the lifetime of the device. Such counters derived from the LFSR may also be pseudo-random.

[0262] In block 2106, the wireless identity transmitter may encrypt the concatenated data using a secret key and encryption algorithm known to the central server. For example, the wireless identity transmitter may encode the counter and/or the device identifier (i.e., *deviceID*) using an AES-CTR block cipher. The encryption algorithm may utilize the secret key for encryption and decryption purposes, as the secret key is known by both the central server and wireless identity transmitter. The encryption algorithm may result in encrypted (or encoded) data of a certain size. For example, using the AES-CTR cipher, the wireless identity transmitter may generate encoded data of 128-bits. In an embodiment, the wireless identity transmitter may generate encrypted data represented by the following equation:

$$(deviceID \parallel bat\_stat) \text{ XOR } (\text{MSB\_N}(\text{AES\_K}(t))),$$

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[0263] where *t* is the value of the wireless identity transmitter's counter (e.g., a 20 bit value), '*bat_stat*' is the battery status information of the wireless identity transmitter (e.g., a 4-bit code), 'll' means concatenation, `XOR' denotes the bitwise exclusive-or operation, 'AES_K()' is the AES block cipher with key '*K*', and 'MSB_N()' means the 'N' most significant bits (e.g., 60 bits). In other words, the embodiment broadcast message may include the counter in the clear (i.e., not encrypted) in addition to a rolling identifier that includes a battery level indicator. In another embodiment, the encrypted data may be represented by the following equation:

(deviceID) XOR (AES_K(t)),

[0264] where *deviceID* is a unique device identifier, *t* is the value of the wireless identity transmitter's counter (e.g., a 20 bit value), `XOR' denotes the bitwise exclusive-or operation, 'AES_K()' is the AES block cipher with key '*K*', and 'MSB_N()' means the 'N' most significant bits (e.g., 60 bits).

[0265] Due to the limited communication capabilities of the wireless identity transmitter, the payload of broadcast messages (e.g., the payloads supported by Bluetooth® LE broadcast packets) may not be able to contain the entire encrypted message, but instead only include a portion of an encrypted piece of data. Accordingly, in block 2108, the wireless identity transmitter may truncate data to generate an indecipherable rolling identifier. In other words, by truncating the encrypted data, the wireless identity transmitter may create an identifier to be put in a broadcast message (or payload) such that the identifier's size may be supported by the utilized communication format, such as Bluetooth® LE. For example, the wireless identity transmitter may truncate the encrypted data to fit within an 80-bit payload maximum size. When encrypted data is truncated, the decryption of that data within the central server may be impossible. However, the incomplete encrypted data may still be used by the central server as described below with reference to FIG. 21B. In an embodiment, truncation may be accomplished with a function, such as a most-significant-bit operation. In

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another embodiment, the truncated data may be represented by the following equation:

TRUNC (*deviceID* XOR AES_K(*t*)),

[0266] where *t* is the value of the wireless identity transmitter's counter (e.g., a 20 bit value), `XOR' denotes the bitwise exclusive-or operation, 'AES_K()' is the AES block cipher with key '*K*', and 'TRUNC ()' denotes a truncation operations that may create a certain number of bits or bytes (e.g., 56 bits or 7 bytes).

[0267] In block 2110, the wireless identity transmitter may concatenate the current counter with the truncated data to make a message payload. For example, the wireless identity transmitter may combine the current wireless identity transmitter system clock value (e.g., 20 bits long) with the unique identification code of the wireless identity transmitter truncated to be 60 bits long. In an embodiment, the payload may include both encrypted data and unencrypted data (or "in the clear" data). For example, the payload may contain many bits representing the encrypted and/or truncated data and several other bits that represent the battery status of the wireless identity transmitter or a counter value.

[0268] In block 2112, the wireless identity transmitter may periodically transmit broadcast messages that include the payload with the rolling identifier, such as by broadcasting via short-range wireless communication techniques as described above. The frequency of transmissions of the broadcast messages may vary dependent upon system configurations, user settings, or any other source of scheduling and timing relevant for wireless identity transmitters communicating via radio signals. For example, the wireless identity transmitter may broadcast the rolling identifier every few seconds.

[0269] In determination block 2114, the wireless identity transmitter may determine whether a predefined counter time period has expired. This counter time period may be set in a similar manner as the broadcast frequency periodicity as described above. For example, the manufacturer or may establish the counter

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time period using various techniques, such as hard-coding variables within the wireless identity transmitter's processor circuitry.

[0270] If the counter time period has not expired (i.e., determination block 2114 = "No"), the wireless identity transmitter may continue with the operations in block 2112. For example, the wireless identity transmitter may broadcast the payload via short-range radio transmissions at a frequency of a few seconds for a time period of many minutes.

[0271] If the device determines the counter time period has expired (i.e., determination block 2114 = "Yes"), in block 2116 the wireless identity transmitter may increment the counter value, such as by adding 1. In block 2117, the wireless identity transmitter may reset the counter time period. For example, after a counter time period has expired, the wireless identity transmitter may increase the counter by a value of 1 and reset the counter time period to 0. The wireless identity transmitter may continue with the operations in block 2106 (e.g., the wireless identity transmitter may create a new payload and broadcast it for another counter time period).

[0272] FIG. 21B illustrates an embodiment method 2150 for a central server receiving messages and syncing timing counters based on payload information. In block 2152, the central server may establish a database entry having the device identifier (i.e., *deviceID*), counter, and secret key data for the wireless identity transmitter at its registration. The central server may maintain a database containing data records for each wireless identity transmitter associated with the central server and/or the central server's affiliated services. The database may be populated with information obtained via registration operations described above. Thus, there may be a data record for each wireless identity transmitter associated with the central server, and each record may contain information that represents a particular device's identification, its current counter (e.g., clock value), and a secret key associated with the wireless identity transmitter. In an embodiment, the secret key may be unique to each wireless identity transmitter registered with

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the central server. In an embodiment, the central server may also store the initial counter value for each wireless identity transmitter registered with the central server.

[0273] In various embodiments, when a wireless identity transmitter is registered, the central server may store the initial counter value for the wireless identity transmitter. Dependent upon the time between the activation of the wireless identity transmitter (e.g., when the battery was inserted and the device became operational) and the registration of the device, the initial counter for the wireless identity transmitter may or may not be 0. For example, if the registration of the wireless identity transmitter with the central server occurred several hours after a user inserted a battery in the wireless identity transmitter, the initial counter may not be 0. In an embodiment, the central server may also indicate the registration status of the wireless identity transmitter by setting a registration flag or other indicator and may store information describing wireless identity transmitters that have yet to be registered in the database. In an embodiment, the central server may maintain a database with initial values provided for all known wireless identity transmitter whether or not they have been registered. For example, based on manufacturing records, the central server may contain a database having information about every wireless identity transmitter created.

[0274] The central server may generate and store model payloads using operations similar to those described above with reference to blocks 2106-2110. Model payloads may be payloads the central server expects to receive from the wireless identity transmitter based on stored secret key, device identifier (deviceID), and counter information. For example, for each registered wireless identity transmitter, the central server may create a model payload by concatenating the device's *deviceID* to a counter value, encrypting the concatenated data using an encryption protocol that employs the secret key for the wireless identity transmitter, and truncating the encrypted data. Each model payload may be stored in a central server data table (or lookup table) in relation

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to the corresponding *deviceID* and counter values used to generate the respective model payloads. For example, for each model payload for each wireless identity transmitter, the central server may store in the data table the model payload, a time offset value (e.g., -2, -1, 1, 2, etc.), and the counter, all in relation to the *deviceID* of the wireless identity transmitter.

[0275] In block 2154, the central server may generate and store initial model payloads for the wireless identity transmitter for a defined initialization period. For example, starting at the initial counter value (e.g., 0 or a pseudo-random value known to the device and the central server), the central server may generate model payloads using counter values that are the same, lower, and/or higher than the actual initial counter of a wireless identity transmitter such that these model counters cover the initialization period. In an embodiment, the initialization period may be an hour, several hours, days, etc.). The central server may store the initial model payloads for use in the event of a registration/reset/reboot of a wireless identity transmitter.

[0276] In block 2155, the central server may also generate and store current model payloads for wireless identity transmitters expected to be received within a defined time window. To account for possible clock drift in wireless identity transmitters, the central server may generate and store model payloads for the defined time window (or time period) by using multiple derivative counter values that represent a range of possible counters. In other words, derivative counter values may be offsets to the current counter value stored for a wireless identity transmitter. For example, the central server may generate model payloads for derivative counter values that are lower and higher than the currently stored counter value in the database. A derivative counter value may be the result of an offset value (e.g., -2, -1, 1, 2, etc.) added to the stored counter value for a wireless identity transmitter. The central server may generate model payloads to represent the stored counter value and derivative counter values that incrementally represent the window time period. For example, the model payloads may represent counters increasing by a small time value, such as an

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hour, and covering a large period of time, such as multiple hours. As another example, the central server may store a payload corresponding to the current counter value stored for a wireless identity transmitter, a payload corresponding to the previous counter value for the device, and a payload corresponding to the next counter value for the device.

[0277] In an embodiment, the first generated current model payloads for a given wireless identity transmitter may be identical to the initial model payloads for the wireless identity transmitter as both sets of payloads may be generated by the central server based on the same initial counter values. In an embodiment, the initialization period may coincide with the defined time window. For example, the initialization period may involve a similar number of days, hours, minutes, etc. as the defined time window.

[0278] In determination block 2156, the central server may determine whether a counter time period has expired. The central server may initialize the evaluation of a counter time period at an arbitrary time or, alternatively, upon the receipt of a wireless identity transmitter registration. The counter time period may be the same period of time used by the wireless identity transmitters as described above with reference to determination block 2114.

[0279] If the counter time period has expired (i.e., determination block 2156 = "Yes"), in block 2155' the central server may generate and store updated current model payloads for registered wireless identity transmitters. The updated current model payloads may replace the previous current model payloads and may be based on the stored counter value in each respective wireless identity transmitter's database record.

[0280] If the counter time period has not expired (i.e., determination block 2156 = "No") or if the counter time period has expired and the central server has generated updated current model payloads, in determination block 2160, the central server may determine whether any payloads have been received. In an embodiment, payloads may be delivered directly from wireless identity

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transmitters or alternatively indirectly from proximity broadcast receivers via sighting messages which include (or relay) rolling identifier payloads from proximate wireless identity transmitters to the central server. If no payloads have been received (i.e., determination block 2160 = "No"), the central server may continue with the operations in determination block 2156.

[0281] If a payload has been received (i.e., determination block 2160 = "Yes"), in block 2162, the central server may be configured to evaluate the received payload using stored, current model payloads, such as the current model payloads stored for each registered wireless identity transmitter. As described above, the central server may maintain two sets of stored model payloads for each registered wireless identity transmitter, an initial model payload set that may include model payloads based on the initial counter and derivative counter values that span the initialization period, and a current model payload set that is based on the current counter value stored within the database record for each wireless identity transmitter. In an embodiment, the central server may set a system variable indicating the central server should compare the received payload to stored, current model payloads. The system variable may be set to direct the central server to evaluate either the current or initial model payloads for wireless identity transmitters.

[0282] In blocks 2164-2172, the central server may perform an operational loop in which the central server compares the received payload (i.e., data broadcast by the wireless identity transmitter) to stored model payloads for all registered wireless identity transmitters until a match is found. In block 2164, the central server may select a next registered wireless identity transmitter. The central server may determine the next registered device based on the database of registered wireless identity transmitters and may sequentially iterate through each device during the operations in blocks 2164-2172. In block 2166, the central server may compare the received payload to the stored model payloads for the selected wireless identity transmitter based on the system configuration, such as the configuration set in the operations in block 2162. For example, based on the

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system variable set to 'current' with the operations in block 2162, the central server may compare the received payload to stored current model payloads for the selected wireless identity transmitter. Based on the form of the encrypted data of the received payload, the comparison may be a pattern-matching routine in which the central server compares the data of the model payloads against the received payload. For example, the central server may compare the bit values for the stored and received payloads.

[0283] In determination block 2168, the central server may determine whether any of the stored model payloads match the received payload. If none of the stored model payloads match the received payload (i.e., determination block 2168 = "No"), in determination block 2170, the central server may determine whether there is another registered wireless identity transmitter to evaluate. In other words, the central server may determine whether the stored model payloads of all registered wireless identity transmitters have been evaluated. If there is another registered wireless identity transmitter to evaluate (i.e., determination block 2170 = "Yes"), the central server may continue by selecting the next registered wireless identity transmitter with the operations in block 2164.

[0284] If the central server has evaluated the stored model payloads of all registered wireless identity transmitters (i.e., determination block 2170 = "No"), in block 2172, the central server may be configured to evaluate the received payload using stored, initial model payloads, such as the initial model payloads stored for each registered wireless identity transmitter at the time of the devices' registration. For example, the central server may set a system variable indicating the central server should compare the received payload to stored, initial model payloads for evaluated registered wireless identity transmitters (e.g., the system variable may be set to 'initial'). The operational loop may then continue with the operations in blocks 2164-2168 wherein the central server may select each registered wireless identity transmitter and compare the initial model payloads of that selected device to the received payload.

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[0285] If the central server does find a match between the received payload and any of the stored model payloads (current or initial) of a registered wireless identity transmitter (i.e., determination block 2168 = "Yes"), in block 2174, the central server may determine a wireless identity transmitter identity based on the match. In other words, the central server may identify the wireless identity transmitter corresponding to the received payload based on the identification information (e.g., *deviceID*) stored in relation to the matching stored model payload. In block 2176, the central server may update the database with the identified wireless identity transmitter's counter based on the received payload. Based on the database record corresponding to the matching stored model payload, the central server may determine the derivative counter value corresponding to the received payload and may update the stored counter value to represent the derivative counter value, thus syncing the identified wireless identity transmitter's counter and the central server counter. In an embodiment, the central server may also store in the database the central server counter (or time) at which the central server received the received payload.

[0286] In an embodiment, the central server may maintain a list (or data table) of recently received messages and the corresponding wireless identity transmitter identification. For example, the central server may record within a data table the *deviceID* and payload information for messages received within a certain period. The central server may compare any subsequently received payload to the data table to determine whether the subsequently received payload is redundant based on recently received payloads from the same wireless identity transmitter. For example, a subsequently received payload may represent a certain counter value from a particular wireless identity transmitter that was already received and processed by the central server a few minutes ago. This may expedite the method 2150 process and decrease search times for the operations in blocks 2164-2172. In an embodiment, the central server may expunge (or clear) the data table of recently identified payloads and wireless identity transmitters and may schedule the clearing operations similarly as described in block 2176 (e.g., the

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recent data table may be cleaned every time the counter time period is determined to be expired).

[0287] FIG. 22 illustrates another embodiment method 2200 for a central server to identify a wireless identity transmitter indicated by encrypted data within a message broadcast by the wireless identity transmitter. In the operations of the method 2200, counter values may never be included in broadcast messages to increase the security with which wireless identity transmitters transmit their identities. For example, as counter values may differ among different wireless identity transmitters, an attacker with the ability to capture a broadcast message may be able to easily predict values within future broadcast messages from the wireless identity transmitter. However, without counter data transmitted in the clear, nefarious snoopers may be better thwarted from following broadcasts from a particular wireless identity transmitter.

[0288] In block 2002, the wireless identity transmitter may receive a shared secret key (i.e., "*K*"). For example, each wireless identity transmitter may be pre-provisioned with a per-device shared secret key which is associated with the wireless identity transmitter's unique device identifier (or *deviceID*) at the central server. In block 2204, the wireless identity transmitter may synchronize a counter. The counter may be synchronized with the central server upon registration of the wireless identity transmitter at the central server. The synchronized counter value may also be associated with the *deviceID* and *K* in a data table stored in the central server (e.g., a table with stored pairs of IDs and *K* values).

[0289] In block 2206, the wireless identity transmitter may increment the counter to the wireless identity transmitter's current device time. For example, the counter may be incremented after a predefined number of seconds (e.g., one second, one hour, etc.). As another example, every 3600 seconds the wireless identity transmitter may increment the counter by one value. In this manner, the counter value may change to the current time as counted by the oscillator on the

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wireless identity transmitter. In block 2208, the wireless identity transmitter may encode via a pseudo-random function the device identifier (i.e., *deviceID*), the shared secret key (i.e., *K*), and the counter to generate a rolling identifier. In this manner, the rolling identifier may be generated as the counter value changes. In an embodiment, the pseudo-random function may be a polynomial time computable function with a seed ('*s*') and input variable ('*x*'), such that when the seed is randomly selected and not known to observers, the pseudo-random function (e.g., PRF(*s*, *x*)) may be computationally indistinguishable from a random function defined on the same domain with output to the same range. For example, the Keyed-Hash Message Authentication Code (HMAC) or the Cipher-Based Message Authentication Code (CMAC) may be used as the pseudo-random function.

[0290] In block 2210, the wireless identity transmitter may broadcast a message (e.g., a Bluetooth® LE chirp message of 1 packet length) that includes the rolling identifier. In an embodiment, the broadcast message (or the payload of the broadcast message) may be represented by the following equation:

$$\text{Payload} = \text{MSB\_N}(\text{PRF}(K, (deviceID \parallel t)))$$

[0291] where *t* is the value of the wireless identity transmitter's counter, '||' means concatenation, 'PRF ()' is the pseudo-random function, and 'MSB_N()' means the 'N' most significant bits (e.g., 80 bits). In other words, the wireless identity transmitter may intentionally obscure (or skew) the device identifier and the counter information, thus the broadcast message's payload may not include either the device identifier or the counter information in the clear.

[0292] In block 2010, the central server may receive the shared secret key (*K*). In block 2212, the central server may synchronize a counter. For example, the counter may be set to represent a value included in a previous message related to the wireless identity transmitter, such as a registration message. In block 2214, the central server may associate the shared secret key (i.e., *K*) and counter with the wireless identity transmitter's device identifier (i.e., *deviceID*). For example,

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the central server may store the *deviceID, K*, and counter in a data table of registered devices (e.g., in a tuple record of a database). In an embodiment, the central server may also store an indicator or flag indicating whether each wireless identity transmitter has been registered or activated.

[0293] In block 2216, the central server may receive a message including the rolling identifier. For example, the received message may be a sighting message from a proximity broadcast receiver that includes the rolling identifier broadcast by the wireless identity transmitter with the operations in block 2210. In block 2018, the central server may extract the rolling identifier, such as by parsing the received message to identify the payload of the rolling identifier.

[0294] In block 2019, the central server may select a wireless identity transmitter (i.e., selected wireless identity transmitter) to evaluate. In other words, the central server may obtain a stored *deviceID*, *K,* and counter for a registered wireless identity transmitter known to the central server, such as from the database or data table storing such information for all registered wireless identity transmitters. In block 2218, the central server may increment the selected wireless identity transmitter's counter to the server's current time. In an embodiment, the central server may then increment the stored counter value to account for the time that has elapsed since the stored counter value was synchronized. As an example, the central server may compare the time of receipt of the message with the operations in block 2216 to the central server's current time (e.g., via a central server clock or time mechanism). Based on a known periodicity that wireless identity transmitters may increment their individual counters (e.g., once every hour), the central server may increment the selected counter value to account for the time difference.

[0295] In an embodiment, the central server may only increment the selected counter an amount that represents the time between broadcasts by a wireless identity transmitter. In other words, the central server may not increment the selected counter to include the time between receiving the message within the

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operations in block 2216 and the time a proximity broadcast receiver received the broadcast message. For example, the proximity broadcast receiver may have buffered broadcast messages before relaying sighting messages to the central server. The central server may calculate this time difference based on metadata within the message received with the operations in block 2216. For example, a sighting message from a proximity broadcast receiver may indicate when a broadcast message was received. Thus, the amount the selected counter is incremented may be based on when the proximity broadcast receiver actually received the broadcast message and not when the message from the proximity broadcast receiver was received by the central server.

[0296] In block 2220, the central server may encode via a pseudo-random function the selected wireless identity transmitter's device identifier, secret key, and counter to generate a server-encrypted data (i.e., *C'*). The pseudo-random function may be the same pseudo-random function utilized in the operations in block 2208. In an embodiment, the generated server-encrypted data may be represented by the following equation:

$$C' = \text{MSB\_N}(\text{PRF}(\ sel\_K, (sel\_deviceID \parallel sel\_t)))),$$

[0297] where *sel_K* is the value of the selected wireless identity transmitter's secret key, *sel*_deviceID is the value of the selected wireless identity transmitter's unique device identifier, *sel_t* is the value of the selected wireless identity transmitter's counter, '||' means concatenation, 'PRF ()' is the pseudo-random function, and 'MSB_N()' means the 'N' most significant bits (e.g., 60 bits, 74 bits, 80 bits, etc.).

[0298] In determination block 2222, the central server may determine whether the generated server-encrypted data (*C'*) is the same as the received rolling identifier. In other words, the central server may compare the received rolling identifier to the generated server-encrypted data to determine whether they match. If the rolling identifier and the generated server-encrypted data match (i.e., determination block 2222 = "Yes"), in block 2024 the central server may

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identify the received message as originating from the selected wireless identity transmitter (e.g., corresponding to the selected wireless identity transmitter's unique identifier).

[0299] If the rolling identifier and the generated data do not match (i.e., determination block 2222 = "No"), in block 2224 the central server may encode device identifiers, secret keys, and counters for other wireless identity transmitters to identify the originator of the received message. In other words, the central server may select the next stored *deviceID*, counter, and *K* group from the database, increment that selected counter value, encode the selected *deviceID*, counter, and *K*, and compare the generated encoded data to the received rolling identifier until a match is found and the identity of the originator of the rolling identifier in the received message is known.

[0300] In an embodiment, when the wireless identity transmitter's battery has been removed and re-installed, the latest counter value may be persisted in the non-volatile memory of the wireless identity transmitter, so that the counter value can be read back from the non-volatile memory of the wireless identity transmitter when the battery is removed and then put back in. Alternatively, if no non-volatile memory is available or is not used, the wireless identity transmitter may fall back to the initial counter value after a battery re-installation. The central server may be required to be modified slightly to accommodate such a "counter synchronization". More specifically, in addition to trying values greater than the largest counter value for the pre-computed counter (or nonce) list, the central server may also try values, such as (counter+i) where i=0, …, n, when a "counter synchronization" is performed. In this case, a wireless identity transmitter user may need to be informed that the battery needs to be re-installed when "counter synchronization" fails multiple times.

[0301] FIG. 23A illustrates an embodiment method 2300 for a wireless identity transmitter employing a pseudo-random function to generate a rolling identifier for broadcasting. The operations in the method 2300 may be similar to the

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embodiment method 2100 described above. However, instead of encrypting data, such as a counter value, with an AES-CTR encryption algorithm, the method 2300 may generate payloads based on the application of a pseudo-random function. As described above, the pseudo-random function and secret keys for each wireless identity transmitter may be known to both the corresponding wireless identity transmitter and a central server so that both may generate similar payloads based on similar data.

[0302] In block 2102, a user of the wireless identity transmitter may register the device with the central server. In block 2104, the wireless identity transmitter may initialize an internal counter, such as by setting the counter to a zero value. In block 2302, the wireless identity transmitter may concatenate the current counter with the wireless identity transmitter's unique device identifier (i.e., *deviceID*). In block 2304, the wireless identity transmitter may generate a payload with a rolling identifier using pseudo-random function with the concatenated data and the secret key. For example, the pseudo-random function may take as inputs the concatenated data (i.e., the *deviceID* + counter) and may use the secret key for the wireless identity transmitter as a randomness seed variable. The payload with the rolling identifier may include the output data from the pseudo-random function. In an embodiment, the payload with the rolling identifier may also include in-the-clear information regarding other aspects of the wireless identity transmitter. For example, the wireless identity transmitter may append to the payload several bits (e.g., 4 bits) of information which describe the battery status of the wireless identity transmitter. In an embodiment, the pseudo-random function may be a polynomial time computable function that is computationally indistinguishable from a random function defined on the same domain with output to the same range as the pseudo-random function. For example, the keyed hash Message Authentication Code (HMAC) or the Cipher-based Message Authentication Code (CMAC) may be used as the pseudo-random function. In an embodiment, the wireless identity transmitter may or may not perform a truncation operation to the generated rolling identifier

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payload. For example, the payload with the rolling identifier may be the result of performing a most-significant-bit operation on the results of the pseudo-random function.

[0303] In block 2112, the wireless identity transmitter may periodically transmit broadcast messages that include the payload with the rolling identifier, such as by broadcasting via short-range wireless communication techniques as described above. In determination block 2114, the wireless identity transmitter may determine whether a predefined counter time period has expired. If the counter time period has not expired (i.e., determination block 2114 = "No"), the wireless identity transmitter may continue with the operations in block 2112. If the device determines the counter time period has expired (i.e., determination block 2114 = "Yes"), in block 2116 the wireless identity transmitter may increment the counter value, such as by adding 1. In block 2117, the wireless identity transmitter may reset the counter time period, and may continue with the operations in block 2302.

[0304] FIG. 23B illustrates an embodiment method 2350 for a central server responding to received messages containing pseudo-random function rolling identifiers. The embodiment method 2350 operations may be similar to the operations described above with reference to FIG. 21B, with the exception that the central server may compare outputs of a pseudo-random function with time-synchronized information stored in the central server to match payloads in messages received from wireless identity transmitters.

[0305] In block 2352, the central server may establish database records having device identifier (i.e., *deviceID*), counter, time, registration status (i.e., '*reg_stat*'), and secret key (i.e., '*K*') information for each wireless identity transmitter in a system. The time may indicate the last time the central server received a message corresponding to a particular wireless identity transmitter (e.g., a sighting message relaying a broadcast message), or in other words, the central server clock value at the moment when the counter value for a wireless

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identity transmitter was received/ recorded in the database. It may be assumed that the period between when a wireless identity transmitter broadcasts a message with a rolling identifier (or rolling identifier payload) and when the central server receives the rolling identifier is very short. Thus, the stored counter and time values may be assumed to create a roughly accurate clock status of a wireless identity transmitter.

[0306] Additionally, once a wireless identity transmitter transmits registration information, the central server may indicate a valid registration by setting a registration flag in the database for the wireless identity transmitter (e.g. '*reg_stat*'). The central server may query the database for all wireless identity transmitter records where the *reg_stat* indicates a valid registration has been conducted and may create data tables that include only registered wireless identity transmitters based on the *reg_stat* values.

[0307] In block 2354, the central server may receive a rolling identifier payload via a sighting message from a proximity broadcast receiver. The sighting message may have time information appended to the payload that describes the time at which the proximity broadcast receiver encountered the payload via a broadcast message from the respective wireless identity transmitter. For example, a payload may be received by a smartphone proximity broadcast receiver which in turn may append its own system clock reading to the payload information and transmit the data to the central server as a sighting message. The time measurement provided by the proximity broadcast receiver may be approximately synchronized with the central server system time. In an embodiment, the proximity broadcast receiver may append other additional information to the sighting message, such as location information (e.g., GPS coordinates) of the proximity broadcast receiver. In block 2356, the central server may obtain a proximity broadcast receiver time (i.e., '*ir_time*') from the sighting message, such as indicated within the sighting message. For example, the central server may parse the sighting message and extract a time value

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indicating when the proximity broadcast receiver received a broadcast message that corresponds to the rolling identifier payload.

[0308] In blocks 2164-2374, the central server may perform an operational loop in which the central server may evaluate all registered wireless identity transmitters stored within the central server's database to find a device record that matches the received rolling identifier payload. In block 2164, the central server may select a next registered wireless identity transmitter. For example, the central server may iteratively select the next wireless identity transmitter represented in a data table of all wireless identity transmitters that have the *reg_stat* variable set to indicate registration occurred. The central server may sequentially iterate through such a data table or list for each device during the operations in blocks 2164-2374. In an embodiment, the central server may access a stored database record corresponding to the selected registered wireless identity transmitter that contains the current values for the information established with registration operations in block 2352.

[0309] In block 2360, the central server may compute the time difference (i.e., '*t_diff*') between the time indicated in the sighting message (*ir_time*) and the time stored within the database record of the selected registered wireless identity transmitter (i.e., '*sel_time*'). For example, the *t_diff* value may be a non-zero or a zero value. This time difference may be a measure of the expected elapsed time between instances of the central server receiving payloads from the selected wireless identity transmitter.

[0310] In block 2362, the central server may set a clock drift offset (i.e., '*offset*') to a next value. In general, the central server may account for possible wireless identity transmitter clock drift (e.g., inaccurate device system clock readings) by setting the clock drift offset value. The clock drift offset values may represent offsets that, when applied to counter values, may represent counters lower, the same, or higher than an expected counter value. In other words, the clock drift offsets may represent time before, during, or after the time represented

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by the current counter for the selected registered device. The clock drift offset value may be one of a sequence of clock drift offset values. In an embodiment, the clock drift offset value may be 0. In an embodiment, possible clock drift offset values may include numbers within a set {-N, ..., -1, 0, 1, ... , N}, where N is an arbitrary number.

[0311] In block 2364, the central server may compute an expected counter value (i.e., '*new_ctr*') using the selected wireless identity transmitter's stored counter value, the computed time difference (i.e., *t_diff*) and the set offset value (i.e., *offset*). As described above, the counter may be stored within the selected registered wireless identity transmitter database record. For example, the central server may calculate *new_ctr* by adding the clock drift offset value to the sum of the *t_diff* value and the stored counter value.

[0312] In determination block 2366, the central server may encode via a pseudo-random function the selected wireless identity transmitter's device identifier, secret key, and computed counter (i.e., *new_ctr*) to generate a server-encrypted data (i.e., *C'*). The pseudo-random function may be the same pseudo-random function utilized by a wireless identity transmitter as described above with reference to FIG. 23A.

[0313] In determination block 2222, the central server may determine whether the generated server-encrypted data (*C'*) is the same as the received rolling identifier. In other words, the central server may compare the received rolling identifier to the generated server-encrypted data to determine whether they match. If the rolling identifier and the generated server-encrypted data match (i.e., determination block 2222 = "Yes"), the central server may identify the received message as originating from the selected wireless identity transmitter (e.g., corresponding to the selected wireless identity transmitter's unique identifier). In an embodiment, the secret key (*K*) may be the seed value of the pseudo-random function. In an embodiment, the central server may concatenate the selected wireless identity transmitter's *deviceID* and the computed *new_ctr*

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value and provide that concatenated data to the pseudo-random function. The pseudo-random function may return (or output) encrypted data having a similar structure as received rolling identifier payload.

[0314] If the rolling identifier, such as received in the sighting message, and the generated server-encrypted data (i.e., *C'*) match (i.e., determination block 2222 = "Yes"), in block 1276 the central server may update the database record of the selected wireless identity transmitter with the counter and time information, such as the *new_ctr* and the *ir_time*. For example, the central server may update the database record's time value to represent the time of receipt of the payload within the proximity broadcast receiver (e.g., *ir_time*) and may also update the stored counter value to represent the *new_ctr* value. The central server may continue with the operations in block 2354.

[0315] If the rolling identifier, such as received in the sighting message, and the generated server-encrypted data (i.e., *C'*) do not match (i.e., determination block 2222 = "No"), the central server may determine whether there is a next clock drift offset value in determination block 2370. In other words, the central server may determine whether *new_ctr* values have been computed using all possible clock drift offset values (e.g., -1, 0, 1, etc.). If there is a next clock drift offset value (i.e., determination block 2370 = "Yes"), the central server may continue with the operations in block 2362. However, if there is not a next clock drift offset value (i.e., determination block 2370 = "No"), in determination block 2170, the central server may determine whether there is another registered wireless identity transmitter to evaluate. If there is another registered wireless identity transmitter to evaluate (i.e., determination block 2170 = "Yes"), the central server may continue with the operations in block 2164. However, if there is no other registered wireless identity transmitter (i.e., determination block 2170 = "No"), in block 2374 the central server may configure the system to evaluate initial counter values stored for each registered wireless identity transmitter. In an embodiment, the registration database described above may further include data that represents the initial counter value corresponding to each registered

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wireless identity transmitter. This initial counter value may be used if/when the various wireless identity transmitters are rebooted or otherwise reset their counters. For example, a wireless identity transmitter may operate and deliver payloads describing non-initial counters for a period of time before resetting its internal counter due to battery replacement. In such a scenario, the wireless identity transmitter may broadcast messages that include rolling identifier payloads based on reset counter information.

[0316] In another embodiment, the operations in block 2374 may be performed for individual registered selected devices during the operational loop in blocks 2362-2370, wherein the stored counter value in block 2364 may be replaced with the initial stored counter value. For example, once the central server determines a selected registered wireless identity transmitter's stored counter value with the various clock drift offset values cannot be used to generate encrypted data that matches the received rolling identifier payload, the central server may evaluate the initial stored counter value of the selected wireless identity transmitter before selecting the next registered wireless identity transmitter.

[0317] FIG. 24A illustrates an embodiment method 2400 for a wireless identity transmitter generating and broadcasting messages with rolling identifiers and encoded counters. The method 2400 may have operations performed by a wireless identity transmitter that are similar to those described above with reference to FIGS. 20, 21A, 22, and 23A. However, the method 2400 may involve broadcasting messages that include a rolling identifier (i.e., an encoded device identifier) as well as an encoded counter that may be evaluated separately by the central server with the operations described below with reference to FIG. 24B. In this manner, the wireless identity transmitter's counter value (or nonce) may not be sent in the clear in the payload of the broadcast message.

[0318] In block 2102, a user of the wireless identity transmitter may register the device with the central server. For example, the wireless identity transmitter may provide the unique device identifier (i.e., *deviceID*) to a central server for storage

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in a database of registered wireless identity transmitters. In block 2402, the wireless identity transmitter may store a first secret key (K) and a second secret key (K') and an initial counter that are known to the central server. For example, these values may be shared between the central server and the wireless identity transmitter during registration operations described in this disclosure. In block 2404, the wireless identity transmitter may initialize a current counter by setting it to the value of the initial counter value.

[0319] Similar to as described above with reference to FIG. 20, in block 2406, the wireless identity transmitter may encode the device identifier (*deviceID*), the first secret key (*K*), and the current counter via a streaming-like encryption algorithm (e.g., AES-CTR) to generate a rolling identifier. In block 2408, the wireless identity transmitter may encode via a pseudo-random function, the current counter, and the second secret key *(K')* to generate an encoded counter (or nonce). In an embodiment, the encoded counter may be represented by the following equation:

$$\text{Encoded counter} = \text{MSB\_M}(\text{PRF}(K', t)),$$

[0320] where '*K*'' is a per-device second secret key (usually different from the first per-device secret key *K*), '*t*' is the current counter, PRF ()' is the pseudo-random function, and 'MSB_M()' means the 'M' most significant bits (e.g., 20 bits).

[0321] In block 2410, the wireless identity transmitter may periodically transmit broadcast messages that include the payload with the rolling identifier and the encoded counter. In determination block 2114, the wireless identity transmitter may determine whether a predefined counter time period has expired. If the counter time period has not expired (i.e., determination block 2114 = "No"), the wireless identity transmitter may continue with the operations in block 2410. If the device determines the counter time period has expired (i.e., determination block 2114 = "Yes"), in block 2412 the wireless identity transmitter may increment the current counter value, such as by adding 1. In block 2117, the

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wireless identity transmitter may reset the counter time period and may continue with the operations in block 2406.

[0322] FIG. 24B illustrates an embodiment method 2450 for a central server receiving and handling messages including rolling identifiers and encoded counters. The central server may perform the operations of method 2450 in combination or response to a wireless identity transmitter performing the method 2400 described above. The method may include two passes: a first pass wherein the central server attempts to identify a wireless identity transmitter based on an encoded counter within a received message (e.g., a sighting message), and a second pass wherein the central server attempts the identification based on a rolling identifier to within the received message

[0323] In block 2452, the central server may establish a database entry having a device identifier (i.e., *deviceID*), initial counter, current counter, and secret keys (*K* and *K'*) for all wireless identity transmitters in the system. The current counter values may be the same as the initial counters at the time of registration of wireless identity transmitters. In block 2454, the central server may pre-compute encoded counters using a pseudo-random function, the second secret key (K'), and current counter values for all wireless identity transmitters. For example, the central server may generate a plurality of encoded counter values for each registered wireless identity transmitter, such as one based on the current counter value, another based on a value one larger than the current counter value, etc. In an embodiment, the central server may pre-compute 24 encoded counters for each registered wireless identity transmitter. In an embodiment, the central server may store a separate list (or data table) of the pre-computed encoded counters for all registered wireless identity transmitters that also includes the device identifiers associated with each stored pre-computed encoded counter.

[0324] In block 2456, the central server may receive a message including an encoded counter and a rolling identifier, such as within a sighting message transmitted by a proximity broadcast receiver. In block 2458, the central server

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may extract an encoded counter from the received message, and in block 2018 may extract a rolling identifier from the received message. In determination block 2460, the central server may determine whether the extracted counter (or '*ctr*') matches any of the pre-computed counters. For example, the central server may compare the encoded counter value extracted from the received message to the plurality of central server-encoded counter values for each registered wireless identity transmitter to identify any matches.

[0325] If the extracted counter matches a pre-computed counter (i.e., determination block 2460 = "Yes"), in block 2462 the central server may identity a candidate wireless identity transmitter based on the matching pre-computed counter. In other words, the central server may identity the candidate as the *deviceID* stored in relation to the pre-computed counter in a data table in the central server. In block 2464, the central server may decode the rolling identifier via a streaming-like encryption algorithm (e.g., the same AES-CTR wireless identity transmitters use when performing the operations in FIG. 24A) using the candidate wireless identity transmitter's stored information (e.g., *deviceID*, secret key, etc.) to find a decoded device identifier (or *M*). In determination block 2466, the central server may determine whether the decoded device identifier (*M*) matches the candidate wireless identity transmitter's *deviceID*. Such a match may enable the central server to identify the wireless identity transmitter associated with that received rolling identifier without decoding the rolling identifier or the encoded counter value.

[0326] If the *deviceID* and decoded identifier (*M*) match (i.e., determination block 2466 = "Yes"), in block 2470 the central server may identity the received message as originating from the candidate wireless identity transmitter. In block 2472, the central server may update current counters and pre-computed encoded counters. For example, the database entry for the wireless identity transmitter identified as the originator of the received message may be updated with new current counter information as well as new pre-computed encoded counters. Additionally, any stored lists of pre-computed encoded counters may have older

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pre-computed encoded counters removed at the same time newly computed encoded counters corresponding to the identified wireless identity transmitter are added to the list.

[0327] In another embodiment, if the wireless identity transmitter identified as the originator of the received message is indicated in the central server's database as "not activated" (i.e., a flag is not set), then the central server may also adjust the database to reflect that the identified wireless identity transmitter is now activated (e.g., set a flag). The central server may then continue with the operations in block 2456.

[0328] If the *deviceID* and decoded identifier (*M*) do not match (i.e., determination block 2466 = "No"), in determination block 2468, the central server may determine whether there are other candidates, such as other registered wireless identity transmitters that have not been evaluated by the central server. If there are other candidates (i.e., determination block 2468 = "Yes"), the central server may continue with the operations in block 2462, such as by identifying the next wireless identity transmitter to evaluate regarding the rolling identifier.

[0329] If there are no other candidates (i.e., determination block 2468 = "No"), or if the extracted counter does not match the pre-computed counter (i.e., determination block 2460 = "No"), the central server may attempt to identify the originator of the received message by comparing the extracted rolling identifier to information associated with all registered wireless identity transmitters in the system. Thus, in determination block 2170 the central server may determine whether there is another registered wireless identity transmitter to evaluate. For example, the central server may iteratively use information of all registered wireless identity transmitters. If there is not another (i.e., determination block 2170 = "No"), the central server may continue with the operations in block 2456.

[0330] If there is another (i.e., determination block 2170 = "Yes"), in block 2164 the central server may select the next registered wireless identity transmitter. In block 2474, the central server may decode the rolling identifier

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via the streaming-like encryption algorithm (e.g., AES-CTR) with the selected wireless identity transmitter's initial counter and first secret key (*K*) to find a decoded device identifier (*M'*), similar to as described above with reference to FIG. 20. In determination block 2476, the central server may determine whether the decoded device identifier (*M'*) matches the selected wireless identity transmitter's *deviceID*. If the identifiers do not match (i.e., determination block 2476 = "No"), the central server may continue with the operations in determination block 2170. However, if the identifiers match (i.e., determination block 2476 = "Yes"), in block 2478 the central server may identify the received messages as originating from the selected wireless identity transmitter, and may continue with the operations in block 2472.

[0331] FIG. 24C illustrates an embodiment method 2480 for a central server receiving and handling messages including rolling identifiers and encoded counters. The operations of method 2480 are similar to the operations of method 2450, except that rather than perform a two pass process as discussed above in FIG. 24B, the central server may perform method 2480 as a one pass process. In particular, the central server may generate both a plurality of central server encrypted counter values for each registered wireless identity transmitter and a plurality of central server-encrypted device identifiers (i.e., *deviceID*). The central server may use the data stored in the database for each wireless identity transmitter (e.g., *deviceID*, *K*, *K'*, initial counter, and current counter) and the plurality of pre-computed counter values for each device to encode a plurality of central server encrypted counter values and a plurality of server encrypted device IDs. When the central server receives the sighting message including the rolling identifier and encoded counter, the central server may compare the plurality of central server encrypted counter values and the plurality of central server encoded device IDs to the rolling identifier and encoded counters obtained from the received sighting message. The device identifier of the wireless identity transmitter that originated the rolling identifier may then be identified based

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entirely on matching the pre-computed counter values and device identifiers without requiring actual decoding of the rolling identifier itself.

[0332] In block 2452, the central server may establish a database entry having a device identifier (i.e., *deviceID*), initial counter, current counter, and secret keys (*K* and *K'*) for all wireless identity transmitters in the system. In block 2454, the central server may pre-compute encoded counters using a pseudo-random function, the second secret key (*K'*), and current counter values for all wireless identity transmitters. In block 2482, the central server may pre-compute encoded device identifiers with a streaming-like encryption algorithm (e.g., AES-CTR block cipher), the device identifier, current counter, and the first secret key (*K*) for all wireless identity transmitters. In other words, the central server may generate a plurality of encoded device identifiers for each registered wireless identity transmitter, such as by using the current counter and predefined offset counter values, or alternatively, only a single encoded device identifier based only on the current counter stored within the central server.

[0333] In block 2456, the central server may receive a message including an encoded counter and a rolling identifier, such as within a sighting message transmitted by a proximity broadcast receiver. In block 2458, the central server may extract an encoded counter from the received message, and in block 2018 may extract a rolling identifier from the received message. In determination block 2460, the central server may determine whether the extracted counter (or '*ctr*') matches any of the pre-computed counters. If the extracted counter matches a pre-computed counter (i.e., determination block 2460 = "Yes"), in block 2462 the central server may identity a candidate wireless identity transmitter based on the matching pre-computed counter. In determination block 2484, the central server may determine whether the extracted rolling identifier matches any of the pre-computed identifiers, such as the pre-computing device identifiers for the candidate wireless identity transmitter.

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[0334] If the extracted rolling identifier does match any of the pre-computed identifiers for the candidate wireless identity transmitter (i.e., determination block 2484 = "Yes"), in block 2470 the central server may identity the received message as originating from the candidate wireless identity transmitter. In block 2472', the central server may update current counters and pre-computed encoded counters and pre-computed encoded device identifiers. For example, the database entry for the wireless identity transmitter identified as the originator of the received message may be updated with new current counter information as well as new pre-computed encoded counters and pre-computed encoded device identifiers. Additionally, any stored lists of pre-computed encoded counters may have older pre-computed encoded counters or encoded device identifiers removed at the same time newly computed encoded counters or device identifiers corresponding to the identified wireless identity transmitter are added to the list. In another embodiment, if the wireless identity transmitter identified as the originator of the received message is indicated in the central server's database as "not activated" (i.e., a flag is not set), then the central server may also adjust the database to reflect that the identified wireless identity transmitter is now activated (e.g., set a flag). The central server may then continue with the operations in block 2456.

[0335] If the extracted rolling identifier does not match any of the pre-computed identifiers for the candidate wireless identity transmitter (i.e., determination block 2484 = "No"), in determination block 2468, the central server may determine whether there are other candidates, such as other registered wireless identity transmitters that have not been evaluated by the central server. If there are other candidates (i.e., determination block 2468 = "Yes"), the central server may continue with the operations in block 2462, such as by identifying the next wireless identity transmitter to evaluate regarding the rolling identifier.

[0336] If there are no other candidates (i.e., determination block 2468 = "No"), or if the extracted counter does not match the pre-computed counter (i.e., determination block 2460 = "No"), the central server may attempt to identify the

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originator of the received message by comparing the extracted rolling identifier to information associated with all registered wireless identity transmitters in the system. Thus, in determination block 2170 the central server may determine whether there is another registered wireless identity transmitter to evaluate. For example, the central server may iteratively use information of all registered wireless identity transmitters. If there is not another (i.e., determination block 2170 = "No"), the central server may continue with the operations in block 2456.

[0337] If there is another (i.e., determination block 2170 = "Yes"), in block 2164 the central server may select the next registered wireless identity transmitter. In block 2474, the central server may decode the rolling identifier via the streaming-like encryption algorithm (e.g., AES-CTR) with the selected wireless identity transmitter's initial counter and first secret key (*K*) to find a decoded device identifier (*M'*). In determination block 2476, the central server may determine whether the decoded device identifier (*M'*) matches the selected wireless identity transmitter's *deviceID*. If the identifiers do not match (i.e., determination block 2476 = "No"), the central server may continue with the operations in determination block 2170. However, if the identifiers match (i.e., determination block 2476 = "Yes"), in block 2478 the central server may identify the received messages as originating from the selected wireless identity transmitter, and may continue with the operations in block 2472'.

[0338] FIGS. 25A-32C describe profile information as used within various embodiments. In general, users registered with a central server (e.g., a party with a wireless identity transmitter, proximity broadcast receiver, or a wireless identity transceiver) may provide the central server with various information, such as during a registration procedure as described above. The information may be stored by the central server as data within user profiles (or accounts), and may include information about individual users, such as their preferences (e.g., food, drinks, restaurants, shops, products, etc.), demographic information (e.g., sex, age, region of residence, race, etc.), payment authentication information (e.g., signature samples, photos, account numbers, etc.), and other personal information

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(e.g., medical information, financial institution memberships, etc.). The central server may update information within profiles based on subsequent input (e.g., editing information via a website connected to the central server) or behaviors indicated via sighting messages. For example, the central server may update a user's profile information to indicate purchase habits, travel routes, preferred items based on information within sighting messages corresponding to devices used by the user over a period of time.

[0339] The central server may store such profile information within databases or other structures and may also include descriptions, codes, tokens, tags, variables, or other indicators that describe the nature, topic, subject, or characteristics (referred to below as 'categories' or a 'category') of the various information. For example, the central server may store within a data table associated with a "Restaurants" category the names of a plurality of eating establishments that a user indicated were favorites of his/hers. As another example, the central server may store within a data table associated with a "Food" category the types of food (e.g., pizza, hotdogs, etc.), the brands of food products (e.g., "John's Cookies," "Soft Drink X," etc.), and the providers of food (e.g., "Store X") that a user indicated were favorites of his/hers. In other words, profiles may include information that may be categorized and identified as relevant to parties related to similar categories.

[0340] In various embodiments, the central server may transmit profile information stored within a profile (or account) of a registered user in response to receiving sighting messages corresponding to a device (e.g., wireless identity transmitter, wireless identity transceiver, mobile proximity broadcast receiver, etc.) associated with the user. For example, as a customer walks around carrying a wireless identity transmitter, a retail store's stationary proximity broadcast receivers may receive and relay a broadcast message, causing the central server to transmit relevant profile information. As another example, the central server may transmit relevant profile information in response to receiving sighting messages from mobile proximity broadcast receivers carried by customers within

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the retail store configured with stationary wireless identity transmitters. In various embodiments, registered services, such as government entities or retail stores, may employ both proximity broadcast receivers and wireless identity transmitters (or identity transceivers) to receive, relay, and process data from both users carrying wireless identity transmitters and/or mobile proximity broadcast receivers.

[0341] Such profile information may be identified as relevant by the central server when related to the device (e.g., proximity broadcast receiver, mobile proximity broadcast receiver, etc.) and/or associated registered service (e.g., merchants, marketing services, stores, users of mobile proximity broadcast receivers, etc.) that transmitted the corresponding sighting message. For example, upon receiving a sighting message from a proximity broadcast receiver within a restaurant, the central server may identify characteristics or categories associated with a proximity broadcast receiver (e.g., "Food," "Dining, "Restaurants," etc.) and match those identified categories to a user's profile to obtain relevant profile information to return to the proximity broadcast receiver. In this way, the central server may dynamically grant access to profile information that is relevant to those registered services within proximity of a user.

[0342] FIG. 25 illustrates an embodiment scenario in which relevant profile information is transmitted to a mobile device 2550 when a wireless identity transmitter 110 is within proximity of a proximity broadcast receiver 142. A user 2504 may carry the wireless identity transmitter 110 within proximity of a table 2502 (labeled in FIG. 25A as "Table #2), such as a bar table within a restaurant. The proximity broadcast receiver 142 (i.e., a stationary proximity broadcast receiver) may be collocated with the table 2502. For example, the proximity broadcast receiver 142 may be within, on top of, or underneath the table 2502. In other embodiments, the proximity broadcast receiver 142 may be in other places in the restaurant, such as at the entry way or at the bar. As the proximity broadcast receiver 142 may be within short-range wireless broadcast range (e.g.,

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a few feet), the proximity broadcast receiver may receive a broadcast message that includes the wireless identity transmitter's rolling identifier via short-range wireless signals 114 from the wireless identity transmitter 110. As described above, in response to receiving the broadcast message, the proximity broadcast receiver 142 may transmit a sighting message via a connection 2520 to the Internet 103 and a central server 120. The central server 120 may process the sighting message as described above, such as decrypting/decoding the rolling identifier and identifying the wireless identity transmitter 110 as being within proximity of the proximity broadcast receiver 142. In various embodiments, the proximity broadcast receiver 142 may be configured to transmit sighting messages to the central server 120 via various types of connection 2520, such as wireless long-range communications via a cellular network, a WiFi connection to a local WiFi router, and/or a wired local area network connection.

[0343] The mobile device 2550 may also be within the restaurant for use by the wait staff, the restaurant manager, or other personnel. For example, the mobile device 2550 may be a tablet device used by a hostess at the front of the restaurant. The mobile device 2550 may receive a message from the central server via the Internet 103 through a wired or wireless communications connection 2522. The message may be received in response to the central server processing the sighting message transmitted by the proximity broadcast receiver 142, and thus may include relevant profile information corresponding to the user 2504. The mobile device 2550 may render the received information for use by the restaurant personnel to approach, accommodate, and otherwise provide effective and efficient customer service to the user 2504.

[0344] For illustration purposes, the mobile device 2550 may display various notices, statements, messages, or other information based on the received relevant profile information. In particular, the mobile device 2550 may render a first notice 2552 that the user (or customer) is near a particular table 2502, such as Table #2. A second rendered notice 2554 may indicate the customer is a vegan. A third rendered notice 2555 may be a command to the restaurant staff

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indicating that only vegan items on the restaurant's menu should be offered to the user 2504. The third rendered notice 2555 may be generated based on the profile information of the user 2504 by software executing on the mobile device 2550 or alternatively by the central server 120. A fourth rendered notice 2556 may indicate the user 2504 is above the legal drinking age and a fifth rendered notice 2558 may indicate the user 2504 has a preference for beer. A sixth rendered notice 2559 may include a command or other instructions to the restaurant staff that they should tell the user 2504 about the beers on tap based on the received profile information that indicates the user 2504 prefers beer. In various embodiments, notices rendered by the mobile device 2550 may include varying specificity and identifying information about the user 2504 based on privacy permissions or settings stored by the central server, as described below. For example, the mobile device 2550 may render a notice that includes the name of the user 2504 for use by wait staff in addressing the user 2504.

[0345] In another exemplary scenario, the proximity broadcast receiver 142 and mobile device 2550 may be used within a hospital. In such an implementation, the system may function as a virtual medical alert bracelet by causing the central server 120 to transmit medical information of the user 2504 for use by the mobile device 2550 accessed by emergency room staff (e.g., nurses, doctors, EMTs, etc.). For example, when the user 2504 enters an emergency room, an attendant carrying the mobile device 2550 may receive a list of medicine allergies and prior medical procedures related to the user 2504.

[0346] FIG. 26A is a process flow diagram illustrating an embodiment method 2600 for a central server to transmit relevant profile information to a computing device. In general, as users execute various activities and movements, their wireless identity transmitters may transmit broadcast messages received by proximate proximity broadcast receivers associated with registered services, such as stationary proximity broadcast receivers within a merchant's restaurant or retail store. The central server may receive sighting messages from these proximity broadcast receivers and identify any information within the users'

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profiles that may be relevant to the registered services. In other words, only profile information that is needed by the registered services to properly assist, approach, or otherwise engage with the users may be transmitted by the central server. For example, a computing device associated with a restaurant may never receive profile information describing a proximate user's favorite type of undergarments or high school alma mater.

[0347] In block 2602, the central server may receive profile information from a user during registration, such as during registration procedures described above. For example, the central server may receive profile information (e.g., dietary restrictions and clothing preferences) when a user registers a wireless identity transmitter via a web portal. In optional block 2604, the central server may automatically obtain profile information related to the user from online sources, such as social networking accounts and shopping websites and/or accounts. For example, the central server may access the user's Facebook account to get information about preferred topics or products, or alternatively access the user's shopping account on the Amazon website and gather purchase history information. In block 2606, the central server may store profile information from the user. For example, the profile information may be stored as a profile or as data entries within a database. In various embodiments, the profile may be associated with the unique identity (i.e., device identifier or deviceID) of the user's wireless identity transmitter. In other words, the central server may use the device identifier as a database key to access relevant stored profile information corresponding to the user. In block 2608, the central server may assign categories to the profile information. For example, food preference information may be assigned a "Food" category, medical data may be assigned a "Personal Info" category, and the names of the user's favorite shirts may be assigned a "Clothing" category.

[0348] As described above, in determination block 1402, the central server may determine whether a sighting message is received, such as a sighting message transmitted by a proximity broadcast receiver located within a retail store or

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restaurant. For example, as a user carrying a wireless identity transmitter walks near the entry of a diner, a proximity broadcast receiver located within the diner may receive broadcast messages from the wireless identity transmitter, create sighting messages based on the received broadcast messages, and transmit the sighting messages to the central server. In an embodiment, the sighting message may also contain indicators of attractions, incentives, point-of-sale devices, and/or products within proximity of the proximity broadcast receiver transmitting the sighting message. For example, a proximity broadcast receiver may be configured to indicate within sighting messages that it is stationed near a wait staff desk, a bar, a cash register, or a 'returns' area in a department store. If the central server does not receive a sighting message (i.e., determination block 1402 = "No"), the central server may continue with the operations in determination block 1402.

[0349] However, if the central server does receive a sighting message (i.e., determination block 1402 = "Yes"), in determination block 1602 the central server may determine whether a wireless identity transmitter identity is known based on the received sighting message. The central server may detect identification information related to the broadcast message within the sighting message, such as by parsing the sighting message, decrypting or decoding identification information related to a wireless identity transmitter (i.e., a rolling identifier), and matching the identification information to a registered user or registered wireless identity transmitter. For example, the central server may compare decrypted (or decoded) identification information from the sighting message to a list of all rolling identifiers related to registered wireless identity transmitters. If the wireless identity transmitter identity is not known by the central server (i.e., determination block 1602 = "No"), in block 1603 the central server may ignore the sighting message and continue with the operations in determination block 1402.

[0350] If the wireless identity transmitter identity is known by the central server (i.e., determination block 1602 = "Yes"), in determination block 1604 the central

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server may determine whether the sighting message is related to a registered service. For example, the central server may evaluate metadata within the sighting message to detect a code that identifies a merchant or retail store as being registered. In an embodiment, registered services may be affiliated with a profile information delivery service managed by the central server. If the sighting message is not related to a registered service (i.e., determination block 1604 = "No"), the central server may continue with the operations in block 1603. If the sighting message is related to a registered service (i.e., determination block 1604 = "Yes"), in block 1414 the central server may store data based on the sighting message in relation to the wireless identity transmitter identity. In other words, the central server may store data in relation to the user of the wireless identity transmitter. The stored data may be used to update individual customer accounts, records, or profiles within the central server. For example, the central server may update a database entry related to the identified wireless identity transmitter (or its associated customer or user account), indicating the wireless identity transmitter was within proximity of the proximity broadcast receiver associated with the sighting message, as well as any other relevant information indicated in the sighting message (e.g., timestamps, etc.). In various embodiments, such stored data may be used by the central server to generate foot traffic reports or statistics for the registered service.

[0351] In block 2612, the central server may identify categories corresponding to the registered service, such as the registered service associated with the received sighting message. In an embodiment, the central server may maintain a database that describes merchants, retailers, and other third-parties in relation to relevant categories or service labels. For example, the central server may store a database that indicates that "Tom's Bar and Grill" relates to "food," "alcohol," and "beverage" categories. Alternatively, the central server may identify categories based on a stored profile associated with the registered service. For example, the central server may identify the registered service's business type, services offered, products offered, demographics, interests, and/or target audience within

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a business profile stored at the time the registered service registered with the central server. In block 2614, the central server may identify relevant profile information associated with the wireless identity transmitter identity by using the identified categories. In other words, the central server may generate a data table that includes subsets of relevant information from the stored profile information corresponding to the user associated with the known wireless identity transmitter. The relevant information may be the data within the user's stored profile information having assigned categories that match the categories identified in the operations in block 2612. For example, the data table may include data describing the user's favorite alcoholic beverage when identifying information relevant to the category "alcohol. In block 2616, the central server may transmit a return message that includes the identified relevant profile information to a local computing device related to the registered service. For example, the central server may transmit a message to a mobile device carried by a waiter working at the restaurant associated with the proximity broadcast receiver that transmitted the received sighting message.

[0352] In optional block 2618, the central server may store data in relation to the registered service based on the identified relevant profile information, and then the central server may then continue with the operations in determination block 1402. For example, the central server may update a database entry for a merchant with the user's (or customer's) proximity or location information determined based on the sighting message. As another example, the central server may record the type of profile information that was determined to be relevant to the registered service for particular users. In general, such stored data may be valuable to stores, merchants, and various services registered with the central server for generating profit equations, mapping foot traffic, calibrating building floor plans, and otherwise understanding user trends (e.g., purchase convergence, number of visits to the retail store per user per time period, etc.). Stored information may also include indicators of behavioral information of users, such as where users are moving within a stores, how long users stay in

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particular areas (e.g., how long a shopper was in front of an end cap), movement routes within evaluated areas (e.g., data showing a user moves from the Toys department to the Automotive department, etc.). In an embodiment, behavioral information may include data describing a user's usage of in-store WiFi provided in relation to a registered service. For example, the central server may store information that indicates a user entered a retail store and accessed a free WiFi local area network to view a website of a competitor store.

[0353] The central server may also update and store statistical information based on the sighting message and/or the transmitted return message, such as modifying data that indicates the number of unique users within a building (e.g., a retail store), the amount of time (i.e., "dwell" time) the user was within a particular area (e.g., aisle, department, cash register line, etc.), the interests of such users, and the travel routes users make within observed places, such as a retail store. The central server may store data that indicates an aggregated amount of time that all users dwelled within a particular area. In another embodiment, the central server may store information from individual sighting messages and/or return message or alternatively may only store summary or average data based on a plurality of messages. For example, each time the central server receives a new sighting message or transmits a return message associated with a particular user's wireless identity transmitter, the central server may store an updated average of the user's dwell time within a particular department of a retail store.

[0354] In various embodiments, the data stored in relation to the registered service may vary based on relevant permissions settings associated with a user's registered account or profile. For example, if the user related to the sighting message and/or wireless identity transmitter does authorize his/her data to be used by registered services, the central server may store behavioral information that identifies the user in relation to his/her activities (e.g., user A walked to a certain area within a local coffee shop, user X bought a coffee and sat in the lobby for an hour, etc.). However, the central server may act as a shield for the user's identity by storing but not providing identifying information to merchants

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without permission or authorization from the users. For example, this stored information may not be communicated, transmitted, or other made available to merchants, retailers, or the retail store, but may instead be used exclusively by the central server. The central server's use of stored permissions is further described below.

[0355] FIG. 26B is a process flow diagram illustrating an embodiment method 2650 for a central server to transmit relevant profile information to a computing device when authorized by permissions indicated in a user profile. The method 2650 is similar to the method 2600 described above, except that the central server may perform operations to transmit profile information that has been authorized to be transmitted to a particular registered service by the user. In other words, relevant profile information may not be transmitted when the user has configured his profile to disallow sharing of that information. This may be important to ensure privacy and enable users to finely control the dissemination of their profile information. For example, based on a prior bad experience with a particular vendor, a user may provide the central server with permissions settings that forbid the transmissions of personal information to that vendor.

[0356] In block 2602, the central server may receive profile information from a user during registration, such as during registration procedures described above. In optional block 2604, the central server may automatically obtain profile information related to the user from online sources, such as social networking accounts and shopping accounts. In block 2606, the central server may store profile information from the user. In block 2608, the central server may assign categories to the profile information.

[0357] In block 2652, the central server may receive profile permissions from the user. As described above, the user may provide identities of third-parties or registered services (e.g., merchants, marketing services, etc.) that are authorized to receive categories of profile information or particular data within the user's profile. The user may also provide permissions that indicate any merchant or

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third-party (or alternatively no merchant or third-party) may receive information in certain categories or particular data. In an embodiment, the profile permissions may indicate whether certain pieces of profile information are public or private. For example, the central server may store a permission that indicates that a user's name is private information not to be shared at large, and another permission setting that indicates the user's favorite sporting team is public to be shared to anyone. In block 2654, the central server may store the profile permissions. For example, each piece of profile data stored in relation to the user may have a tag, flag, or indicator that indicates whether the central server may transmit that data to a particular merchant.

[0358] In determination block 1402, the central server may determine whether a sighting message is received, such as a sighting message transmitted by a proximity broadcast receiver located within a retail store or restaurant. If the central server does not receive a sighting message (i.e., determination block 1402 = "No"), the central server may continue with the operations in determination block 1402. However, if the central server does receive a sighting message (i.e., determination block 1402 = "Yes"), in determination block 1602 the central server may determine whether a wireless identity transmitter identity is known based on the received sighting message. If the wireless identity transmitter identity is not known by the central server (i.e., determination block 1602 = "No"), in block 1603 the central server may ignore the sighting message and continue with the operations in determination block 1402.

[0359] If the wireless identity transmitter identity is known by the central server (i.e., determination block 1602 = "Yes"), in determination block 1604 the central server may determine whether the sighting message is related to a registered service. If the sighting message is not related to a registered service (i.e., determination block 1604 = "No"), the central server may continue with the operations in block 1603. If the sighting message is related to a registered service (i.e., determination block 1604 = "Yes"), in block 1414 the central server may store data based on the sighting message in relation to the wireless identity

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transmitter identity. In block 2612, the central server may identify categories corresponding to the registered service, such as the registered service associated with the received sighting message. In block 2614, the central server may identify relevant profile information associated with the wireless identity transmitter identity by using the identified categories.

[0360] In block 2660, the central server may identify relevant profile information the registered service is authorized to receive based on stored permissions. For example, the central server may evaluate permissions indicators associated with the identified relevant profile information and identify a subset (or window) of the profile information relevant to the identified categories that the user has authorized to be delivered to the registered service (e.g., merchant, retailer, etc.). In an embodiment, all, some, or none of the relevant information identified in the operations in block 2614 may be authorized to share with the registered service. For example, although the profile information includes several pieces of data relevant to the category of "Food," the central server may not identify any authorized information to transmit to a restaurant registered service when the user has indicated the restaurant may not receive any profile information.

[0361] In determination block 2662, the central server may determine whether the registered service is authorized to receive any information. If the registered service is not authorized to receive information (i.e., determination block 2662 = "No"), the central server may continue with the operations in determination block 1402. However, if the registered service is authorized to receive the information (i.e., determination block 2662 = "Yes"), in block 2664 the central server may transmit a return message that includes authorized, relevant profile information to a computing device related to the registered service. For example, the central server may transmit the return message to a point-of-sale device near the proximity broadcast receiver that transmitted the sighting message. In an embodiment, the computing device may display the profile information to an employee, such as a waiter. In another embodiment, the central server and/or the

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computing device may generate instructions for the employee based on the identified profile information. For example, the central server and/or the computing device may generate instructions that direct a waiter to present a vegetarian menu to the user/ customer when the identified profile information indicates the user doesn't eat meat. In optional block 2618, the central server may store data in relation to the registered service based on the identified relevant profile information, and then the central server may then continue with the operations in determination block 1402.

[0362] FIG. 27A shows exemplary data tables 2700, 2720, 2730 that include various profile information that may be stored by a central server and transmitted in response to receiving a sighting message in accordance with various embodiments. For example, the central server may generate the data tables 2700, 2720, 2730 while performing the operations described above with reference to FIG. 26B. As described above, the user may be associated with a wireless identity transmitter that has been registered with the central server and that has a unique identifier. The central server may use such an identifier as a key to generate data tables of the user's stored profile information. In various other embodiments, data tables of the user's profile information may be generated based on other unique information or look-up keys, such as the unique device identifier of a mobile proximity broadcast receiver associated with the user or the user's own personal identifier (e.g., a social security number, etc.). Further, although such exemplary data tables 2700, 2720, 2730 illustrate possible ways of storing and utilizing profile information, those skilled in the art may appreciate other manners of storing, organizing, and accessing such information.

[0363] The central server may generate a first data table 2700 that includes information obtained by the central server by performing the operations in blocks 2602-2654 in FIG. 26B. For example, the first data table 2700 may be the result of the user providing profile information to the central server during registration and/or subsequent updates via a web portal or web site associated with the central server. The first data table 2700 may include a complete set of profile

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information associated with a particular user. For example, the central server may generate the first data table 2700 by querying a database using only the device ID of the user's wireless identity transmitter.

[0364] The first data table 2700 may include numerous data columns 2701-2706 that describe various information stored in the profile. For the purposes of illustration, the first data table 2700 may include a first data column 2701 ("Description") that includes descriptive labels for stored profile information. For example, a description in the first data column 2701 may be a question posed to the user during registration ("What is your favorite drink?) or a general label (e.g., "Birthdate"). The first data table 2700 may also include a second data column 2702 ("Value") that includes the stored value of a profile entry, and a third data column 2703 ("Category") that indicates the general topic, subject matter, category, or other means of organizing and relating the profile information stored within a particular data entry. The first data table 2700 may also include a fourth column 2706 ("Permissions") that may include information representing the names and/or categories of registered services (e.g., merchants, vendors, stores, people, etc.) that are authorized to receive the profile information within an entry. The fourth column 2706 may also include tokens that indicate whether related profile information may be available to any recipient (i.e., "Public") or no recipient (i.e., "Private").

[0365] The first data table 2700 may also include numerous data rows 2710-2718 that include the stored profile information provided by the user. For illustration purposes, a first data row 2710 may include profile information that indicates the user is a vegan, a second data row 2711 may include profile information that indicates the user's show size is 11.5", a third data row 2712 may include profile information that indicates the user's favorite type of drink is beer, a fourth data row 2713 may include profile information that indicates the user's favorite bar is McCall's Pub, a fifth data row 2714 may include profile information that indicates the user's birth date is June 1, 1978, a sixth data row 2715 may include profile information that indicates the date the user last visited

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any restaurant as August 12, 2012, a seventh data row 2716 may include profile information that indicates the user's home country as the United States, an eighth data row 2717 may include profile information that indicates the user's name is John Smith, and a ninth data row 2718 may include profile information that indicates that the user does not mind if customer service people approach him.

[0366] The central server may also generate a second data table 2720 that includes information related to the operations in block 2612 in FIG. 26B. In particular, once a registered service is determined to be related to the sighting message (e.g., the central server detects identifying information within metadata of the sighting message), the central server may identify the categories related to the registered service based on information stored within the central server. For example, the central server may perform a look-up on a database of all registered services to find categories relevant to the registered service. Stored information about registered services may be provided by the various services, such as via a registration procedure as described above. In an embodiment, the second data table 2720 may be the result of the central server performing a look-up using a key that is the registered service's name (e.g., "Tom's Bar & Grill") or other unique information, such as a unique proximity broadcast receiver device ID. The second data table 2720 may include only categories (or labels) that define the services, activities, characteristics, or other indicators of the registered service. For illustration purposes, the second data table 2720 may include a data column 2722 ("Registered Service Category") that includes the categories relevant to the registered service. The second data table 2720 may include a first data row 2723 that includes information indicating the categories of "Food," "Alcohol," "Service," and "Personal." In other words, the registered service may be identified as relevant to (or concerned with) any profile information that is related to personal information of users, food and alcohol products, and the service industry (i.e., the registered service may be a restaurant).

[0367] The central server may generate a third data table 2730 that includes profile information from the first data table 2700 based on a comparison with the

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information from the second data table 2720. In other words, the third data table 2730 may be generated by the central server by performing the operations in block 2660 in FIG. 26B, and may include all of the user's profile information that is relevant and authorized to be transmitted to the registered service. For the purposes of illustration, the third data table 2730 may include a first data column 2731 ("Description") that includes descriptive labels for stored profile information, and a second data column 2732 ("Value") that includes values related to the descriptions indicated in the first column 2731.

[0368] The third data table 2730 may include data rows 2741-2746 that include profile information that are both relevant to the categories of the registered service indicated within the second data table 2720 and authorized by the user based on permissions indicated within the first data table 2700. For the purposes of illustration, a first data row 2741 may include profile information that indicates the user is vegan because that information is relevant to the "Food" category and authorized by the "All Food" permission, a second data row 2742 may include profile information that indicates the user's favorite drink is beer because that information is relevant to the "Alcohol" category and authorized by the "Tom's Bar & Grill" permission, a third data row 2743 may include profile information that indicates the user's birth date because that information is relevant to the "Personal" category and authorized by the "All Food" permission, a fourth data row 2744 may include profile information that indicates the user's country because that information is relevant to the "Personal" category and authorized by the "Public" permission, a fifth data row 2745 may include profile information that indicates the user's name because that information is relevant to the "Personal" category and authorized by the "All Services" permission, and a sixth data row 2746 may include profile information that indicates the user does not mind being approached by customer service agents because that information is relevant to the "Service" category and authorized by the "All Services" permission.

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[0369] FIG. 27B shows another exemplary data table 2750 that includes various profile information that may be stored by a central server and transmitted in response to receiving a sighting message in accordance with various embodiments. The data table 2750 may be generated in a similar manner as the data table 2700 described above, and may include profile information of various specificity and nature. For example, the data table 2750 may include profile information indicating that a user is allergic to chocolate, as well as the user's specific preferences, such as beer and wine product preferences. Further, the data table 2750 may include profile information indicating the user's interests, such as sports or anime, which may be used by the central server for performing profile matching. For example, the central server may use the user's interests to compare to interests stored in other's profiles to find matches, such as part of a dating or friend-finding service.

[0370] FIGS. 28A-28B are diagrams illustrating proximity broadcast receivers and a mobile device receiving different authorized information based on related profiles. As described above, a central server may transmit profile information from stored profiles of registered users. For example, in response to receiving a sighting message from a proximity broadcast receiver within proximity of a user's wireless identity transmitter (or wireless identity transceiver) within a juice bar, the central server may transmit a return message that includes the user's beverage preference. However, it should be emphasized that different profile information may be transmitted to various registered services, even when the services are within the same proximity to the user. For example, when a user carrying a wireless identity transmitter walks within proximity of a movie theater employing a proximity broadcast receiver, the movie theater proximity broadcast receiver may receive profile information indicating the user is over 18 and may watch rated 'R' movies. However, when that same user also walks within proximity of a candy shop employing a proximity broadcast receiver, the candy shop proximity broadcast receiver may receive profile information indicating the user is allergic to nuts and may not eat peanut brittle.

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[0371] FIG. 28A illustrates a user's wireless identity transmitter 110 in proximity of a plurality of proximity broadcast receivers 142, 142', 142''. The user may also carry a mobile device 2810, such as a smartphone. In various embodiments, the mobile device 2810 may be configured to operate as a wireless identity transmitter or transceiver such that the separate wireless identity transmitter 110 may be unneeded by the user in order to transmit broadcast messages for receipt by proximate devices of registered services, such as retail stores.

[0372] For the purposes of illustration, the user and the proximity broadcast receivers 142, 142', 142'' may be within a mall or some other place where each may be within proximity of the wireless identity transmitter 110 at the same time. Additionally, each proximity broadcast receiver 142, 142', 142''may be associated with different registered services. For example, the first proximity broadcast receiver 142 may be associated with a "Shop A" (e.g., an electronics shop), the second proximity broadcast receiver 142 may be associated with a "Shop B" (e.g., a restaurant), and the third proximity broadcast receiver 142 may associated with a "Shop C" (e.g., an accounting firm office), all within the mall.

[0373] As the proximity broadcast receivers 142, 142', 142'' are within proximity of the wireless identity transmitter 110 (i.e., each is within the broadcast range), broadcast messages may be received by each of the proximity broadcast receivers 142, 142', 142'' via short-range wireless signals 114. As described above, in response, the proximity broadcast receivers 142, 142', 142'' may transmit sighting messages 2802, 2804, 2806 via the Internet 103 to a central server 120 for processing. Each of the sighting messages 2802, 2804, and 2806 may include different information (i.e., metadata or header information) that indicates the various associated registered services, location information, etc. However, the sighting messages 2802, 2804, and 2806 may all report similar information based on the received broadcast message from the user's wireless identity transmitter 110. In other words, each of the sighting messages 2802,

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2804, and 2806 may include the same rolling identifier of the wireless identity transmitter 110.

[0374] FIG. 28B illustrates different information transmitted by a central server 120 in response to receiving sighting messages from a plurality of proximity broadcast receivers 142, 142', 142'' concurrently within proximity of a wireless identity transmitter 110 described above with reference to FIG. 28A. In other words, FIG. 28B shows how messages 2852, 2854 with differing profile information may be transmitted to proximate devices in response to the central server 120 processing sighting messages from proximity broadcast receivers 142, 142', 142'' associated with various registered services. As indicated above, such sighting messages may be transmitted based on a user associated with a wireless identity transmitter 110 being within proximity of the proximity broadcast receivers 142, 142', 142''.

[0375] For illustration purposes, the central server 120 may transmit to a first proximity broadcast receiver 142 associated with "Shop A" a first message 2852 that includes profile information indicating the user's customer identity (i.e., "customerId") and photo. Such profile information may be used for authenticating a payment, purchase, or other transaction within Shop A. The central server 120 may also transmit to a second proximity broadcast receiver 142 associated with "Shop B" a second message 2854 that includes profile information indicating the user's allergies, food preferences, and first name. Such profile information may be used for expediting food-related customer service with the user within Shop B.

[0376] In an embodiment, the user may provide the central server 120 with permissions that disallow transmission of profile information to any registered service when the user has not explicitly indicated that a particular registered service (or category of registered service) may receive profile information. For example, based on performing the method 2650 described above, the central server 120 may not identify any profile information that the user has authorized

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to be transmitted to the registered service associated with "Shop C," and thus the central server 120 may not transmit any message to a third proximity broadcast receiver 142 associated with Shop C.

[0377] As another illustration, the user carrying the wireless identity transmitter 110 may walk inside of a movie theater that houses a bar, a concessions stand, and a ticket counter, all of which having a proximity broadcast receiver. In response to sighting messages sent by the various proximity broadcast receivers, the central server may transmit a first message to the bar that includes the user's age, a second message to the concessions stand that includes the user's favorite candy type, and a third message to the ticket counter that indicates the user is eligible for a student discount.

[0378] In another embodiment, the central server 120 may perform operations as described above with reference to FIGS. 18A-18D to identify the closest proximity broadcast receiver 142, 142', 142'' to the user based on signal strength information within the sighting messages 2802-2806. In such a case, the central server 120 may only transmit a signal return message to the closest proximity broadcast receiver to the user.

[0379] In further embodiments, the central server 120 may also transmit messages 2860, 2862, 2864 to the user's mobile device 2810 based on the sighting messages 2802, 2804, 2806 received from the proximity broadcast receivers 142, 142', 142''. Such messages 2860, 2862, and 2864 may include information corresponding to the registered services associated with the proximity broadcast receivers 142, 142', 142''. In other words, registered services may also wish to control their privacy (or information flow), and so the central server 120 may identify profile information of registered services that is authorized to be shared with the user. The information within such messages may be identified using operations similar to those described below with reference to FIGS. 28C.

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[0380] For illustration purposes, the central server 120 may transmit to the mobile device 2810 a first message 2860 that includes information indicating Shop A's store hours, a second message 2862 that includes information indicating Shop B's culinary specialties, and a third message 2864 that includes information indicating Shop C's logo and mission statement.

[0381] In other embodiments, the central server 120 may also transmit coupons, promotions, and marketing information to the mobile device 2810. For example, the central server may generate coupons that are relevant to the user of the mobile device 2810 based on his/her profile information.

[0382] FIG. 28C illustrates an embodiment method 2870 for a central server to identify authorized data to share based on two different profiles. In various embodiments, the central server may store profiles and related permissions (or privacy settings) for any party registered with the central server. For example, vendors, individuals, merchants, and services may provide profile information that describes their interests, characteristics, qualities, and other identifying information as well as who may receive such information. By comparing categories of information within multiple profiles, such as a first profile associated with a proximity broadcast receiver in a retail store and a second profile associated with a proximate user's wireless identity transmitter, the central server may transmit messages to both parties with relevant, authorized profile information.

[0383] In block 2602', the central server may receive profile information from parties during registration. Such parties may include registered services, user, vendors, merchants, and any other parties that provide identifying information to the central server during a registration procedure. For example, a merchant registering with the central server may provide profile information that indicates the merchant's type of business, preferred customer base/demographics, Securities and Exchange Commission filings information, and any other identifying information. In block 2606', the central server may store the profile

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information from the parties, such as by storing profiles within a database. The central server may store the profiles in different databases based on the type of party being registered, such as by storing business profiles in a business database and individual profiles in a users database. In block 2608, the central server may assign categories to the stored profile information. In block 2652', the central server may receive profile permissions from the parties. For example, a merchant registering a profile may indicate to the central server that only other users who are shareholders of the merchant's corporation may receive certain profile information. In block 2654, the central server may store the profile permissions, such as within data tables associated with the parties as described above.

[0384] In determination block 1402, the central server may determine whether a sighting message is received, such as a sighting message transmitted by a proximity broadcast receiver located within a retail store or restaurant. If the central server does not receive a sighting message (i.e., determination block 1402 = "No"), the central server may continue with the operations in determination block 1402. However, if the central server does receive a sighting message (i.e., determination block 1402 = "Yes"), the central server may process the sighting message (e.g., decrypt, decode, access rolling identifiers, etc.) as described above. In block 2872 the central server may identity a first profile based on the wireless identity transmitter rolling identifier within the sighting message. For example, the central server may decode the rolling identifier and identify the profile corresponding to the user of the wireless identity transmitter. The operations in block 2872 may be similar to those described above with reference to determining whether a wireless identity transmitter identity is known by the central server (e.g., the operations in determination block 1602). In block 2874, the central server may identify a second profile based on information related to a proximity broadcast receiver within the sighting message. In other words, the central server may evaluate the received sighting message to detect the identity of the proximity broadcast receiver that transmitted the received sighting message

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and may use that identity to identify the second profile. For example, the sighting message may include metadata that indicates the sighting message was transmitted by a device within a certain retail store that has registered a profile with the central server. The operations in block 2874 may be similar to those described above with reference to determining whether a received sighting message relates to a registered service (e.g., the operations in determination block 1604).

[0385] In block 2876, the central server may identify authorized, relevant first profile information to share based on the permissions of the first profile and the assigned categories of the first and second profiles. The operations in block 2876 may be similar to the operations in blocks 2612, 2614, and 2660 with reference to FIG. 26B as described above. For example, the central server may find profile information having assigned categories within the first profile that matches assigned categories within the second profile.

[0386] In an embodiment, the central server may identify relevant, authorized first profile information based on public profile information within the second profile. The central server may only be enabled to match categories of information within the first profile with categories of information set as "public" within the second profile. For example, the central server may use the public information of "favorite sports team" within a second profile to match with the first profile, but not the second profile's private information of "religious affiliation." In this way, both parties and profiles may be secured from divulging private information.

[0387] In an embodiment, the central server may determine relevant information based on various characteristics stored within a profile. For example, the central server may identify food preferences from the first profile as relevant when the second profile includes profile information that indicates the user of the second profile is a waitress and/or affiliated with a restaurant. The central server may also determine relevance of profile information based on location information

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provided by the received sighting message. For example, the central server may determine the proximity broadcast receiver that transmitted the sighting message is within a restaurant based on metadata, and thus may combine that location information with profile information that indicates a waitress occupation to conclude that the user of the proximity broadcast receiver is a waitress on-duty within the restaurant.

[0388] In determination block 2878, the central server may determine whether there is any first profile information to share. In other words, the central server may determine whether any authorized and relevant information from the first profile was identified in the operations in block 2876. If there is first profile information is to be shared (i.e., determination block 2878 = "Yes"), in block 2880 the central server may transmit a message including the authorized first profile information to a device associated with the second profile. Such a device associated with the second profile may be a local server, proximity broadcast receiver, or mobile device that is indicated in the second profile as being an appropriate recipient for the first profile information. In various embodiments, such a device may be the proximity broadcast receiver that transmitted the received sighting message.

[0389] If no first profile information is to be shared (i.e., determination block 2878 = "No"), or if the message is transmitted in block 2880, in block 2882 the central server may identify authorized, relevant second profile information to share based on the permissions of the second profile and the assigned categories of the first and second profiles. The operations in block 2882 may be similar to the operations described above related to identifying authorized, relevant first profile information. In other words, the central server may compare assigned categories of the two profiles to identify relevant information of the second profile and check the second profile's permissions to determine whether any relevant information is authorized to be shared from the second profile.

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[0390] In determination block 2884, the central server may determine whether there is any second profile information to share. In other words, the central server may determine whether any authorized and relevant information from the second profile was identified in the operations in block 2882. If there is second profile information is to be shared (i.e., determination block 2884 = "Yes"), in block 2886 the central server may transmit a message including the authorized second profile information to a device associated with the first profile. For example, the central server may transmit an email, SMS text message, or other message to a mobile device associated with the first profile as described above with reference to FIG. 28B. The central server may continue with the operations in determination block 1402.

[0391] In another illustration, when authorized by permissions, the central server may transmit medical information from the first profile to a device associated with the second profile (or vice versa) when the second profile corresponds to a user with a medical background (e.g., doctor, EMT, nurse, etc.). Due to the sensitive nature of medical information, the central server may utilize other determinations before transmitting such medical information, such as whether an emergency is indicated (e.g., sensor data within the received sighting message indicates the user of the first profile is sick/injured) and/or whether the user of the second profile is on active duty and/or within a medical care facility (e.g., the nurse is on-duty and within a hospital geofence, etc.).

[0392] In an embodiment, the method 2870 may be performed by the central server to enable speed dating. Based on received sighting messages from one or both identity transceivers carried by speed dating participants, the central server may identify related profiles, match the identified profiles, and transmit messages to the participants when there is matching profile information. For example, the central server may compare the occupations indicated in two profiles to identify if they are similar, within the same field, or other measures of commonality. Alternatively, the central server may simply analyze the two profiles and return any public profile information that may be of interest to the participants. For

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example, if a user sets permissions to allow her salary range to be a public or shared piece of information, the central server may transmit a message indicating the salary to another participant.

[0393] FIGS. 29A-29B illustrate a second device 2902 (referred to as "Device B") sharing authorized profile information in response to receiving short-range signals from a first device 2901 (referred to as "Device A") within proximity. The first device 2901 and the second device 2902 may be mobile computing devices (e.g., smartphones, tablets, etc.) that are configured to perform operations of wireless identity transceivers and that are associated with various users, such as a customer, or alternatively a merchant, vendor, or business (e.g., Starbucks, etc.). Alternatively, either of the devices 2901, 2902 may be proximity broadcast receivers stationed within a place. For example, the first device 2901 may be a stationary identity transceiver collocated with a cash register in a coffee shop and the second device 2902 may be a mobile identity transceiver carried by a customer. The communications described in FIGS. 29A-B and the method described below with reference to FIG. 29C may be important as they permit relevant, public profile information stored on devices to be transmitted by devices when within proximity. However, as a central server may not be included with reference to FIGS. 29A-B, the shared information may be less secure, as broadcasting messages with public information may be received by any proximate devices and as no authentication (or verification) of the information or parties may be provided via the central server. Accordingly, profile information transmitted in various embodiments may only be non-sensitive data authorized for sharing to the public by users.

[0394] FIG. 29A shows the first device 2901 broadcasting a message 2904 that includes information related to the first device 2901. The message 2904 may include public profile information that the user of the first device 2901 has authorized as open for anyone to receive. For example, the message 2904 may include indications of the categories, topics of interest, or the businesses or services relevant to the user of the first device 2901, such as a coffee shop.

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When within proximity of the first device 2901, the second device 2902 may receive the message 2904 via a short-range transceiver, such as a Bluetooth® LE radio.

[0395] FIG. 29B shows the second device 2902 transmitting a response message 2914 that includes profile information related to the second device 2902. The response message 2914 may include public profile information the user of the second device 2902 has authorized as open for anyone to receive and that is relevant to the received message from the first device 2901. For example, the response message 2914 may include public information the user of the second device 2902 does not mind transmitting in the clear (i.e., authorized via permissions as 'public') and that is relevant based on matching information received from the first device 2901 with the profile stored on the second device 2902.

[0396] In an embodiment, the profile information within the response message 2914 may be normally set as private by the user of the second device 2902 and may only be transmitted when the received message from the first device 2901 includes certain information. For example, the second device 2902 may only transmit the response message 2914 when it receives a message from the first device 2901 that indicates the first device 2901 is associated with an emergency service (e.g., an EMT).

[0397] FIG. 29C is a process flow diagram of an embodiment method for a computing device to share authorized profile information in response to receiving short-range signals from a device within proximity. In various embodiments, the method 2950 may be performed by a mobile device, such as those described above with reference to FIGS. 29A-B. For example, the computing device may be a smartphone or an identity transceiver (e.g., a smartphone configured to transmit short-range signals as well as process incoming broadcast messages from proximate devices). Additionally, the method 2950 may be similar to the method described above with reference to FIG. 28C, except that the method 2950

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may only include operations for transmitting profile information from a single profile that is stored locally on the computing device.

[0398] In optional block 2952, the computing device may receive profile information from user interaction, such as inputs on a smartphone graphical user interface. For example, a user input may provide text or selections that indicate personal information, categories of information relevant to the user of the computing device, as well as permissions for the profile information (e.g., indicators of the public/private nature of particular pieces of information, whether certain third-parties may receive certain data, etc.). In optional block 2954, the computing device may download profile information from a central server. For example, the computing device may be configured to periodically download profile information associated with the user of the computing device as is currently stored in the central server. In other words, users may download their current profiles from the central server for use with software and services executing on the computing device (e.g., an app executing on a smartphone).

[0399] In block 2956, the computing device may store profile information locally, such as in a database within the computing device. The profile information may also include permissions as described above, such as indicators whether various pieces of the profile may be shared with certain categories of third-parties (e.g., public, private, only for sharing with "Tom's BBQ Restaurant," etc.). In an embodiment, the computing device may store the profile information such that the information is connected to or otherwise accessible to software executing on the computing device that is in communication with the central server. In determination block 2957, the computing device may determine whether a short-range wireless message is received from a proximate device, such as a broadcast message from a proximate wireless identity transmitter. In various embodiments, the short-range wireless message may be transmitted by a wireless identity transceiver or alternatively any device configured to broadcast signals in a protocol and format recognized by the computing device. If a message is not received (i.e., determination block 2957 =

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"No"), the computing device may continue with the operations in determination block 2957.

[0400] If a message is received (i.e., determination block 2957 = "Yes"), in block 2958 the computing device may identify categories based on an evaluation of the received message. In particular, the computing device may parse the received message to detect whether any profile information and/or descriptive indicators are within the received message. The computing device may evaluate metadata, header information, or other information appended to or within the received message. In an embodiment, the computing device may generate categories for information included in the received message, such as by performing natural language evaluation routines to determine the content or meaning of any data within the message. In block 2960, the computing device may identity relevant, authorized profile information to share based on stored profile permissions and the identified categories. In other words, the computing device may match the identified categories related to the received message with the locally stored profile information to find relevant information, and may use stored permissions to identify any of such relevant information that may be shared. For example, in response to the computing device identifying that the received message includes information regarding a restaurant, the computing device may identify food-related profile information that has been authorized (or labeled) by the user to be public information. In determination block 2962, the computing device may determine whether there is profile information to share, such as profile information marked with a "public" permissions setting that also relates to the received message. If there is no profile information to share (i.e., determination block 2962 = "No"), the computing device may continue with the operations in determination block 702.

[0401] If there is profile information to share (i.e., determination block 2962 = "Yes"), in optional block 2964 the computing device may obscure authorized profile information based on instructions in the received message. In an embodiment, received messages may solicit response messages and may include

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instructions, such as encryption requests and transmissions scheduling, that the computing device may perform prior to transmitting the profile information. For example, the computing device may detect instructions which indicate a secret key that may be used to encrypt, encode, or otherwise obscure any authorized profile information such that only the device that transmitted the received message may access the profile information. In block 2966, the computing device may transmit a response message that includes the authorized profile information, and may continue with the operations in determination block 702.

[0402] FIGS. 30-32C describe the use of profile information to authenticate a payment. Payment authentication information may be information stored within a registered user's profile that may be used by other parties to facilitate and verify transactions. As described above, payment authentication information may include profile information stored within a central server that is associated with a user, such as photographic information (e.g., Facebook imagery, driver's license photo, previous security footage from store surveillance, etc.), audio samples of the user's voice, signature samples, customer account information, and purchase history information. Additionally, the payment authentication information may include financial and/or credit data to facilitate payment processes. For example, credit card numbers, social security data, addresses, email addresses, phone numbers, and other personal information may be included within the payment authentication information received at the point-of-sale device.

[0403] Once received from the central server, merchants, vendors, and other registered services may utilize payment authentication to expedite a purchase or customer service with a registered user. For example, a proximity broadcast receiver within a retail store may receive payment authentication for a proximate user and may display photographic information of the user for use by customer service agents. As another example, a point-of-sale device may receive and display a list of previous purchases by a user along with a message to a retail store's agent instructing him/her to go talk to the user.

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[0404] FIG. 30 illustrates an exemplary display 3090 of various payment authentication information on a local computing device within a retail store. As described below, the local computing device may be configured to receive return messages that include payment authentication information as stored within profiles and authorized by various permissions or other privacy settings corresponding to the profiles. The local computing device may be configured to operate as a point-of-sale device, such as a cash register or store kiosk. As described below, the local computing device configured to perform as a cash register may render payment authentication information on a display 3090, such as a computer screen viewed by store employees. For example, the local computing device may display information related to a restaurant or a food court area within the retail store.

[0405] For illustration purposes, the display 3090 may include a food items section 3096, a pricing section 3097, and a customer section 3091 that may include payment authentication information based on data within return messages received from the central server. In particular, the customer section 3091 of the display 3090 may include an in-line section 3092 that indicates customers (i.e., customers who are users registered with a central server) within proximity of the local computing device as well as an in-store section 3098 that indicates customers that are within the retail store but not within proximity of the local computing device. The display 3090 may indicate customer names 3093, customer photographs 3094, and even prior purchase information 3095, such as food items previously purchased by the various customers. Such displayed information may be used by store employees to identify and facilitate payments and customer interactions.

[0406] FIG. 31 describes an embodiment method 3100 for using wireless identity transmitters to improve experiences and services within a place (e.g., a retail store) by providing payment authentication information based on proximity of users to point-of-sale devices within the place. Additionally, the various methods may enable registered services (e.g., merchants) associated with the

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place to amass data based on broadcast messages that describes valuable foot traffic and other user information.

[0407] In general, as users walk around the retail store, they may pause to browse inventory, exit the retail store, and wait in particular areas of the retail store. For example, users may wait in line to pay for merchandise, return products, and/or receive user service assistance. In particular, users' wireless identity transmitters may transmit broadcast messages that are received by proximity broadcast receivers within the retail store. The central server may receive sighting messages from these proximity broadcast receivers and may determine whether a point-of-sale device is located near the users. If users are near point-of-sale devices, such as computing devices configured to perform as cash registers or user kiosks, the central server may transmit relevant, authorized payment authentication information for use in the retail store.

[0408] In block 3102, the central server may store profile information that may include permissions settings from a user. As described above, profile information, such as personal information (e.g., name, birth date, etc.) may be stored in databases or other data structures and may also include indicators of how, when, and/or to whom profile information may be shared. In determination block 1402, the central server may determine whether a sighting message is received. As described above, the sighting message may be transmitted by a proximity broadcast receiver located within the retail store. For example, as a user carrying a wireless identity transmitter walks within proximity of a point-of-sale device (e.g., a cash register device), a proximity broadcast receiver located within the point-of-sale device may receive broadcast messages from the wireless identity transmitter and transmit sighting messages to the central server based on the received broadcast messages. If the central server does not receive a sighting message (i.e., determination block 1402 = "No"), the central server may continue with the operations in determination block 1402.

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[0409] However, if the central server does receive a sighting message (i.e., determination block 1402 = "Yes"), in determination block 1602 the central server may determine whether a wireless identity transmitter identity is known based on the received sighting message. If the wireless identity transmitter identity is not known by the central server (i.e., determination block 1602 = "No"), in block 1603 the central server may ignore the sighting message and continue with the operations in determination block 1402. If the wireless identity transmitter identity is known by the central server (i.e., determination block 1602 = "Yes"), in determination block 1604 the central server may determine whether the sighting message is related to a registered service, such as the retail store. If the sighting message is not related to a registered service (i.e., determination block 1604 = "No"), the central server may continue with the operations in block 1603. If the sighting message is related to a registered service (i.e., determination block 1604 = "Yes"), in block 1414 the central server may store data based on the sighting message in relation to the wireless identity transmitter identity, such as by updating information within the user's profile. In another embodiment, the central server may also store data that may be used by the registered service (e.g., merchant, retail store, etc.) for generating foot traffic data. For example, the central server may use the received sighting message to update and/or modify information describing the number of unique users within the retail store at a given time, day, week, or month.

[0410] In determination block 3104, the central server may determine whether the wireless identity transmitter is near a point-of-sale device. For example, the central server may determine whether the wireless identity transmitter is within a few inches, feet, or meters of any computing device within the retail store that is used for performing sales transactions. In various embodiments, the retail store may include various proximity broadcast receivers that are placed throughout the retail store (e.g., around show floors, at the entrance, on shelves, etc.). The central server may store data that indicates the location of such stationary proximity broadcast receivers within the retail store and well as data that

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indicates the location of various known point-of-sale devices within the retail store. For example, the central server may maintain a database that describes the GPS coordinates and/or relative location information of all stationary proximity broadcast receivers and point-of-sale devices within the retail store. Since the wireless identity transmitter is within proximity of the proximity broadcast receiver associated with the received sighting message, the central server may compare a location (e.g., GPS coordinates) of the proximity broadcast receiver to stored location data of point-of-sale devices to determine whether the wireless identity transmitter is near a point-of-sale device. When the distance between the location of the proximity broadcast receiver and the location of a point-of-sale device is within a proximity threshold, the wireless identity transmitter may be considered near to (or within proximity of) the point-of-sale device.

[0411] In various embodiments, proximity broadcast receivers within the retail store may be positioned near (or collocated) and connected to point-of-sale devices. For example, a proximity broadcast receiver positioned on top of a point-of-sale device may transmit text and/or audio data received from the central server to the point-of-sale device for rendering. Alternatively, proximity broadcast receivers and point-of-sale devices may be within a common (or same) device. For example, a cash register point-of-sale device may include a short-range wireless transceiver configured to receive short-range broadcast messages from proximate wireless identity transmitters.

[0412] In various embodiments, the central server may utilize additional information when determining whether the wireless identity transmitter is near a point-of-sale device. In particular, the central server may estimate the position of the wireless identity transmitter as within a circular area of the proximity broadcast receiver that transmitted the sighting message. The circular area may have a radius equal to the wireless identity transmitter's average broadcast range. The central server may also evaluate signal strength information describing the broadcast message reported within the sighting message to determine more precise proximity information of the wireless identity transmitter. For example,

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based on known capabilities of the proximity broadcast receiver and the signal strength of the associated broadcast message, the central server may determine that the wireless identity transmitter was within a certain distance from the proximity broadcast receiver at the time of transmitting the broadcast message within the sighting message. In an embodiment, the central server may use received signal strength indication (or "RSSI") information from within the sighting message to determine approximate distance of the wireless identity transmitter to the proximity broadcast receiver. In another embodiment, the central server may also employ schematics or other floor plan or blueprint data of the retail store to determine more precise location information of the proximity broadcast receiver and thus the wireless identity transmitter. For example, the central server may determine that the wireless identity transmitter is located to the east or south side of the proximity broadcast receiver based on a floor plan that indicates the proximity broadcast receiver is surrounded by exterior walls to the north and west. In an embodiment, the central server may also perform the operations of the methods 1820 and/or 1860 described above to determine more precise proximity information for the wireless identity transmitter. For example, the central server may compare information within concurrent sighting messages to define a precise proximity of a wireless identity transmitter within the retail store.

[0413] If the central server determines the wireless identity transmitter is within proximity of server point-of-sale devices, such as a cluster or line of check-out terminals, the central server may identify a closest point-of-sale device based on signal strength information within the sighting message. For example, if the proximity broadcast receiver (and thus the wireless identity transmitter) is determined to be within the proximity threshold of more than one cash register devices within a store, the central server may determine the closest register device (or the device that is most likely to be the closest) as the device with the shortest distance to the proximity broadcast receiver's estimated location. When point-of-sale devices are proximity broadcast receivers, the central server may

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simply determine the closest point-of-sale device as the device related to a sighting message indicating the strongest signal strength. In another embodiment, the central server may utilize dead reckoning and other estimation routines or algorithms to determine whether the customer (and the wireless identity transmitter) may be near a point-of-sale device in the near future. For example, the central server may evaluate recent movement patterns of the customer to determine within a few seconds he/she may be in front of a product display.

[0414] Returning to FIG. 31A, if the wireless identity transmitter is not near a point-of-sale device (i.e., determination block 3104 = "No"), the central server may continue with the operations in determination block 1402. For example, the user may be located near an aisle that is within the retail store but not within proximity of a cash register, so payment authentication information is not likely needed yet. However, if the wireless identity transmitter is near a point-of-sale device (i.e., determination block 3104 = "Yes"), the wireless identity transmitter may be in a position indicating that the associated user is attempting to pay for an item (e.g., the user is waiting in a check-out line). Thus, in block 3105, the central server may identify payment authentication information from the user's profile that is relevant to the proximate point-of-sale device and that is authorized for sharing by the profile permissions. In general, the central server may perform operations as described above to match categories relevant to the retail store to profile information stored for the user associated with the wireless identity transmitter. In particular, the central server may identify the profile information that may be useful for purchases or other transactions relevant to the retail store. For example, when the retail store is a restaurant, the central server may identify food-related profile information, such as previous food products purchased at the retail store, as well as the payment methods used previously used by the user (e.g., a store rewards card, a credit card, cash, etc.). Further, the central server may only identify the payment authentication information that is authorized by the user based on the stored permissions defined within the user's profile. For

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example, when the user indicates the central server may not provide credit card information to any registered service, the central server may only be able to identify payment authentication information that includes the user's name and photo. In an embodiment, the identified payment authentication information may be based on the capabilities of the near point-of-sale device. For example, if the central server stores information indicating a cash register device is configured to only display text information, the identified payment authentication information may only include text information identifying the user and not visual or audible data (e.g., photo, sound file, etc.).

[0415] In block 3106, the central server may transmit a return message to the point-of-sale device that includes payment authentication information. For example, the point-of-sale device may be a computing device that is configured to receive return messages via Internet protocols from the central server. This return message may be used by the point-of-sale device to assist in a transaction between the retail store and the user. In an embodiment, the central server may generate a return message for transmission to a local computing device within the retail store which in turn may deliver payment authentication information to the point-of-sale device near the user. For example, the point-of-sale device may be a computing device that is configured to receive return messages routed from a retail store server. Once the payment authentication information is transmitted, the central server may continue with the operations in determination block 1402.

[0416] In another embodiment, the central server may perform the method 3100 in response to receiving a sighting message transmitted by a mobile proximity broadcast receiver carried by the user within the retail store. As described above, instead of deploying proximity broadcast receivers, a retail store may deploy wireless identity transmitters throughout the building, such as in departments or at check-out or payment lines. When a user's mobile proximity broadcast receiver (e.g., such as smartphone configured to execute software that can relay broadcast messages to the central server) is within proximity of one of the retail store's wireless identity transmitters, the mobile proximity broadcast receiver

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may receive a broadcast message and transmit a sighting message to the central server. In such a scenario, the central server may identify that the wireless identity transmitter is a store device and that the proximity broadcast receiver that transmitted the received sighting message belongs to the user (i.e., the user may be considered a "registered service" as referred to in FIG. 31). Further, the central server may determine whether the wireless identity transmitter is near a point-of-sale device by comparing stored locations of point-of-sale devices to either location information within the sighting message (e.g., via metadata indicating the GPS coordinates of the user's mobile proximity broadcast receiver) or a stored list of locations of the wireless identity transmitters within the retail store. For example, the central server may compare a known location within the retail store corresponding to the wireless identity transmitter indicated in the received sighting message to all stored locations of cash register devices within the retail store.

[0417] FIGS. 32A-32C illustrate embodiment methods 3200, 3250, and 3275 for a local computing device to utilize payment authentication information to facilitate transactions with a user within a retail store. As described above, the local computing device may be a retail store server, a point-of-sale device, proximity broadcast receiver, or other computing device within the retail store that is configured to utilize payment authentication information received from a central server. For example, the local computing device may be a point-of-sale device that is configured to be used by store agents when performing payment and other transaction operations with the user. In other embodiments, the local computing device may receive return messages from the central server and transmit payment authentication information to point-of-sale devices within the retail store. For example, the local computing device may be a local server that may transmit photographic information of a user to a cash register computing device at a payment area within the retail store.

[0418] FIG. 32A illustrates an embodiment method 3200 for a local computing device receiving payment authentication information from a central server. In

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determination block 1101, the local computing device may determine whether a return message is received from the central server. For example, the local computing device may monitor a buffer, message queue, communications port, etc. for incoming Internet protocol communications from the central server. If a return message is not received (i.e., determination block 1101 = "No"), the local computing device may continue with the operations in determination block 1101.

[0419] If a return message is received (i.e., determination block 1101 = "Yes"), in block 3202 the local computing device may parse the return message to detect data related to a user, such as identification and proximity (or location) information related to a user's wireless identity transmitter within the retail store. For example, the local computing device may evaluate the received return message and identify wireless identity transmitter identification information, a data segment that includes software instructions (e.g., firmware update instructions, etc.), and/or a data segment that contains payment authentication information associated with the user's profile stored on the central server. In an embodiment, the local computing device may also decode, decrypt, or otherwise access obscured data transmitted by the central server. For example, the local computing device and central server may share a secret code that may be used by the local computing device to decode contents of the return message.

[0420] In optional block 3203, the local computing device may store the data from the return message and/or sighting message in a local database. For example, payment authentication information for a particular user may be stored in the local computing device (e.g., a local store server) so that subsequent transactions may be more efficient without the need for the central server to retransmit the same data numerous times. In an embodiment, the local computing device may store data to generate statistical or historical information, as described above. For example, in addition to or in place of the central server accumulating data for foot traffic reports (e.g., the number of unique visitors to the retail store within a certain period, the duration of a particular user's dwelling within a certain area of the retail store, etc.), the local computing device may

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maintain similar statistical information. In an embodiment, the local computing device may be configured to only store data relevant to the particular store building, or alternatively, to interactions related to the local computing device itself. For example, when the local computing device is configured to operate as a proximity broadcast receiver and/or point-of-sale device, payment authentication information may be stored only when it relates to broadcast messages directly received by the local computing device.

[0421] In determination block 3204, the local computing device may determine whether the return message contains payment authentication data. For example, the local computing device may evaluate metadata associated with various data segments within the return message. In an embodiment, the return message may contain metadata and/or header information that indicates when payment authentication information is contained within the return message. For example, header information may include a code known by the local computing device to indicate the presence of payment authentication information. In an embodiment, the local computing device may determine whether imagery, credit card information, or other particular data types are contained within the return message and its data segments. For example, if the return message contains a photographic image of a face, or alternatively, facial characteristics data as generated by a facial recognition algorithm, the local computing device may determine that payment authentication information is contained within the return message. If the return message does not contain payment authentication information (i.e., determination block 3204 = "No"), the local computing device may continue with the operations in determination block 1101.

[0422] However, if the return message does contain payment authentication information (i.e., determination block 3204 = "Yes"), in block 3206 the local computing device may utilize the payment authentication information to assist in a transaction with the user. For example, the local computing device may display a picture of the user on a connected LCD screen so that a customer service agent using the local computing device may recognize the user waiting in line. In an

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embodiment, the local computing device may initiate software, applications, or routines based on receiving the payment authentication information. For example, upon receiving the return message, the local computing device may enter a transaction application and auto-fill data to represent the user's personal information. Additionally, the local computing device may transmit various messages to assist in the transaction based on the payment authentication information. For example, if the payment authentication information indicates the user is a preferred or rewards member, the local computing device may display a message for customer service representatives to make certain promotional offers and/or address the user in a particular manner (e.g., by name or by rewards zone experience or status indicators, etc.). As another example, the local computing device may instruct store agents by sending texts to employees, such as a manager or a particular sales rep, to come greet the user or try to conduct follow-up communications. After utilizing the payment authentication information, the local computing device may continue with the operations in determination block 1101.

[0423] FIG. 32B illustrates an embodiment method 3250 for a local computing device receiving sighting messages from a proximity broadcast receiver and receiving payment authentication information from a central server. The method 3250 is similar to method 3200 described above with reference to FIG. 32A, except that method 3250 includes operations for the local computing device to receive and transmit sighting messages from associated proximity broadcast receivers. For example, stationary proximity broadcast receivers within a retail store may receive broadcast messages from users' wireless identity transmitters and transmit sighting messages to the local computing device, which may serve as a router or communications path to the Internet and thus the central server.

[0424] In determination block 3252, the local computing device may determine whether a sighting message is received from a proximity broadcast receiver. If the local computing device does not receive a sighting message (i.e., determination block 3252 = "No"), the local computing device may continue

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with the operations in determination block 3252. However, if the local computing device receives a sighting message (i.e., determination block 3252 = "Yes"), in optional block 3254 the local computing device may append additional data to the sighting message. For example, the appended information may include data identifying the local computing device, such as a local server ID, relative location information within the store, a registered service code known by the central server, the store's name/address/ contact information, etc.). In block 3256, the local computing device may relay the sighting message (and any additional data) to the central server.

[0425] In determination block 1101, the local computing device may determine whether a return message has been received from the central server. If a return message is not received (i.e., determination block 1101 = "No"), the local computing device may continue to perform the operations in determination block 1101. In an alternative embodiment, if a return message is not received (i.e., determination block 1101 = "No"), the local computing device may continue to perform the operations in determination block 3252.

[0426] However, if a return message is received (i.e., determination block 1101 = "Yes"), in block 3202 the local computing device may parse the return message to detect data related to a user, and in optional block 3203, the local computing device may store the data from the return message and/or sighting message in a local database. In determination block 3204, the local computing device may determine whether the return message contains payment authentication data. If the return message does not contain payment authentication information (i.e., determination block 3204 = "No"), the local computing device may continue with the operations in determination block 3252. If the return message does contain payment authentication information (i.e., determination block 3204 = "Yes"), in block 3206 the local computing device may utilize the payment authentication information to assist in a transaction with the user, and may continue with the operations in determination block 3252.

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[0427] FIG. 32C illustrates an embodiment method 3275 for a local computing device associated with a retail store receiving payment authentication information from a central server. The method 3275 is similar to method 3200 described above with reference to FIG. 32A, except that method 3275 includes operations for the local computing device to determine whether the wireless identity transmitter is within proximity of a point-of-sale device. In other words, instead of the central server, the local computing device may perform operations to determine whether the wireless identity transmitter is near a point-of-sale device within the retail store. For example, the retail store may not provide location information of all point-of-sale devices within the store to the central server for storage, and thus may be required to determine to which cash registered computing device in the store a user's payment authentication information should be delivered.

[0428] In determination block 1101, the local computing device may determine whether a return message is received from the central server. If a return message is not received (i.e., determination block 1101 = "No"), the local computing device may continue with the operations in determination block 1101. If a return message is received (i.e., determination block 1101 = "Yes"), in block 3202 the local computing device may parse the return message to detect data related to a users, such as profile information related to the user's preferred payment methods and/or proximity information related to a user's wireless identity transmitter within the retail store. In optional block 3203, the local computing device may store the data from the return message. In determination block 3204, the local computing device may determine whether the return message contains payment authentication data. If the return message does not contain payment authentication information (i.e., determination block 3204 = "No"), the local computing device may continue with the operations in determination block 1101.

[0429] However, if the return message does contain payment authentication information (i.e., determination block 3204 = "Yes"), in block 3276 the local computing device may identify a proximity broadcast receiver within proximity

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of the user based on the return message. In other words, based on information within the return message (e.g., metadata, etc.) the local computing device may obtain the identifier (e.g., a unique code) of the proximity broadcast receiver that transmitted the sighting message reporting the user's wireless identity transmitter. For example, the return message may include data indicating that the return message was transmitted in response to receiving a sighting message from a particular proximity broadcast receiver within the retail store. In addition, the return message may include the identity of the wireless identity transmitter as well as the signal strength of the broadcast message related to the return message. In an embodiment, the return message may include the location information of the proximity broadcast receiver in addition to or instead of the proximity broadcast receiver identifier.

[0430] In determination block 3278, the local computing device may determine whether the proximity broadcast receiver is near a point-of-sale device. The operations in determination block 3278 may be similar to the operations in determination block 3104 described above with reference to FIG. 31. In particular, the local computing device may compare the location of the identified proximity broadcast receiver to locations of known point-of-sale devices within the retail store. For example, the local computing device may determine the distance between the identified proximity broadcast receiver's location information (as obtained from the return message or alternatively stored within a data table) to all known point-of-sale device locations within the retail store, and determine whether the shortest distance is within a proximity or distance threshold. In an embodiment, the local computing device may also use signal strength information (e.g., RSSI value) of broadcast messages indicated within the return message to determine an estimated distance from the proximity broadcast receiver (and the user's wireless identity transmitter) to the closest point-of-sale device.

[0431] In various embodiments, the proximity broadcast receivers of the retail store may be the same as the point-of-sale devices in the retail store. For

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example, the proximity broadcast receivers may all be cash register computing devices that are configured to receive and relay broadcast messages from users' wireless identity transmitters. In another embodiment, the proximity broadcast receiver related to the return message may be coincident with or the same as the local computing device. For example, the return message may correspond to a sighting message generated and transmitted by the local computing device.

[0432] If the proximity broadcast receiver is not near a point-of-sale device within the retail store (i.e., determination block 3278 = "No"), the local computing device may continue with the operations in determination block 1101. However, if the proximity broadcast receiver is near a point-of-sale device (i.e., determination block 3278 = "Yes"), in block 3206 the local computing device may utilize the payment authentication information to assist in a transaction with the user, as described above. In optional block 3280, the local computing device may transmit a message to a point-of-sale device with payment authentication. For example, based on the operations in blocks 3276-3278, the local computing device may identify a cash register computing device that is within proximity of the user and that is capable of presenting the user's payment authentication to customer service agents. The local computing device may then continue with the operations in determination block 1101.

[0433] FIG. 33A illustrates components of an exemplary wireless identity transmitter 110. The wireless identity transmitter 110 may include a microcontroller 3302, a short-range radio 3304 (e.g., a Bluetooth® radio or transceiver) coupled to an antenna 3306, a memory 3308, and a battery 3310. Although these components are shown linked by a common connection, they may be interconnected and configured in various ways. For example, a wireless identity transmitter 110 may be configured such that the microcontroller 3302 may determine when to transmit a message based on the contents of the memory 3308. In an embodiment, the microcontroller 3302 may be a Bluetooth® system-on-chip unit. The memory 3308 may also include one or more messages or message portions to be transmitted by the short-range radio 3304 via the antenna

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3306 based on commands from the microcontroller 3302. The battery 3310 may supply power as needed by the other components. Also, in some implementations the microcontroller 3302, the short-range radio 3304 and/or the memory 3308 may be integrated together as a single integrated circuit. Since these components may be microchips of standard or off-the-shelf configuration, they are represented in FIG. 33A as blocks consistent with the structure of an example embodiment.

[0434] The wireless identity transmitter 110 may be coupled with or built into various objects, such as a bracelet. For example, an exemplary wireless identity transmitter 110 may be in a form easily attached to a strap, such as a watchband or dog collar. Alternate embodiments may incorporate a wireless identity transmitter 110 into any other mobile objects that may need tracking.

[0435] The wireless identity transmitter 110 may conserve power by periodically entering a power saving mode or going to sleep, such as regularly alternating between sleeping and broadcasting of the packet with the wireless identity transmitter 110's identification code. Various embodiments may include different cycles of broadcasting and sleeping, such as some embodiments broadcasting more or less frequently, such as waking and broadcasting every few seconds or minutes between periods of sleep.

[0436] In an embodiment, the battery 3310 may be a replaceable coin cell battery. In another embodiment, the wireless identity transmitter 110 may utilize the antenna 3306 to receive update software, instructions, or other data for storage and use in configuration operations, such as configuring transmission intervals and/or transmissions power. The wireless identity transmitter 110 may also store and execute software, algorithms, instructions, code, or other routines for generating rolling codes or identifiers, as described above. In an embodiment, the wireless identity transmitter may not maintain time (e.g., UTC) information, but may instead use a 30 ppm 16 kHz crystal as a clock. Such use

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of a crystal as a clock may create a timing drift of approximately 40 seconds per year.

[0437] FIG. 33B illustrates components of an embodiment wireless identity transmitter 110. Similar to the embodiment described above with reference to FIG. 33A, the wireless identity transmitter 110 may include a microcontroller 3302, a short-range radio 3304 (e.g., Bluetooth®, BTLE, Zigbee®, Peanut®, etc.) connected to an antenna 3306 and coupled to the microcontroller 3302, memory 3308, and a battery unit 3310. Alternatively the memory 3308 may be contained within the microcontroller 3302, which may also include a separate processing unit. The short-range radio 3304 may be a transmitter capable of broadcasting messages or signals including a device ID or, alternatively, a transceiver configured to transmit and receive RF signals, enabling communications with other devices utilizing a communication protocol. For example, the wireless identity transmitter 110 may be configured to communicate with other short-range radio enabled devices, such as smartphones. In an embodiment, the short-range radio 3304 may be configured to communicate via various low-energy, wireless communication protocols, such as LTE-D, peer-to-peer LTE-D, and WiFi-Direct.

[0438] In an embodiment, the wireless identity transmitter 110 may include a speaker (not shown) configured to emit a sound capable of being received by a proximity broadcast receiver and/or being heard by a heard by a user. For example, the wireless identity transmitter 110 may emit audible communications that may indicate its presence to listening proximity broadcast receivers. In another embodiment, the wireless identity transmitter 110 may be configured to transmit signals at varying signal strengths, thereby varying the range at which broadcasts from the wireless identity transmitter 110 may be received by proximity broadcast receivers.

[0439] Additionally, the wireless identity transmitter 110 may include one or more sensors for measuring various conditions and variables. In an embodiment,

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the wireless identity transmitter 110 may include an accelerometer 3315 (or any other motion sensor such as a gyroscope or gravitometer), which may collect data indicative of motion of an asset associated with the wireless identity transmitter 110. For example, the accelerometer 3315 may generate motion data describing the movements of a child carrying the wireless identity transmitter 110. Other sensors that may be included within the wireless identity transmitter 110 include a temperature sensor 3316 (such as a thermistor), a radiation sensor 3317, a humidity sensor 3318, and a carbon dioxide (CO_2) sensor 3319. In the various embodiments, the wireless identity transmitter 110 may include any combination of these and other sensors. These potential sensors are only examples of the types of sensors that may be integrated into wireless identity transmitters 110 and other types of sensors may be included. For example, the wireless identity transmitter 110 may also include sensors not shown in the various diagrams, such as a microphone, a camera, a heat sensor, a pressure sensor, and a light sensor.

[0440] FIG. 34A illustrates primary components of an exemplary proximity broadcast receiver embodiment. The proximity broadcast receiver 142 may include a short-range radio 3404 (e.g., a Bluetooth radio or transceiver) capable of communicating with a short-range wireless radio (e.g., a Bluetooth® radio in the wireless identity transmitter) coupled to an antenna 3406, and a secondary network device 3408 capable of communicating directly or indirectly back to a central server via a network, such as the Internet. In some embodiments, the secondary network device 3408 may be a cellular or wireless radio or a modem or other wired network device. The proximity broadcast receiver 142 may also include a processor 3402, a memory 3412, and a battery 3410 either as the primary power supply or as a backup power supply in the case of proximity broadcast receiver 142 coupled to utility power. The proximity broadcast receiver 142 may include a GPS receiver 3414 or other type of location determining mechanism for determining a current location to associate with any message received from a wireless identity transmitter. If the proximity broadcast receiver is not mobile, it may not include a GPS receiver 3414 in some

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embodiments since the location may be known and constant. Although these components are shown linked by a common connection, they may interconnected and configured in various ways. Since these components may be microchips of standard or off-the-shelf configuration, they are represented in FIG. 34A as blocks consistent with the structure of an example embodiment.

[0441] FIG. 34B illustrates an embodiment proximity broadcast receiver 3475 that can be plugged into a power outlet. Similar to the embodiment described above with reference to FIG. 34A, the proximity broadcast receiver 3475 may include a processor 3402, a memory unit 3412, and a short-range radio 3404 (e.g., Bluetooth®, Bluetooth® LE, LTE-D, peer-to-peer LTE-D, Zigbee®, Peanut®, etc.) connected to an antenna 3406. The proximity broadcast receiver 3475 may also include a WiFi system-on-chip 3478 (referred to as "SOC" in FIG. 34C) coupled to a second antenna 3476. In another embodiment, the system-on-chip 3478 may be a Bluetooth® Low Energy system-on-chip. The proximity broadcast receiver 3475 may utilize the system-on-chip 3478 to exchange data over a wireless local area network, such as by communicating with a WiFi router. Additionally, the proximity broadcast receiver 3475 may include a plug 3482 for interfacing with a power supply or otherwise receiving power, such as alternating current power (or "AC"). In various embodiments, the plug 3482 may be configured to connect with different power outlets standards (e.g., British Standards, National Electrical Manufacturers Association, etc.), and may include a grounding element (not shown). The plug 3482 may be coupled to a USB Power supply 3480 that provides power to the various components of the proximity broadcast receiver 3475, such as the processor 3402. In an alternative embodiment, the proximity broadcast receiver 3475 may recharge an internal battery (not shown) using power received from the plug 3482 and/or USB power supply 3480.

[0442] In an embodiment, the proximity broadcast receiver 3475 may store software instructions, such as within the memory 3412 or other circuitry that may be utilized by the processor 3402 and/or the system-on-chip 3478 to perform

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operations to transmit and/or receive short-range and long-range signals, respectively. In an embodiment, the proximity broadcast receiver 3475 may utilize the antennas 3406, 3476 to receive update software, instructions, or other data for storage and use in updating firmware, modifying operating parameters, and other configuration modifications.

[0443] FIG. 35 is a system block diagram of a smartphone type mobile device suitable for use with various embodiments. A smartphone 3500 may include a processor 3501 coupled to internal memory 3502, a display 3503, and to a speaker 3554. Additionally, the smartphone 3500 may include an antenna 3504 for sending and receiving electromagnetic radiation that may be connected to a wireless data link and/or cell telephone transceiver 3505 coupled to the processor 3501 and capable of communicating over a wide area wireless communication network. Smartphones may include a separate short-range radio transceiver 3524 capable of communicating or pairing with wireless identity transmitters. Smartphones 3500 typically may also include menu selection buttons or rocker switches 3508 for receiving user inputs.

[0444] FIG. 36 is a system block diagram of a server 3600 suitable for implementing the various embodiments of this disclosure. The server 3600 may be a commercially available server device. Such a server 3600 typically includes a processor 3601 coupled to volatile memory 3602 and a large capacity nonvolatile memory, such as a disk drive 3603. The server 3600 may also include a floppy disc drive, compact disc (CD) or DVD disc drive 3606 coupled to the processor 3601. The server 3600 may also include network access ports 3604 coupled to the processor 3601 for establishing data connections with a network 3605, such as a local area network coupled to other broadcast system computers and servers.

[0445] The processors 3501, 3601 may be any programmable microprocessor, microcomputer or multiple processor chip or chips that can be configured by software instructions (applications) to perform a variety of functions, including

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the functions of the various embodiments described below. In some mobile proximity broadcast receivers, multiple processors 3501 may be provided, such as one processor dedicated to wireless communication functions and one processor dedicated to running other applications. Typically, software applications may be stored in the internal memory 3502, 3602 before they are accessed and loaded into the processor 3501, 3601. The processor 3501, 3601 may include internal memory sufficient to store the application software instructions.

[0446] The foregoing method descriptions and the process flow diagrams are provided merely as illustrative examples and are not intended to require or imply that the steps of the various embodiments must be performed in the order presented. As will be appreciated by one of skill in the art the order of steps in the foregoing embodiments may be performed in any order. Words such as "thereafter," "then," "next," etc. are not intended to limit the order of the steps; these words are simply used to guide the reader through the description of the methods. Further, any reference to claim elements in the singular, for example, using the articles "a," "an" or "the" is not to be construed as limiting the element to the singular.

[0447] The various illustrative logical blocks, modules, circuits, and algorithm steps described in connection with the embodiments disclosed herein may be implemented as electronic hardware, computer software, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present invention.

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[0448] The hardware used to implement the various illustrative logics, logical blocks, modules, and circuits described in connection with the aspects disclosed herein may be implemented or performed with a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but, in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration. Alternatively, some steps or methods may be performed by circuitry that is specific to a given function.

[0449] In one or more exemplary aspects, the functions described may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. The steps of a method or algorithm disclosed herein may be embodied in a processor-executable software module, which may reside on a tangible, non-transitory computer-readable storage medium. Tangible, non-transitory processor-readable storage medium or non-transitory computer-readable storage media may be any available media that may be accessed by a computer. By way of example, and not limitation, such non-transitory processor-readable and computer-readable storage media may comprise RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium that may be used to store desired program code in the form of instructions or data structures and that may be accessed by a computer. Disk and disc, as used herein, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk, and blu-ray disc where disks usually reproduce

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data magnetically, while discs reproduce data optically with lasers. Combinations of the above should also be included within the scope of non-transitory processor-readable storage medium. Additionally, the operations of a method or algorithm may reside as one or any combination or set of codes and/or instructions on a tangible, non-transitory machine readable medium and/or computer-readable medium, which may be incorporated into a computer program product.

[0450] The preceding description of the disclosed embodiments is provided to enable any person skilled in the art to make or use the present invention. Various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without departing from the spirit or scope of the invention. Thus, the present invention is not intended to be limited to the embodiments shown herein but is to be accorded the widest scope consistent with the following claims and the principles and novel features disclosed herein.

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CLAIMS

What is claimed is:

1. A method for providing profile information associated with a user based on proximity, comprising:

receiving in a server a sighting message that includes a rolling identifier of a wireless identity transmitter associated with an individual, wherein the rolling identifier is generated via an algorithm that uses a unique device identifier of the wireless identity transmitter, a secret key shared with the server, and a counter;

determining in the server whether the wireless identity transmitter is associated with the user based on the rolling identifier;

determining in the server whether the sighting message is related to a registered service based on information included within the sighting message regarding a proximity broadcast receiver;

identifying profile information within stored profile information associated with the user that is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service; and

transmitting a message that includes the identified relevant profile information.

2. The method of claim 1, wherein the relevant profile information includes at least one of personal demographics, interests, birth date, residence, medical information, health conditions, customer preferences, and clothing and shoe size information.

3. The method of claim 1, wherein identifying relevant profile information within the stored profile information associated with the user that is relevant to the registered service comprises:

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identifying categories corresponding to the registered service, wherein categories describe at least one of services offered, products offered, a type of business, demographics, interests, and target audience of the registered service; and

matching the identified categories to the profile information associated with the user.

4. The method of claim 1, further comprising storing profile information received from the user during a registration process.

5. The method of claim 1, further comprising automatically obtaining the profile information related to the user from online sources, wherein the online sources include at least one of social networking accounts and shopping websites.

6. The method of claim 1, further comprising storing profile permissions from the user, wherein identifying profile information within stored profile information associated with the user that is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service comprises identifying the relevant profile information associated with the user that is relevant to the registered service and authorized by the stored profile permissions from the user when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service.

7. The method of claim 1, wherein transmitting a message that includes the identified relevant profile information comprises transmitting the message to a local computing device associated with the registered service that includes the identified relevant profile information, wherein the local computing device is at least one of a point-of-sale device, a mobile device used by an employee of the registered service, and the proximity broadcast receiver associated with the registered service.

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8. The method of claim 1, further comprising:

determining whether the wireless identity transmitter is near a point-of-sale device associated with the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service,

wherein transmitting a message that includes the identified relevant profile information comprises transmitting the message to the point-of-sale device that is near the wireless identity transmitter, and

wherein the identified relevant profile information associated with the user includes payment authentication information for confirming an identity of the user.

9. The method of claim 8, wherein the payment authentication information includes at least one of address information, an email address, a photo, a signature sample, audio samples, credit card information, and preferred banking account information.

10. A method for sharing profile information of an individual based on proximity, comprising:

receiving in a server a sighting message that includes a rolling identifier of a wireless identity transmitter associated with the individual, wherein the rolling identifier is generated via an algorithm that uses a unique device identifier of the wireless identity transmitter, a secret key shared with the server, and a counter;

identifying a first profile based on the rolling identifier of the wireless identity transmitter;

identifying a second profile based on information related to a proximity broadcast receiver included within the sighting message;

identifying relevant profile information from the first profile that is authorized to be shared based on permissions of the first profile;

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identifying relevant profile information from the second profile that is authorized to be shared based on permissions of the second profile;

transmitting a first message to a first device associated with the second profile when there is relevant profile information from the first profile that is identified and authorized to be shared; and

transmitting a second message to a second device associated with the first profile when there is relevant profile information from the second profile that is identified and authorized to be shared.

11. A server configured to provide profile information associated with a user based on proximity, comprising:

a server processor configured with server-executable instructions to perform operations comprising:

receiving in the server a sighting message that includes a rolling identifier of a wireless identity transmitter associated with an individual, wherein the rolling identifier is generated via an algorithm that uses a unique device identifier of the wireless identity transmitter, a secret key shared with the server, and a counter;

determining in the server whether the wireless identity transmitter is associated with the user based on the rolling identifier;

determining in the server whether the sighting message is related to a registered service based on information included within the sighting message regarding a proximity broadcast receiver;

identifying profile information within stored profile information associated with the user that is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service; and

transmitting a message that includes the identified relevant profile information.

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12. The server of claim 11, wherein the relevant profile information includes at least one of personal demographics, interests, birth date, residence, medical information, health conditions, customer preferences, and clothing and shoe size information.

13. The server of claim 11, wherein the server processor is configured with server executable instructions to perform operations such that identifying relevant profile information within the stored profile information associated with the user that is relevant to the registered service comprises:

identifying categories corresponding to the registered service, wherein categories describe at least one of services offered, products offered, a type of business, demographics, interests, and target audience of the registered service; and

matching the identified categories to the profile information associated with the user.

14. The server of claim 11, wherein the server processor is configured with server executable instructions to perform operations further comprising storing profile information received from the user during a registration process.

15. The server of claim 11, wherein the server processor is configured with server executable instructions to perform operations further comprising automatically obtaining the profile information related to the user from online sources, wherein the online sources include at least one of social networking accounts and shopping websites.

16. The server of claim 11, wherein the server processor is configured with server executable instructions to perform operations further comprising storing profile permissions from the user, wherein the server processor is configured with server executable instructions to perform operations such that identifying profile information within stored profile information associated with the user that

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is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service comprises identifying the relevant profile information associated with the user that is relevant to the registered service and authorized by the stored profile permissions from the user when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service.

17. The server of claim 11, wherein the server processor is configured with server executable instructions to perform operations such that transmitting a message that includes the identified relevant profile information comprises transmitting the message to a local computing device associated with the registered service that includes the identified relevant profile information, wherein the local computing device is at least one of a point-of-sale device, a mobile device used by an employee of the registered service, and the proximity broadcast receiver associated with the registered service.

18. The server of claim 11, wherein the server processor is configured with server executable instructions to perform operations further comprising:

determining whether the wireless identity transmitter is near a point-of-sale device associated with the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service,

wherein the server processor is configured with server executable instructions to perform operations such that transmitting a message that includes the identified relevant profile information comprises transmitting the message to the point-of-sale device that is near the wireless identity transmitter, and

wherein the identified relevant profile information associated with the user includes payment authentication information for confirming an identity of the user.

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19. The server of claim 18, wherein the payment authentication information includes at least one of address information, an email address, a photo, a signature sample, audio samples, credit card information, and preferred banking account information.

20. A server configured to share profile information of an individual based on proximity, comprising:

a server processor configured with server-executable instructions to perform operations comprising:

receiving in the server a sighting message that includes a rolling identifier of a wireless identity transmitter associated with the individual, wherein the rolling identifier is generated via an algorithm that uses a unique device identifier of the wireless identity transmitter, a secret key shared with the server, and a counter;

identifying a first profile based on the rolling identifier of the wireless identity transmitter;

identifying a second profile based on information related to a proximity broadcast receiver included within the sighting message;

identifying relevant profile information from the first profile that is authorized to be shared based on permissions of the first profile;

identifying relevant profile information from the second profile that is authorized to be shared based on permissions of the second profile;

transmitting a first message to a first device associated with the second profile when there is relevant profile information from the first profile that is identified and authorized to be shared; and

transmitting a second message to a second device associated with the first profile when there is relevant profile information from the second profile that is identified and authorized to be shared.

21. A server configured to provide profile information associated with a user based on proximity, comprising:

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means for receiving in the server a sighting message that includes a rolling identifier of a wireless identity transmitter associated with an individual, wherein the rolling identifier is generated via an algorithm that uses a unique device identifier of the wireless identity transmitter, a secret key shared with the server, and a counter;

means for determining in the server whether the wireless identity transmitter is associated with the user based on the rolling identifier;

means for determining in the server whether the sighting message is related to a registered service based on information included within the sighting message regarding a proximity broadcast receiver;

means for identifying profile information within stored profile information associated with the user that is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service; and

means for transmitting a message that includes the identified relevant profile information.

22. The server of claim 21, wherein the relevant profile information includes at least one of personal demographics, interests, birth date, residence, medical information, health conditions, customer preferences, and clothing and shoe size information.

23. The server of claim 21, wherein means for identifying relevant profile information within the stored profile information associated with the user that is relevant to the registered service comprises:

means for identifying categories corresponding to the registered service, wherein categories describe at least one of services offered, products offered, a type of business, demographics, interests, and target audience of the registered service; and

means for matching the identified categories to the profile information associated with the user.

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24. The server of claim 21, further comprising means for storing profile information received from the user during a registration process.

25. The server of claim 21, further comprising means for automatically obtaining the profile information related to the user from online sources, wherein the online sources include at least one of social networking accounts and shopping websites.

26. The server of claim 21, further comprising means for storing profile permissions from the user, wherein means for identifying profile information within stored profile information associated with the user that is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service comprises means for identifying the relevant profile information associated with the user that is relevant to the registered service and authorized by the stored profile permissions from the user when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service.

27. The server of claim 21, wherein means for transmitting a message that includes the identified relevant profile information comprises means for transmitting the message to a local computing device associated with the registered service that includes the identified relevant profile information, wherein the local computing device is at least one of a point-of-sale device, a mobile device used by an employee of the registered service, and the proximity broadcast receiver associated with the registered service.

28. The server of claim 21, further comprising:

means for determining whether the wireless identity transmitter is near a point-of-sale device associated with the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service,

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wherein means for transmitting a message that includes the identified relevant profile information comprises means for transmitting the message to the point-of-sale device that is near the wireless identity transmitter, and

wherein the identified relevant profile information associated with the user includes payment authentication information for confirming an identity of the user.

29. The server of claim 28, wherein the payment authentication information includes at least one of address information, an email address, a photo, a signature sample, audio samples, credit card information, and preferred banking account information.

30. A server configured to share profile information of an individual based on proximity, comprising:

means for receiving in the server a sighting message that includes a rolling identifier of a wireless identity transmitter associated with the individual, wherein the rolling identifier is generated via an algorithm that uses a unique device identifier of the wireless identity transmitter, a secret key shared with the server, and a counter;

means for identifying a first profile based on the rolling identifier of the wireless identity transmitter;

means for identifying a second profile based on information related to a proximity broadcast receiver included within the sighting message;

means for identifying relevant profile information from the first profile that is authorized to be shared based on permissions of the first profile;

means for identifying relevant profile information from the second profile that is authorized to be shared based on permissions of the second profile;

means for transmitting a first message to a first device associated with the second profile when there is relevant profile information from the first profile that is identified and authorized to be shared; and

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means for transmitting a second message to a second device associated with the first profile when there is relevant profile information from the second profile that is identified and authorized to be shared.

31. A non-transitory server-readable storage medium having stored thereon server-executable instructions configured to cause a server to perform operations for providing profile information associated with a user based on proximity, the operations comprising:

receiving in the server a sighting message that includes a rolling identifier of a wireless identity transmitter associated with an individual, wherein the rolling identifier is generated via an algorithm that uses a unique device identifier of the wireless identity transmitter, a secret key shared with the server, and a counter;

determining in the server whether the wireless identity transmitter is associated with the user based on the rolling identifier;

determining in the server whether the sighting message is related to a registered service based on information included within the sighting message regarding a proximity broadcast receiver;

identifying profile information within stored profile information associated with the user that is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service; and

transmitting a message that includes the identified relevant profile information.

32. The non-transitory server-readable storage medium of claim 31, wherein the relevant profile information includes at least one of personal demographics, interests, birth date, residence, medical information, health conditions, customer preferences, and clothing and shoe size information.

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33. The non-transitory server-readable storage medium of claim 31, wherein the stored server-executable instructions are configured to cause the server to perform operations such that identifying relevant profile information within the stored profile information associated with the user that is relevant to the registered service comprises:

identifying categories corresponding to the registered service, wherein categories describe at least one of services offered, products offered, a type of business, demographics, interests, and target audience of the registered service; and

matching the identified categories to the profile information associated with the user.

34. The non-transitory server-readable storage medium of claim 31, wherein the stored server-executable instructions are configured to cause the server to perform operations further comprising storing profile information received from the user during a registration process.

35. The non-transitory server-readable storage medium of claim 31, wherein the stored server-executable instructions are configured to cause the server to perform operations further comprising automatically obtaining the profile information related to the user from online sources, wherein the online sources include at least one of social networking accounts and shopping websites.

36. The non-transitory server-readable storage medium of claim 31, wherein the stored server-executable instructions are configured to cause the server to perform operations further comprising storing profile permissions from the user, and wherein the stored server-executable instructions are configured to cause the server to perform operations such that identifying profile information within stored profile information associated with the user that is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service comprises

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identifying the relevant profile information associated with the user that is relevant to the registered service and authorized by the stored profile permissions from the user when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service.

37. The non-transitory server-readable storage medium of claim 31, wherein the stored server-executable instructions are configured to cause the server to perform operations such that transmitting a message that includes the identified relevant profile information comprises transmitting the message to a local computing device associated with the registered service that includes the identified relevant profile information, wherein the local computing device is at least one of a point-of-sale device, a mobile device used by an employee of the registered service, and the proximity broadcast receiver associated with the registered service.

38. The non-transitory server-readable storage medium of claim 31, wherein the stored server-executable instructions are configured to cause the server to perform operations further comprising:

determining whether the wireless identity transmitter is near a point-of-sale device associated with the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service,

wherein the stored server-executable instructions are configured to cause the server to perform operations such that transmitting a message that includes the identified relevant profile information comprises transmitting the message to the point-of-sale device that is near the wireless identity transmitter, and

wherein the identified relevant profile information associated with the user includes payment authentication information for confirming an identity of the user.

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39. The non-transitory server-readable storage medium of claim 38, wherein the payment authentication information includes at least one of address information, an email address, a photo, a signature sample, audio samples, credit card information, and preferred banking account information.

40. A non-transitory server-readable storage medium having stored thereon server-executable instructions configured to cause a server to perform operations for sharing profile information of an individual based on proximity, the operations comprising:

receiving in the server a sighting message that includes a rolling identifier of a wireless identity transmitter associated with the individual, wherein the rolling identifier is generated via an algorithm that uses a unique device identifier of the wireless identity transmitter, a secret key shared with the server, and a counter;

identifying a first profile based on the rolling identifier of the wireless identity transmitter;

identifying a second profile based on information related to a proximity broadcast receiver included within the sighting message;

identifying relevant profile information from the first profile that is authorized to be shared based on permissions of the first profile;

identifying relevant profile information from the second profile that is authorized to be shared based on permissions of the second profile;

transmitting a first message to a first device associated with the second profile when there is relevant profile information from the first profile that is identified and authorized to be shared; and

transmitting a second message to a second device associated with the first profile when there is relevant profile information from the second profile that is identified and authorized to be shared.

41. A system, comprising:

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a server;

a wireless identity transmitter; and

a proximity broadcast receiver,

wherein the wireless identity transmitter comprises:

a first memory;

a first transceiver configured to broadcast short-range wireless signals capable of being received by the proximity broadcast receiver; and

a first processor coupled to the first memory and the first transceiver, and configured with processor-executable instructions to perform operations comprising:

generating a rolling identifier periodically via an algorithm that uses a unique device identifier of the wireless identity transmitter that is associated with an individual, a secret key shared with the server, and a counter; and

periodically broadcasting via the first transceiver a short-range wireless signal including the rolling identifier of the wireless identity transmitter, and

wherein the proximity broadcast receiver comprises:

a second memory;

a second transceiver configured to exchange short-range wireless signals with the wireless identity transmitter;

a network device configured to exchange signals with the server;

a second processor coupled to the second memory, the second transceiver, and the network device and configured with processor-executable instructions to perform operations comprising:

receiving via the second transceiver the short-range wireless signal including the rolling identifier broadcast by the wireless identity transmitter within proximity;

generating a sighting message in response to the received signal, wherein the sighting message includes the rolling identifier and associated data; and

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transmitting the sighting message via long-range communications using the network device, and

wherein the server is configured with server-executable instructions to perform operations comprising:

storing the profile information associated with a user;

receiving in the server the sighting message that includes the rolling identifier;

determining in the server whether the wireless identity transmitter is associated with the user based on the rolling identifier;

determining in the server whether the sighting message is related to a registered service based on information included within the sighting message regarding the proximity broadcast receiver;

identifying relevant profile information within the stored profile information associated with the user that is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service; and

transmitting a message that includes the identified relevant profile information.

42. The system of claim 41, wherein the relevant profile information includes at least one of personal demographics, interests, birth date, residence, medical information, health conditions, customer preferences, and clothing and shoe size information.

43. The system of claim 41, wherein the server is configured with server-executable instructions to perform operations such that identifying relevant profile information within the stored profile information associated with the user that is relevant to the registered service comprises:

identifying categories corresponding to the registered service, wherein categories describe at least one of services offered, products offered, a type of

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business, demographics, interests, and target audience of the registered service; and

matching the identified categories to the profile information associated with the user.

44. The system of claim 41, wherein the server is configured with server-executable instructions to perform operations such that storing the profile information associated with the user comprises storing data received from the user during a registration that includes the profile information.

45. The system of claim 41, wherein the server is configured with server-executable instructions to perform operations further comprising automatically obtaining the profile information related to the user from online sources, wherein the online sources include at least one of social networking accounts and shopping websites.

46. The system of claim 41, wherein:

the server is configured with server-executable instructions to perform operations further comprising storing profile permissions from the user; and

the server is configured with server-executable instructions to perform operations such that identifying relevant profile information within the stored profile information associated with the user that is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service comprises identifying the relevant profile information within the stored profile information associated with the user that is relevant to the registered service and authorized by the stored profile permissions from the user when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service.

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47. The system of claim 41, wherein the server is configured with server-executable instructions to perform operations such that transmitting a message that includes the identified relevant profile information comprises transmitting the message to a local computing device associated with the registered service that includes the identified relevant profile information, wherein the local computing device is at least one of a point-of-sale device, a mobile device used by an employee of the registered service, and the proximity broadcast receiver associated with the registered service.

48. The system of claim 41, wherein the server is configured with server-executable instructions to perform operations further comprising:

determining whether the wireless identity transmitter is near a point-of-sale device associated with the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service, and

wherein the server is configured with server-executable instructions to perform operations such that transmitting a message that includes the identified relevant profile information comprises transmitting the message to the point-of-sale device that is near the wireless identity transmitter, and

wherein the identified relevant profile information associated with the user includes payment authentication information for confirming an identity of the user.

49. The system of claim 48, wherein the payment authentication information includes at least one of address information, an email address, a photo, a signature sample, audio samples, credit card information, and preferred banking account information.

50. A system, comprising:

a server;

a wireless identity transmitter; and

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a proximity broadcast receiver,

wherein the wireless identity transmitter comprises:

a first memory;

a first transceiver configured to broadcast short-range wireless signals capable of being received by the proximity broadcast receiver; and

a first processor coupled to the first memory and the first transceiver, and configured with processor-executable instructions to perform operations comprising:

generating a rolling identifier periodically via an algorithm that uses a unique device identifier of the wireless identity transmitter that is associated with an individual, a secret key shared with the server, and a counter; and

periodically broadcasting via the first transceiver a short-range wireless signal including the rolling identifier of the wireless identity transmitter, and

wherein the proximity broadcast receiver comprises:

a second memory;

a second transceiver configured to exchange short-range wireless signals with the wireless identity transmitter;

a network device configured to exchange signals with the server;

a second processor coupled to the second memory, the second transceiver, and the network device and configured with processor-executable instructions to perform operations comprising:

receiving via the second transceiver the short-range wireless signal including the rolling identifier broadcast by the wireless identity transmitter within proximity;

generating a sighting message in response to the received signal, wherein the sighting message includes the rolling identifier and associated data; and

transmitting the sighting message via long-range communications using the network device, and

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wherein the server is configured with server-executable instructions to perform operations comprising:

receiving in the server the sighting message that includes the rolling identifier;

identifying a first profile based on the rolling identifier of the wireless identity transmitter;

identifying a second profile based on information related to the proximity broadcast receiver included within the sighting message;

identifying relevant profile information from the first profile that is authorized to be shared based on permissions of the first profile;

identifying relevant profile information from the second profile that is authorized to be shared based on permissions of the second profile;

transmitting a first message to a first device associated with the second profile when there is relevant profile information from the first profile that is identified and authorized to be shared; and

transmitting a second message to a second device associated with the first profile when there is relevant profile information from the second profile that is identified and authorized to be shared.

51. A method for a mobile device to provide profile information associated with a user based on proximity, comprising:

storing the profile information locally within the mobile device;

receiving a short-range wireless message from a proximate device;

identifying relevant profile information within the stored profile information that is authorized to be shared based on the received message; and

transmitting a response message including the identified relevant profile information that is authorized to be shared.

52. A mobile device configured to provide profile information associated with a user based on proximity, comprising:

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means for storing the profile information locally within the mobile device;

means for receiving a short-range wireless message from a proximate device;

means for identifying relevant profile information within the stored profile information that is authorized to be shared based on the received message; and

means for transmitting a response message including the identified relevant profile information that is authorized to be shared.

53. A mobile device configured to provide profile information associated with a user based on proximity, comprising:

a memory; and

a processor coupled to the memory, wherein the processor is configured with processor-executable instructions to perform operations comprising:

storing the profile information locally within the mobile device;

receiving a short-range wireless message from a proximate device;

identifying relevant profile information within the stored profile information that is authorized to be shared based on the received message; and

transmitting a response message including the identified relevant profile information that is authorized to be shared.

54. A non-transitory processor-readable storage medium having stored thereon processor executable instructions configured to cause a mobile device to perform operations to provide profile information associated with a user based on proximity, the operations comprising:

storing the profile information locally within the mobile device;

receiving a short-range wireless message from a proximate device;

identifying relevant profile information within the stored profile information that is authorized to be shared based on the received message; and

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transmitting a response message including the identified relevant profile information that is authorized to be shared.

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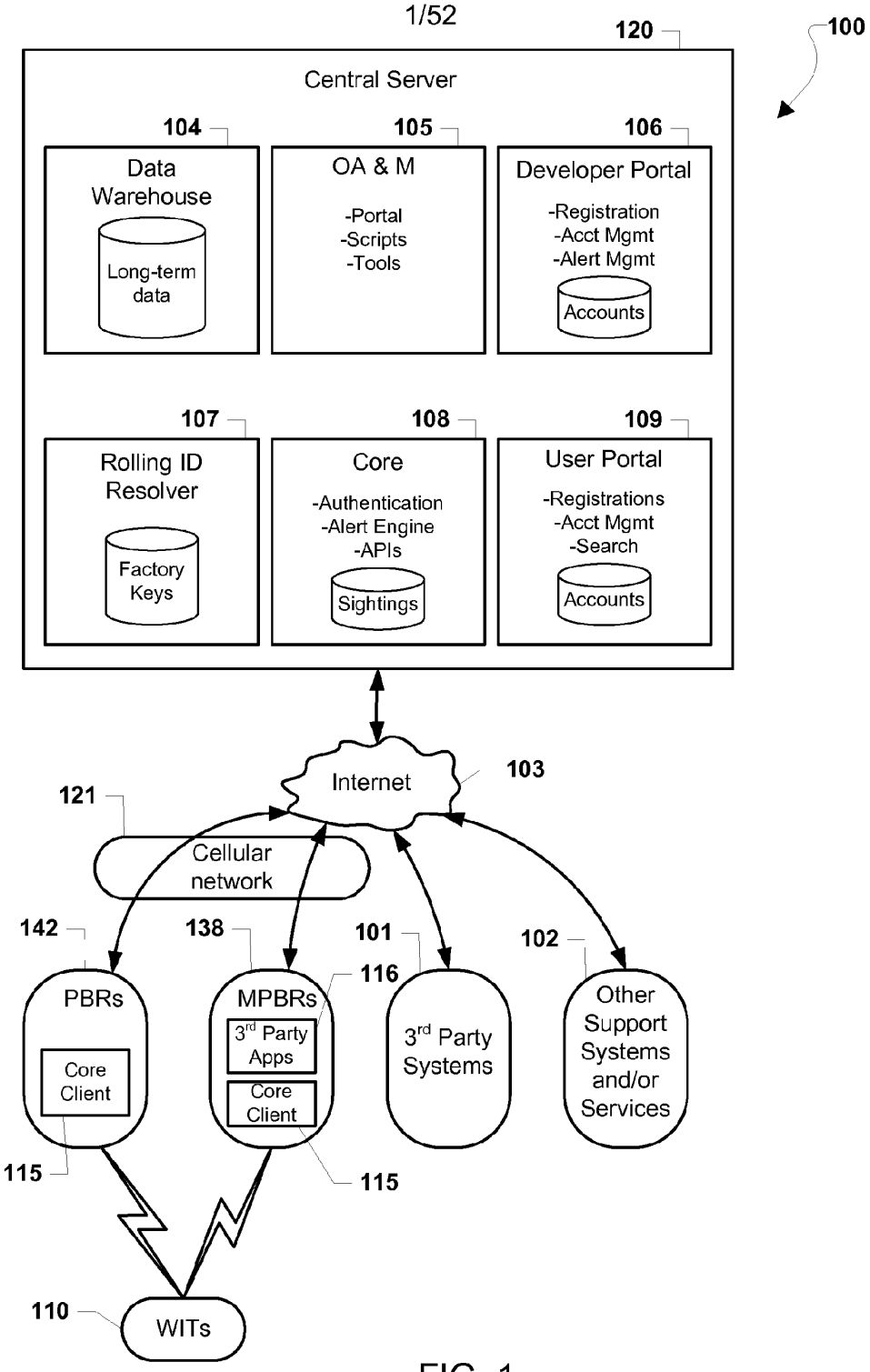


FIG. 1

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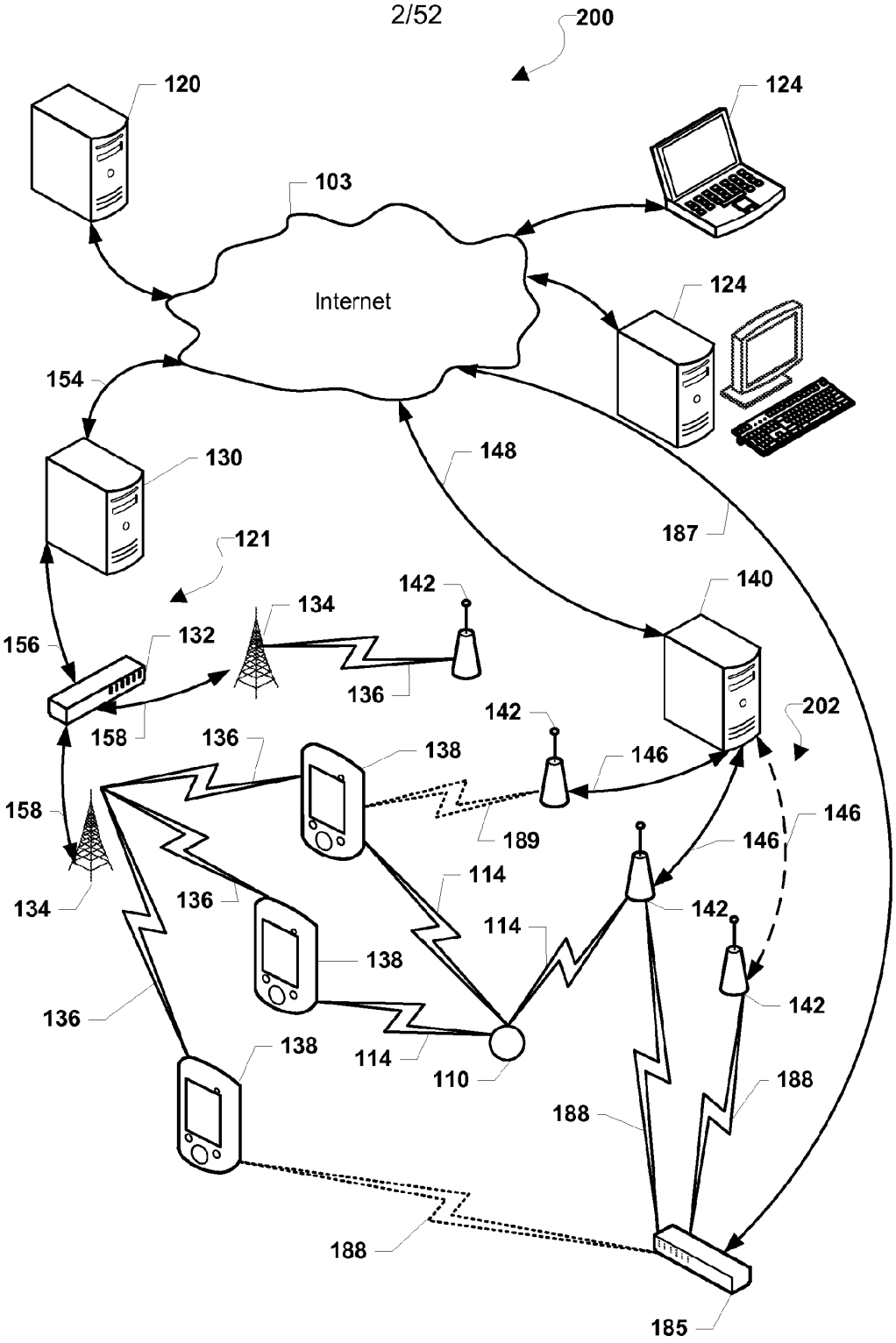

200
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Internet
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FIG. 2

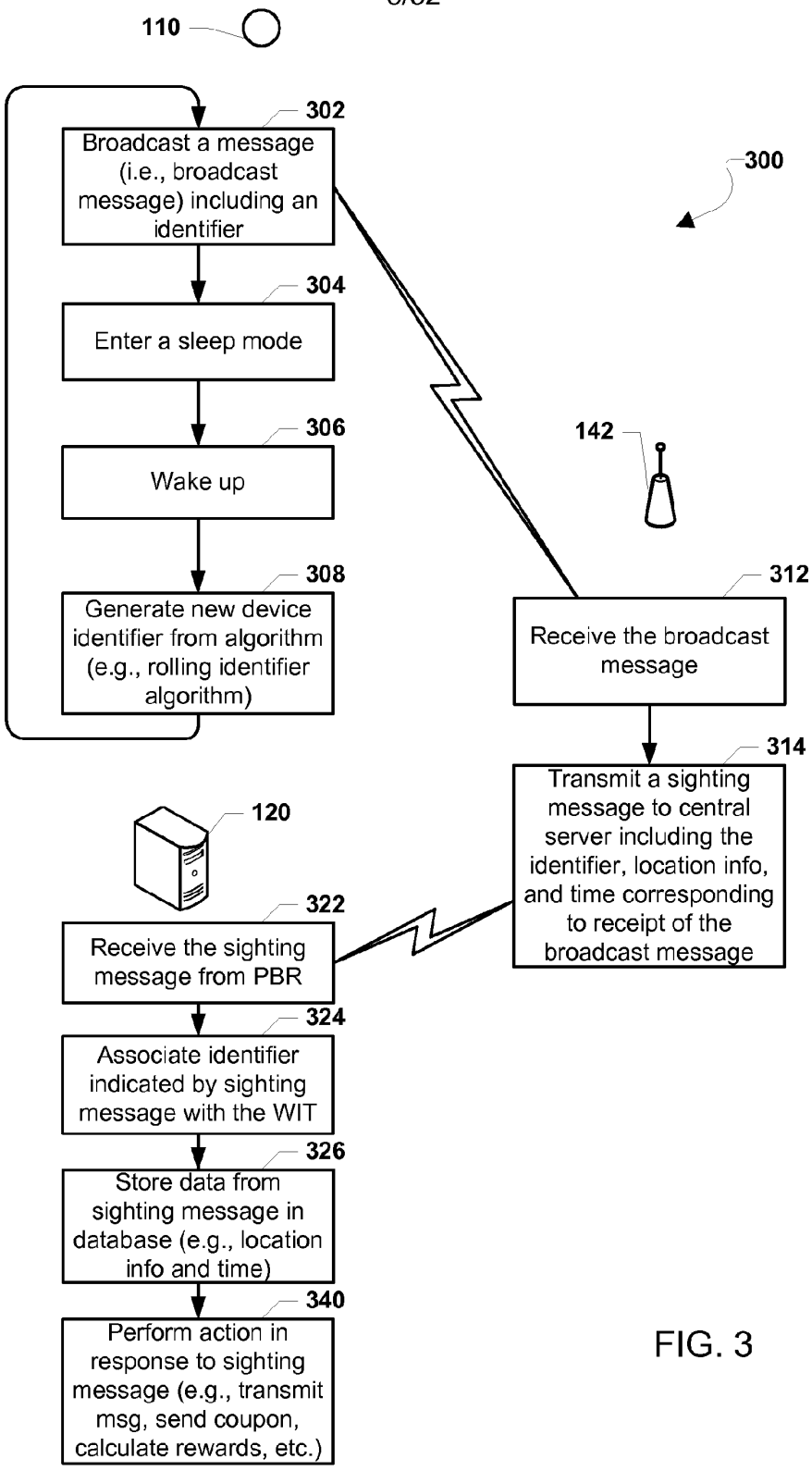

110
302
Broadcast a message (i.e., broadcast message) including an identifier
304
Enter a sleep mode
306
Wake up
308
Generate new device identifier from algorithm (e.g., rolling identifier algorithm)
300
142
312
Receive the broadcast message
314
Transmit a sighting message to central server including the identifier, location info, and time corresponding to receipt of the broadcast message
120
322
Receive the sighting message from PBR
324
Associate identifier indicated by sighting message with the WIT
326
Store data from sighting message in database (e.g., location info and time)
340
Perform action in response to sighting message (e.g., transmit msg, send coupon, calculate rewards, etc.)

FIG. 3

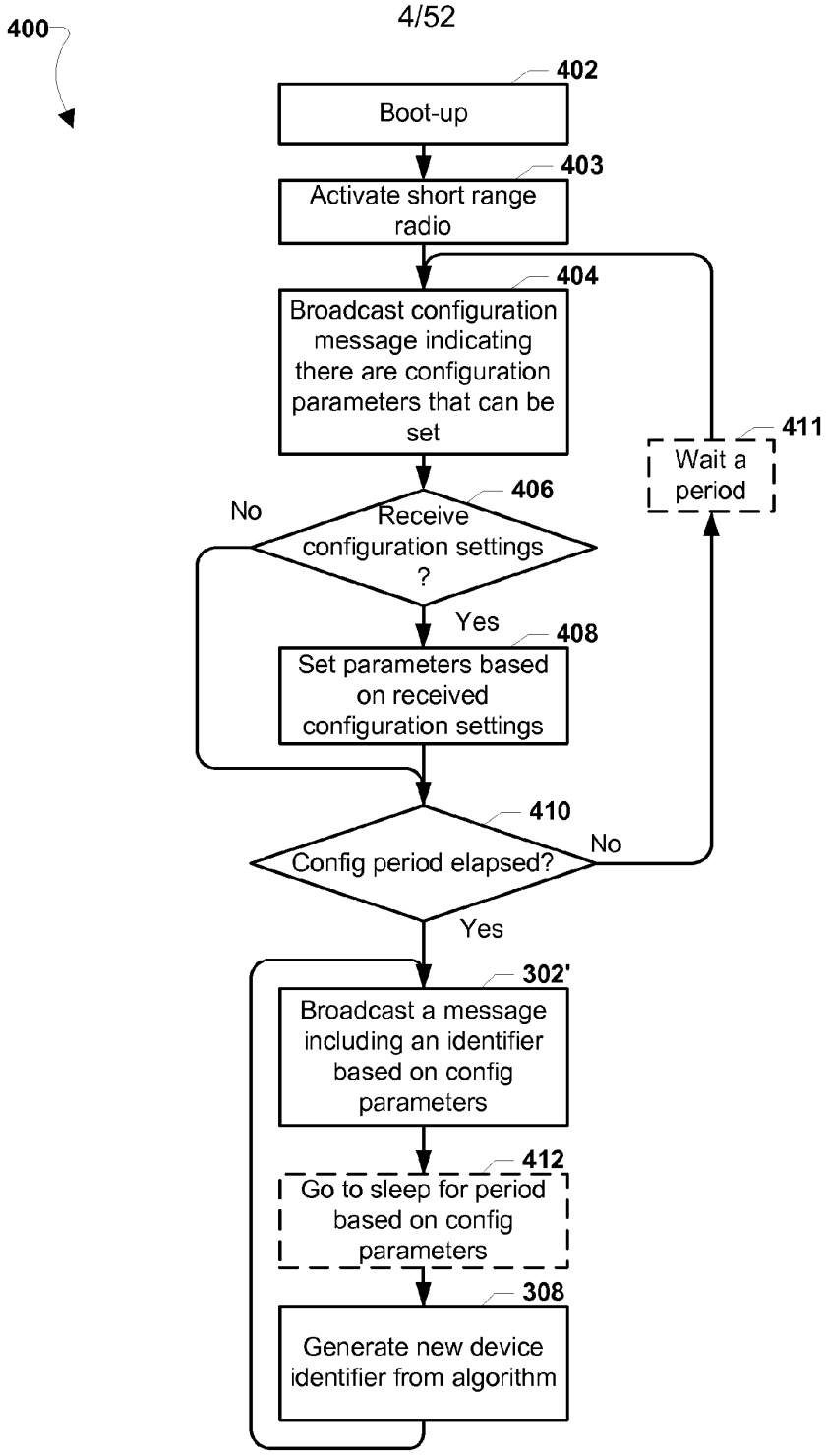

400
402
Boot-up
403
Activate short range radio
404
Broadcast configuration message indicating there are configuration parameters that can be set
406
Receive configuration settings ?
No
Yes
408
Set parameters based on received configuration settings
410
Config period elapsed?
No
Yes
411
Wait a period
302'
Broadcast a message including an identifier based on config parameters
412
Go to sleep for period based on config parameters
308
Generate new device identifier from algorithm

FIG. 4

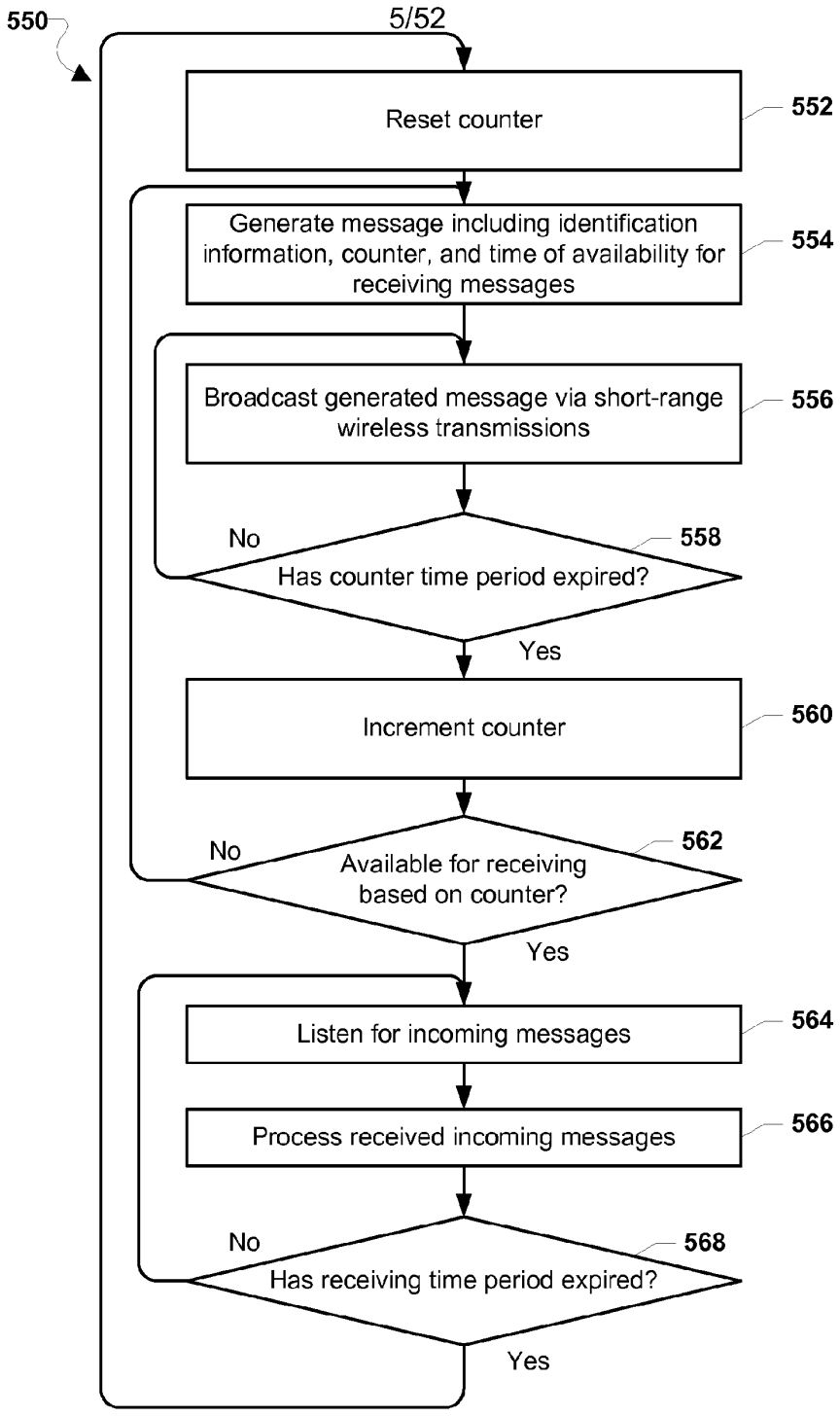

550
5/52
Reset counter
552
Generate message including identification information, counter, and time of availability for receiving messages
554
Broadcast generated message via short-range wireless transmissions
556
No
Has counter time period expired?
558
Yes
Increment counter
560
No
Available for receiving based on counter?
562
Yes
Listen for incoming messages
564
Process received incoming messages
566
No
Has receiving time period expired?
568
Yes

FIG. 5

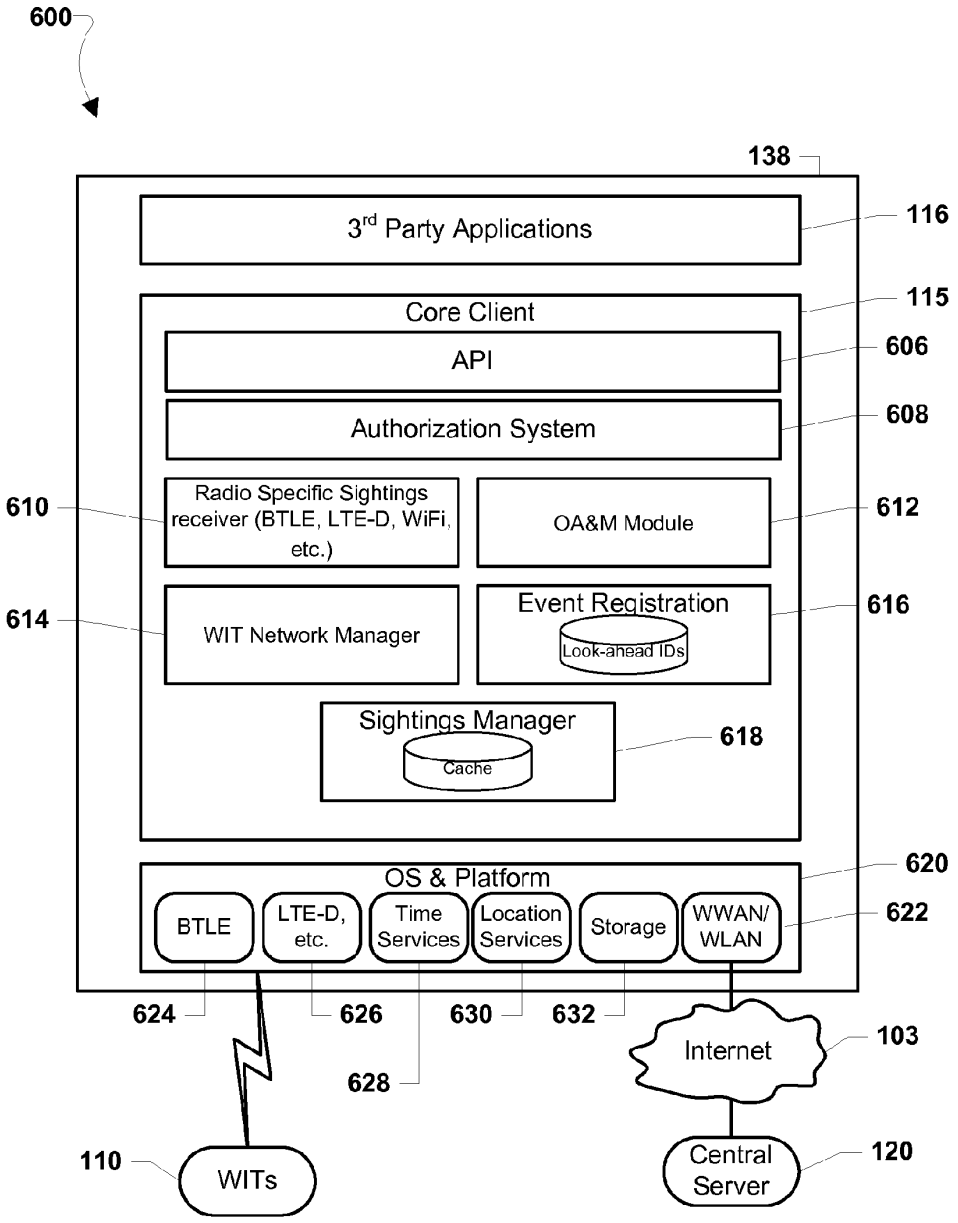

600
138
3rd Party Applications
116
Core Client
115
API
606
Authorization System
608
610
Radio Specific Sightings receiver (BTLE, LTE-D, WiFi, etc.)
OA&M Module
612
614
WIT Network Manager
Event Registration
Look-ahead IDs
616
Sightings Manager
Cache
618
OS & Platform
620
BTLE
LTE-D, etc.
Time Services
Location Services
Storage
WWAN/ WLAN
622
624
626
628
630
632
Internet
103
110
WITs
Central Server
120

FIG. 6

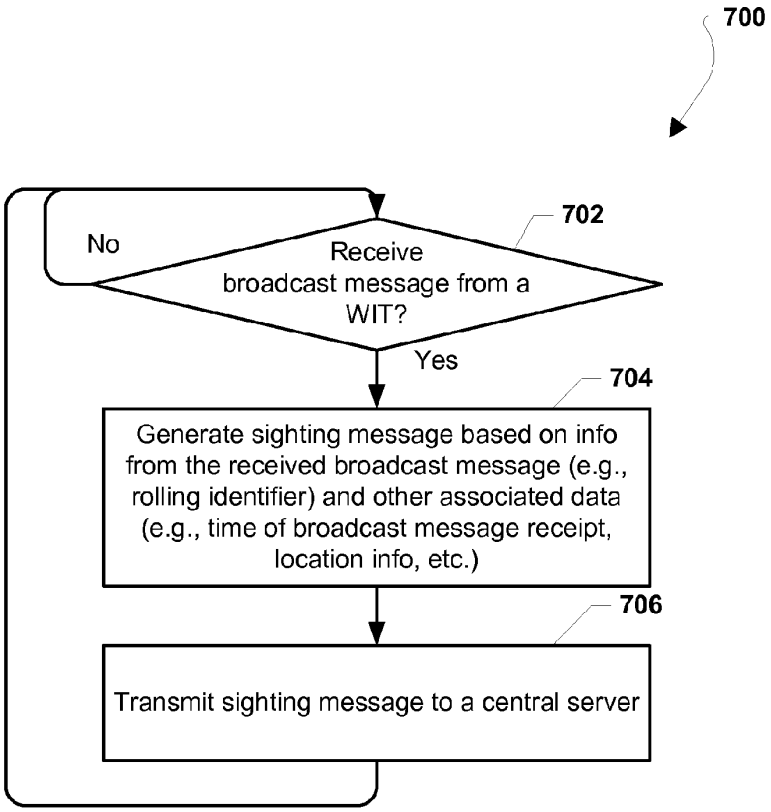

700
702
No
Receive broadcast message from a WIT?
Yes
704
Generate sighting message based on info from the received broadcast message (e.g., rolling identifier) and other associated data (e.g., time of broadcast message receipt, location info, etc.)
706
Transmit sighting message to a central server

FIG. 7

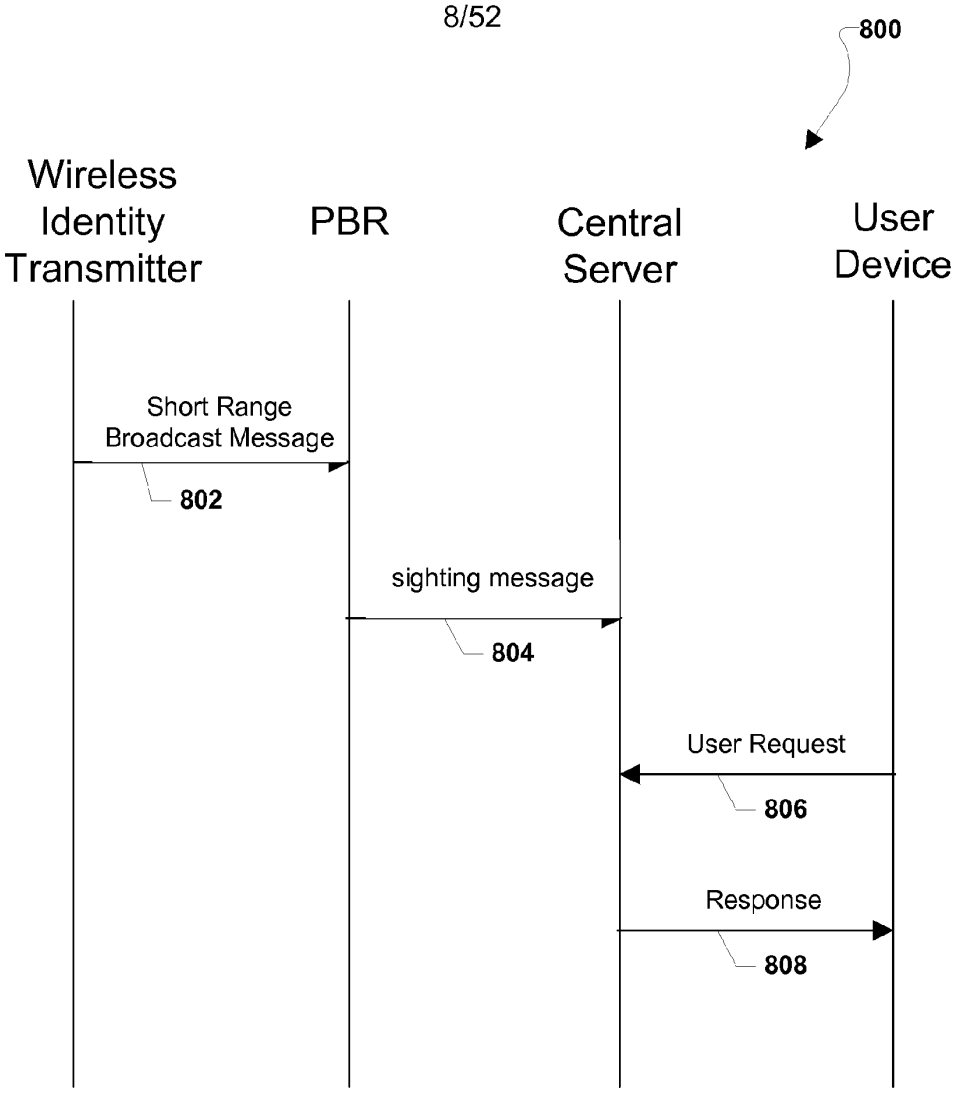

800
Wireless Identity Transmitter
PBR
Central Server
User Device
Short Range Broadcast Message
802
sighting message
804
User Request
806
Response
808

FIG. 8

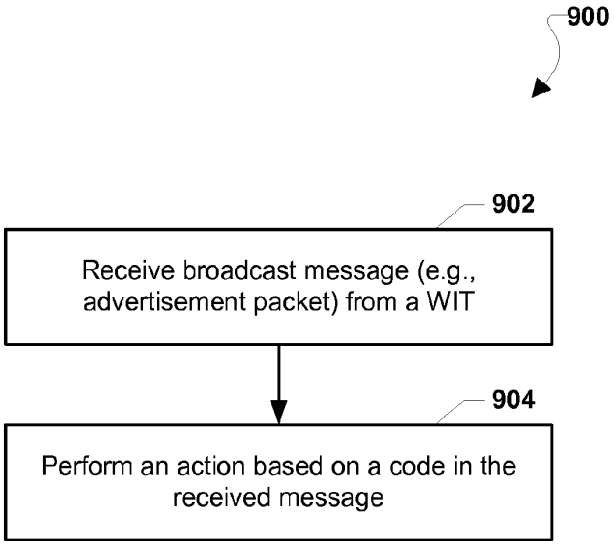

900
902
Receive broadcast message (e.g., advertisement packet) from a WIT
904
Perform an action based on a code in the received message

FIG. 9

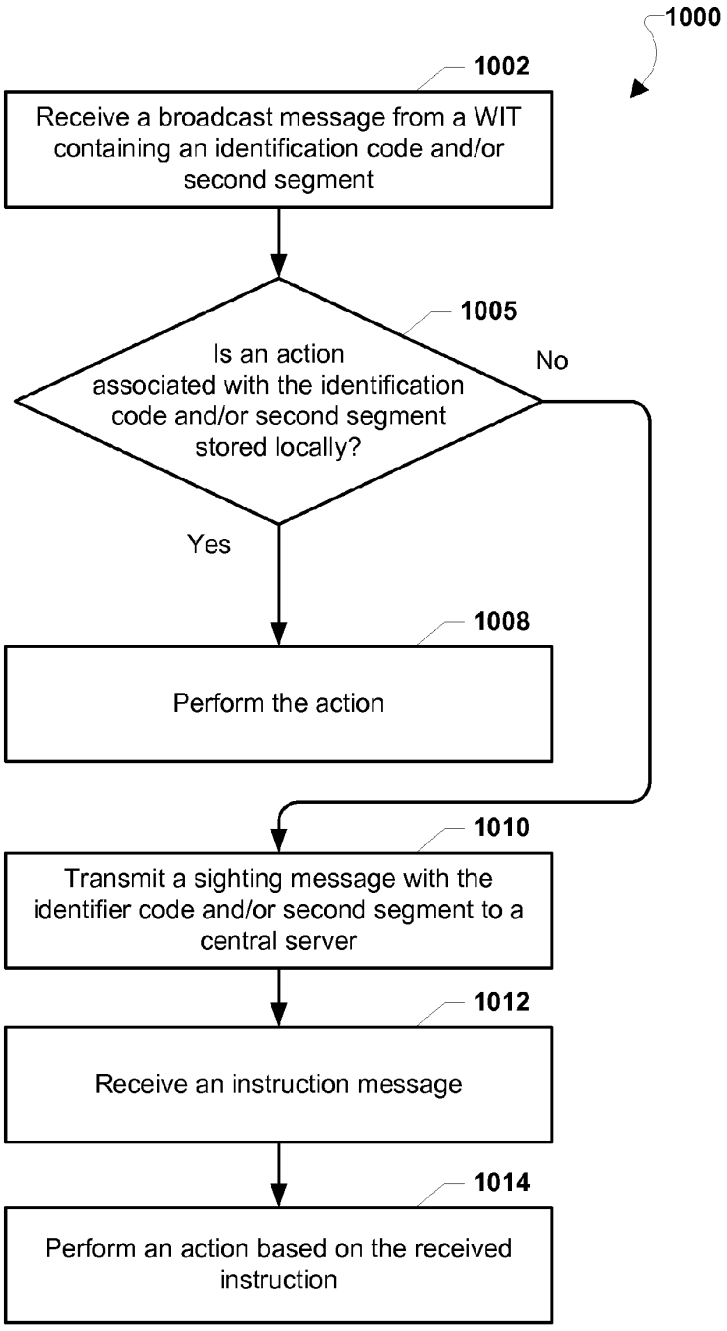

1000
1002
Receive a broadcast message from a WIT containing an identification code and/or second segment
1005
Is an action associated with the identification code and/or second segment stored locally?
No
Yes
1008
Perform the action
1010
Transmit a sighting message with the identifier code and/or second segment to a central server
1012
Receive an instruction message
1014
Perform an action based on the received instruction

FIG. 10

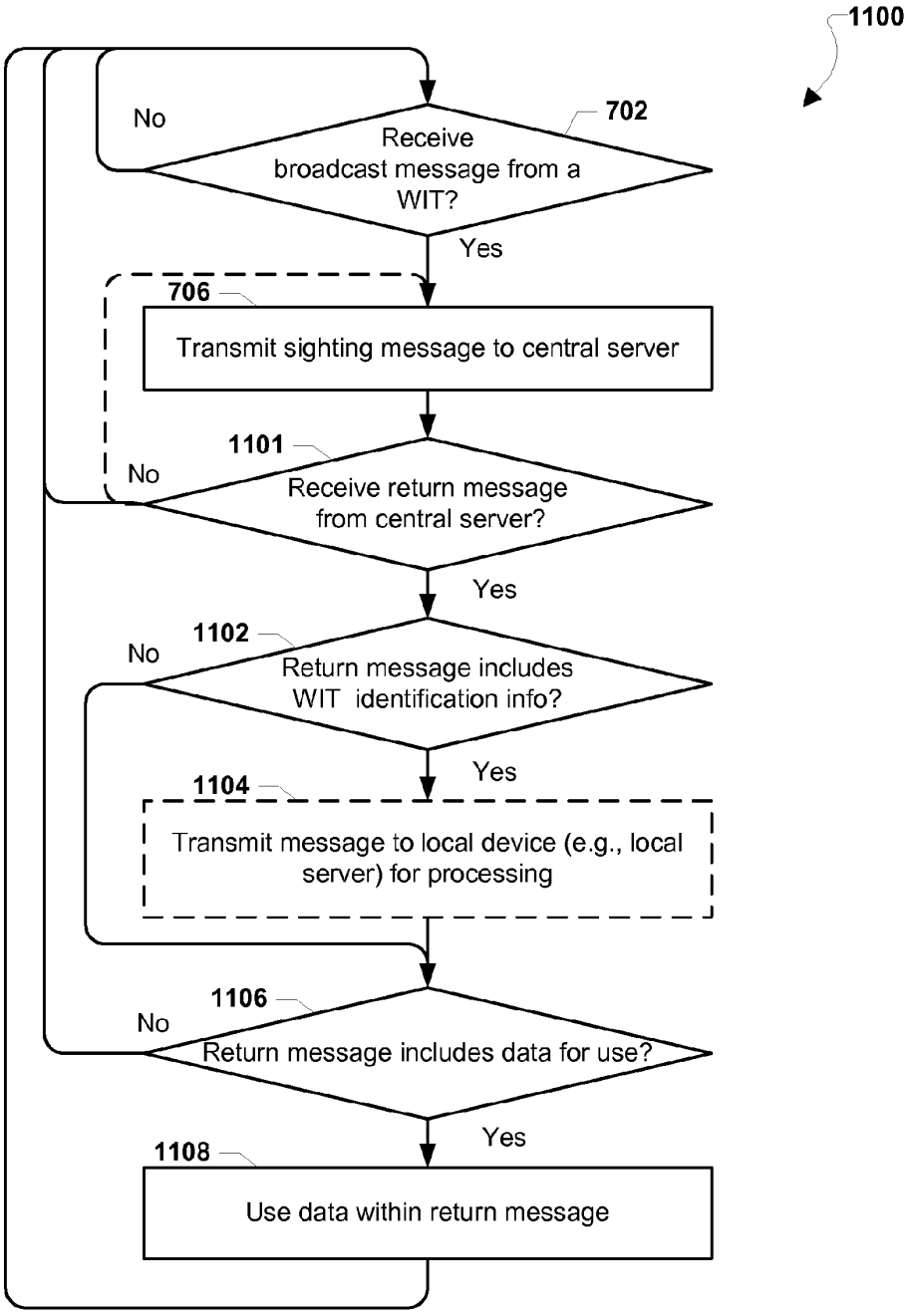

1100
No
Receive broadcast message from a WIT?
702
Yes
706
Transmit sighting message to central server
1101
No
Receive return message from central server?
Yes
1102
No
Return message includes WIT identification info?
Yes
1104
Transmit message to local device (e.g., local server) for processing
1106
No
Return message includes data for use?
Yes
1108
Use data within return message

FIG. 11

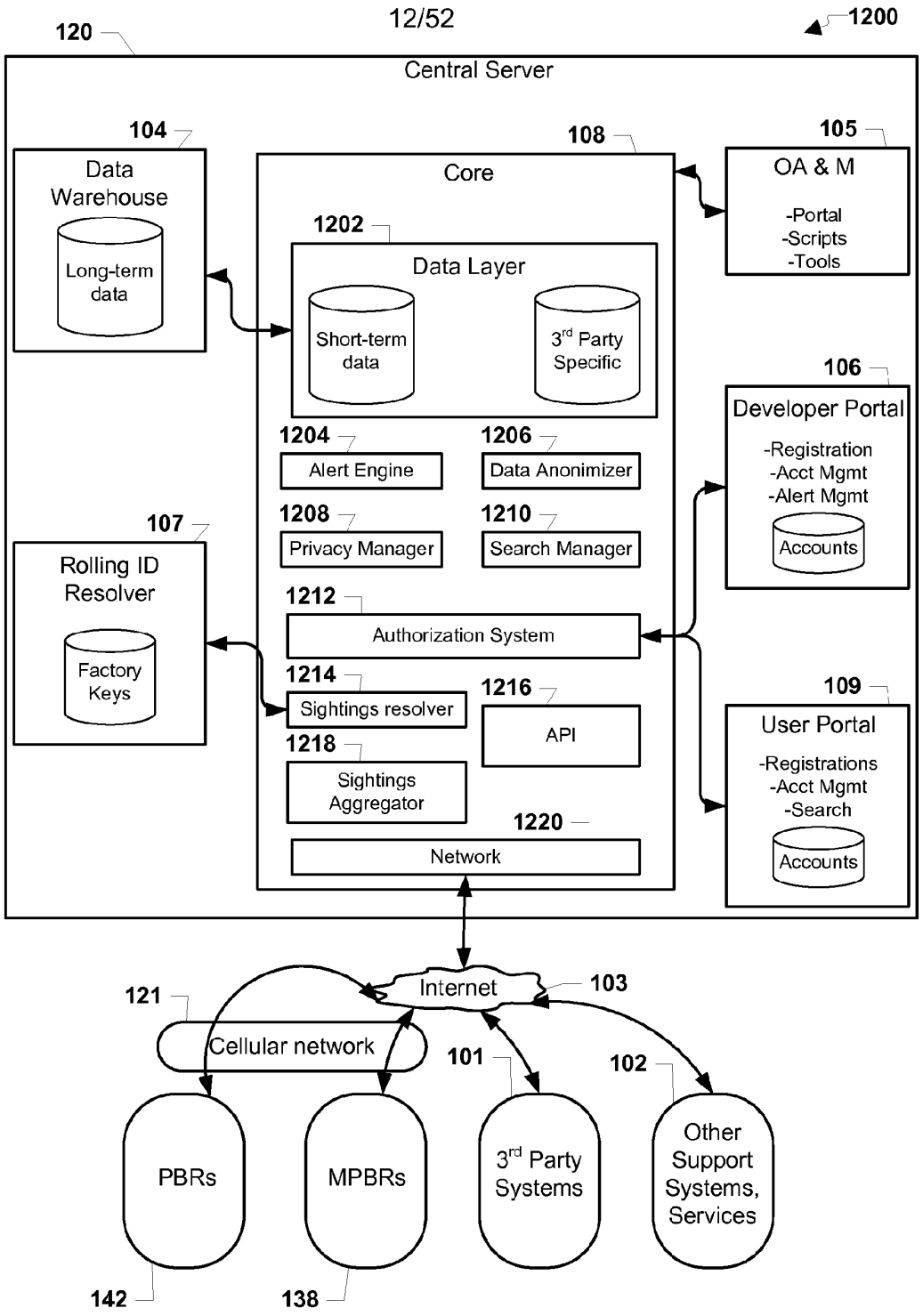

120
1200
Central Server
104
Data Warehouse
Long-term data
108
Core
1202
Data Layer
Short-term data
3rd Party Specific
105
OA & M
-Portal
-Scripts
-Tools
106
Developer Portal
-Registration
-Acct Mgmt
-Alert Mgmt
Accounts
1204
Alert Engine
1206
Data Anonimizer
1208
Privacy Manager
1210
Search Manager
107
Rolling ID Resolver
Factory Keys
1212
Authorization System
1214
Sightings resolver
1216
API
1218
Sightings Aggregator
1220
Network
109
User Portal
-Registrations
-Acct Mgmt
-Search
Accounts
Internet
103
121
Cellular network
101
102
PBRs
MPBRs
3rd Party Systems
Other Support Systems, Services
142
138

FIG. 12

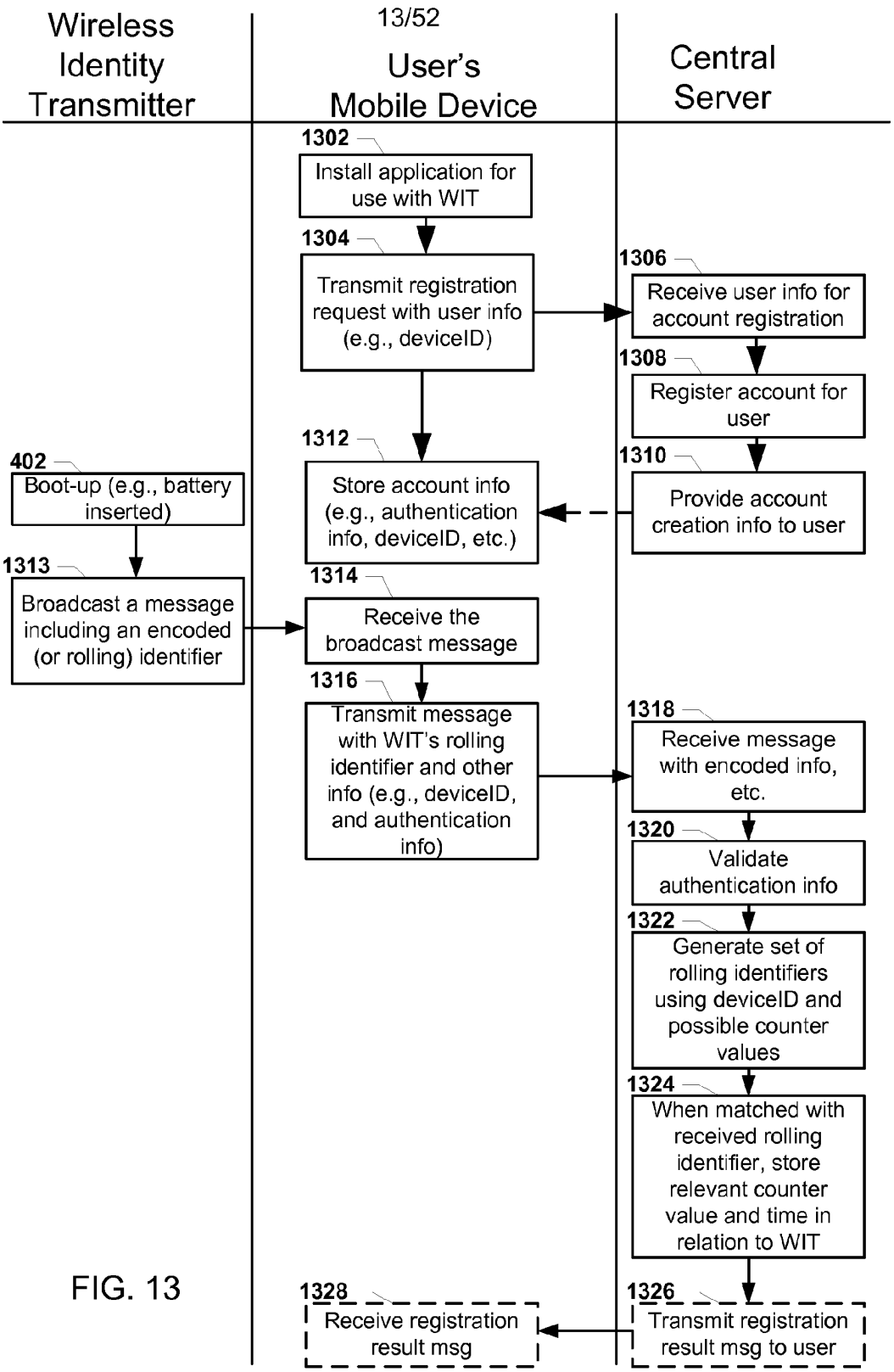


FIG. 13

Petitioner Samsung Ex-1004, 0619

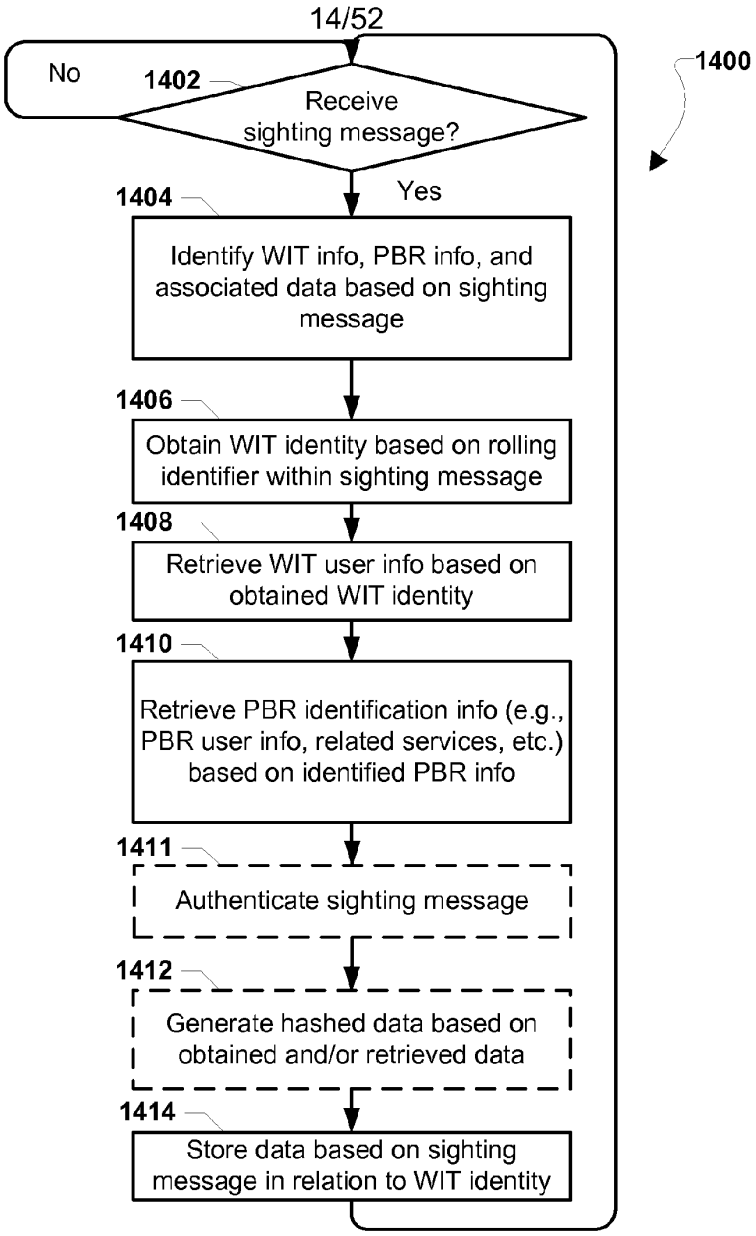

1400
1402
Receive sighting message?
No
Yes
1404
Identify WIT info, PBR info, and associated data based on sighting message
1406
Obtain WIT identity based on rolling identifier within sighting message
1408
Retrieve WIT user info based on obtained WIT identity
1410
Retrieve PBR identification info (e.g., PBR user info, related services, etc.) based on identified PBR info
1411
Authenticate sighting message
1412
Generate hashed data based on obtained and/or retrieved data
1414
Store data based on sighting message in relation to WIT identity

FIG. 14A

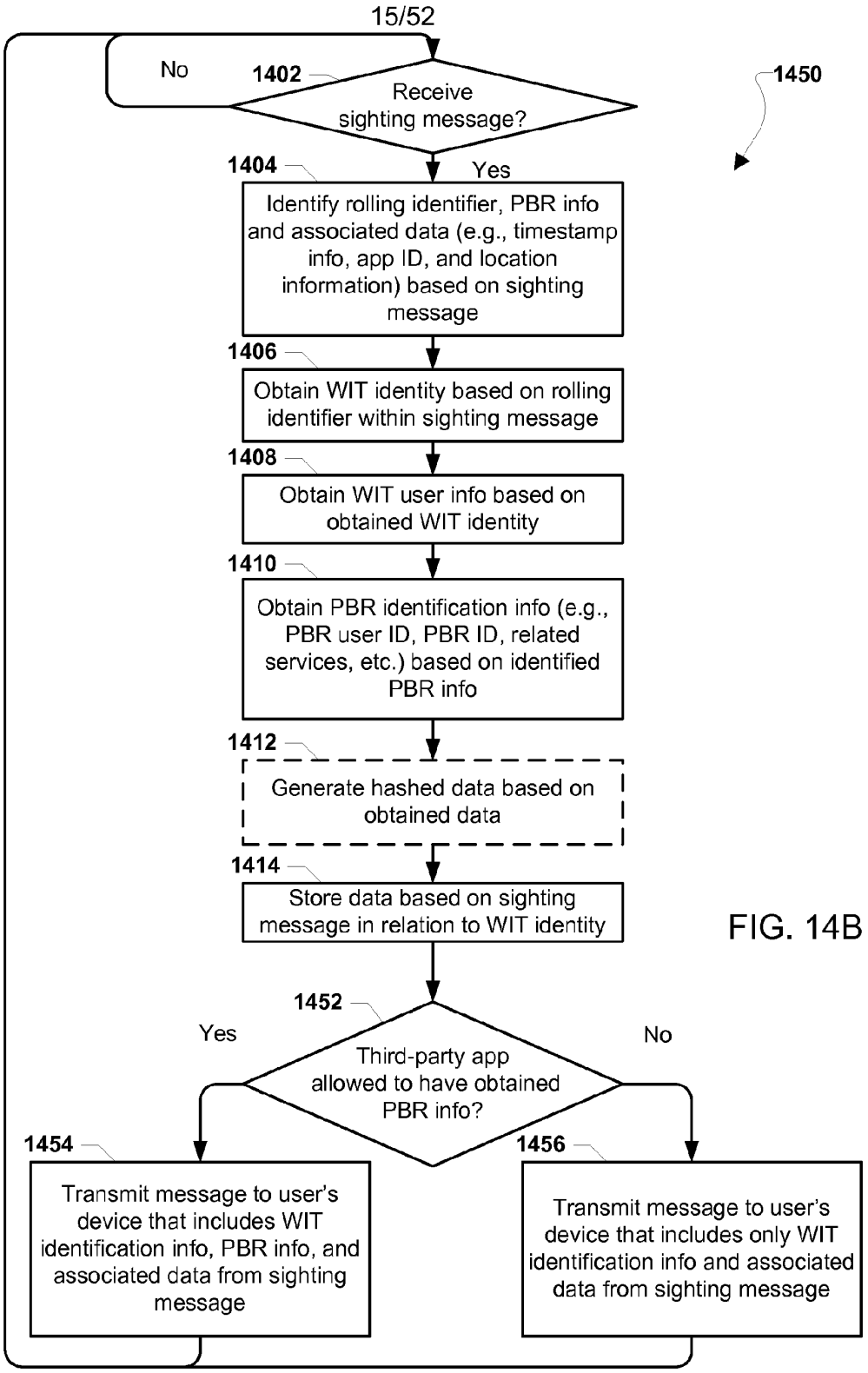

1450
1402
Receive sighting message?
No
Yes
1404
Identify rolling identifier, PBR info and associated data (e.g., timestamp info, app ID, and location information) based on sighting message
1406
Obtain WIT identity based on rolling identifier within sighting message
1408
Obtain WIT user info based on obtained WIT identity
1410
Obtain PBR identification info (e.g., PBR user ID, PBR ID, related services, etc.) based on identified PBR info
1412
Generate hashed data based on obtained data
1414
Store data based on sighting message in relation to WIT identity
1452
Third-party app allowed to have obtained PBR info?
Yes
No
1454
Transmit message to user's device that includes WIT identification info, PBR info, and associated data from sighting message
1456
Transmit message to user's device that includes only WIT identification info and associated data from sighting message

FIG. 14B

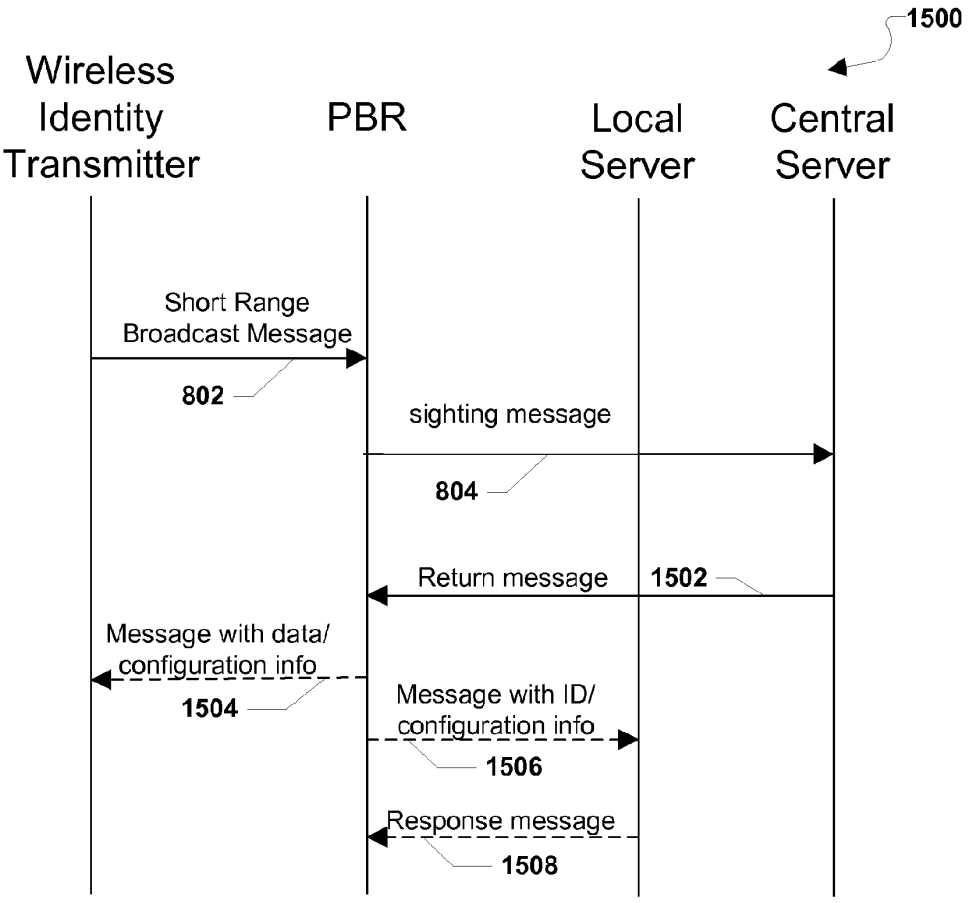

1500
Wireless Identity Transmitter
PBR
Local Server
Central Server
Short Range Broadcast Message
802
sighting message
804
Return message
1502
Message with data/ configuration info
1504
Message with ID/ configuration info
1506
Response message
1508

FIG. 15A

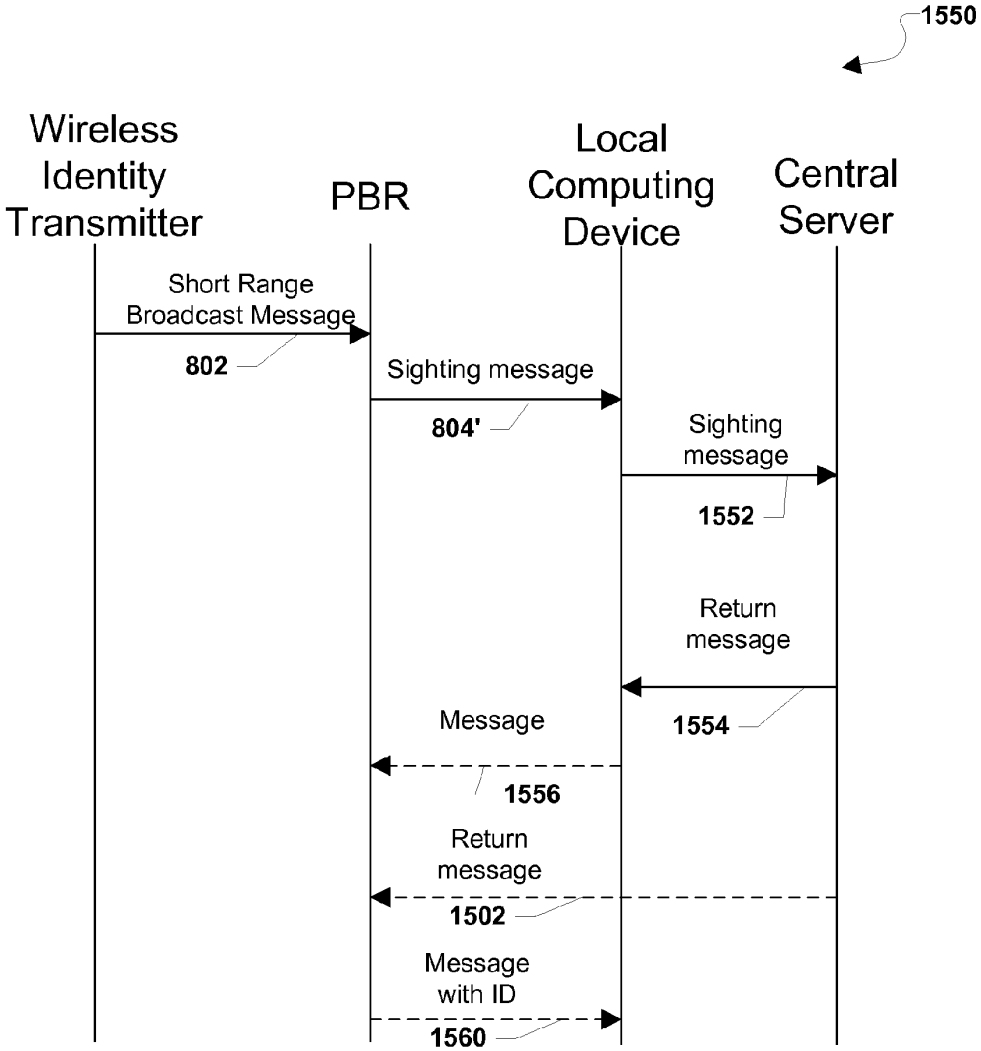

1550
Wireless Identity Transmitter
PBR
Local Computing Device
Central Server
Short Range Broadcast Message
802
Sighting message
804'
Sighting message
1552
Return message
1554
Message
1556
Return message
1502
Message with ID
1560

FIG. 15B

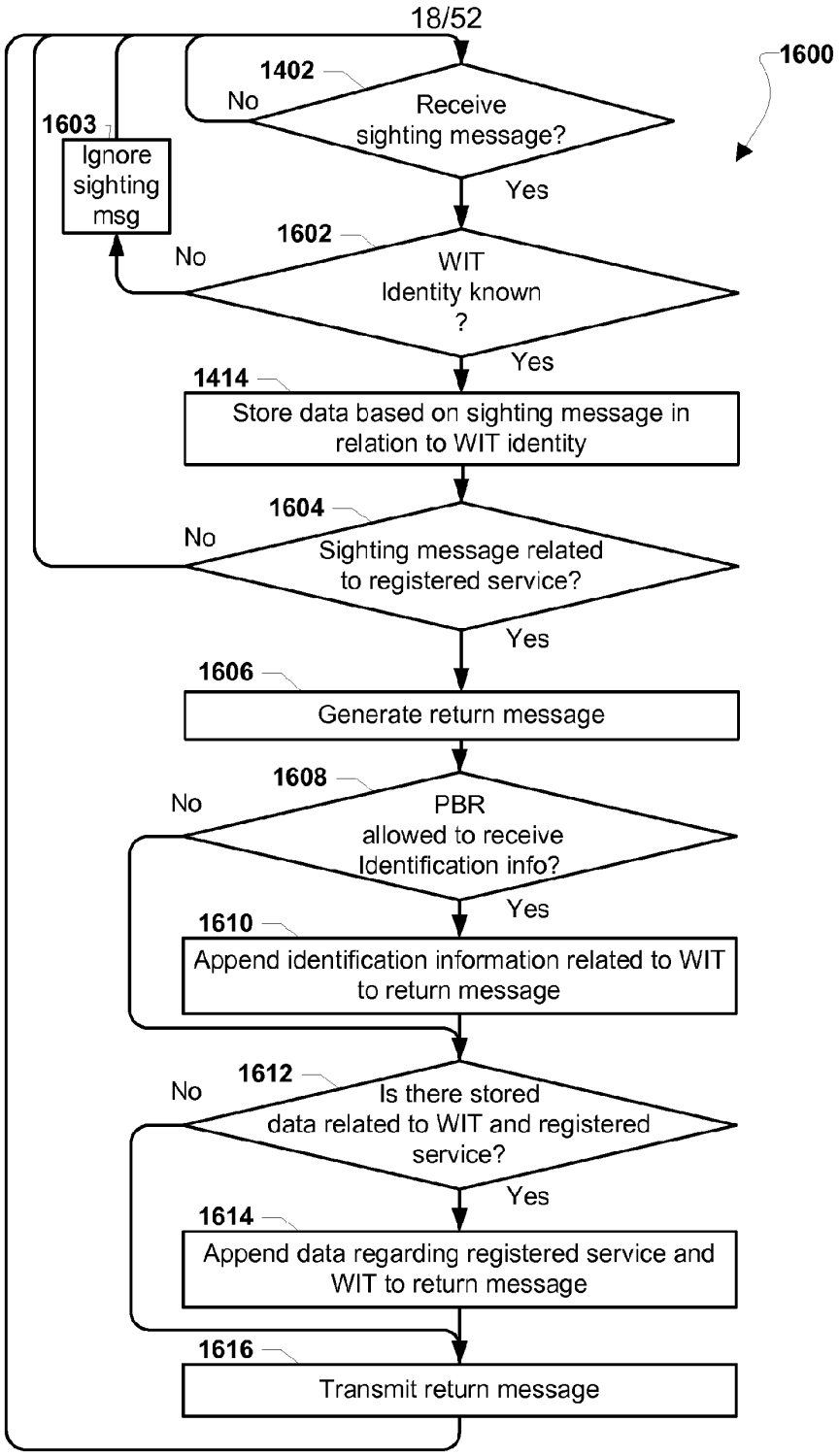

1600
1402
Receive sighting message?
No
Yes
1603
Ignore sighting msg
1602
WIT Identity known ?
No
Yes
1414
Store data based on sighting message in relation to WIT identity
1604
Sighting message related to registered service?
No
Yes
1606
Generate return message
1608
PBR allowed to receive Identification info?
No
Yes
1610
Append identification information related to WIT to return message
1612
Is there stored data related to WIT and registered service?
No
Yes
1614
Append data regarding registered service and WIT to return message
1616
Transmit return message

FIG. 16

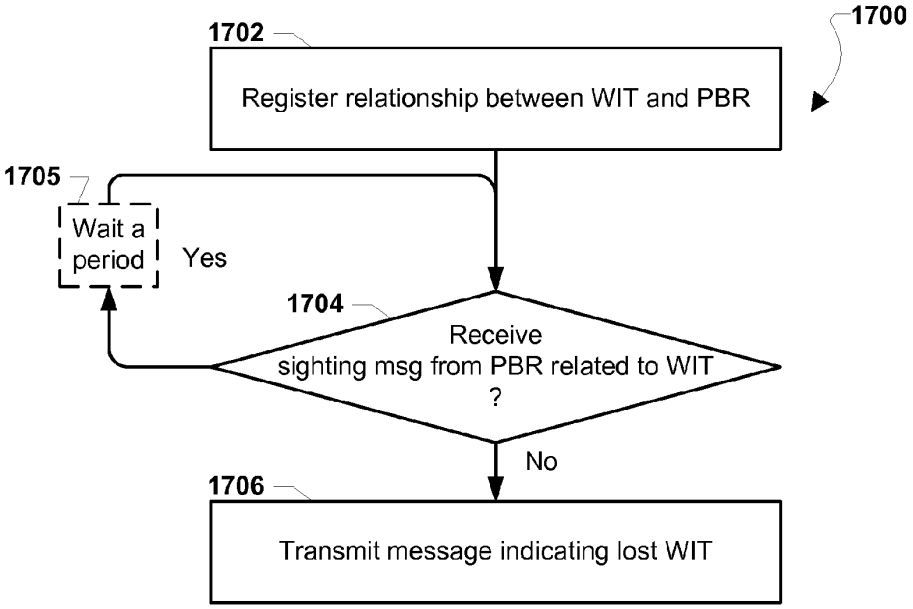

1700
1702
Register relationship between WIT and PBR
1705
Wait a period
Yes
1704
Receive sighting msg from PBR related to WIT ?
No
1706
Transmit message indicating lost WIT

FIG. 17

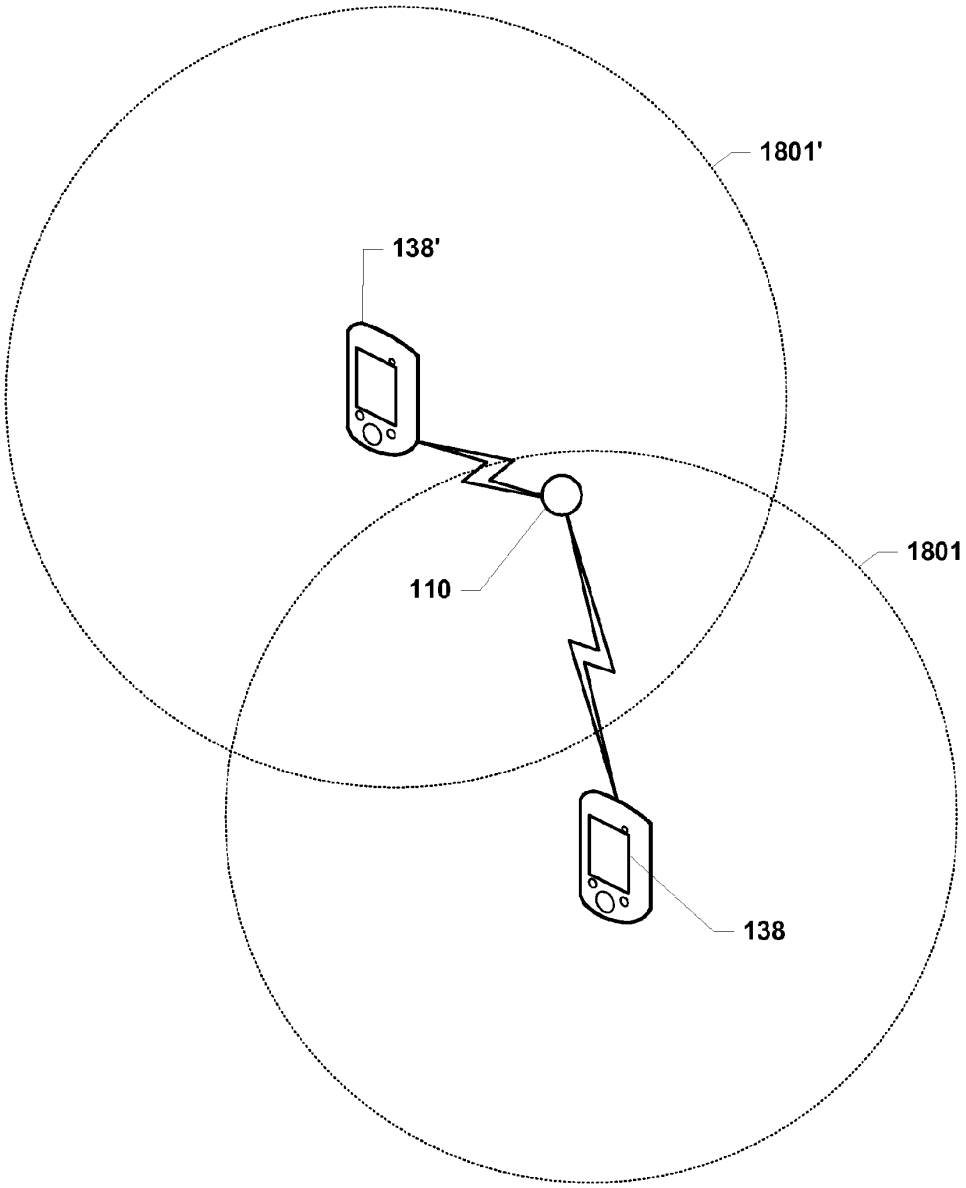


FIG. 18A

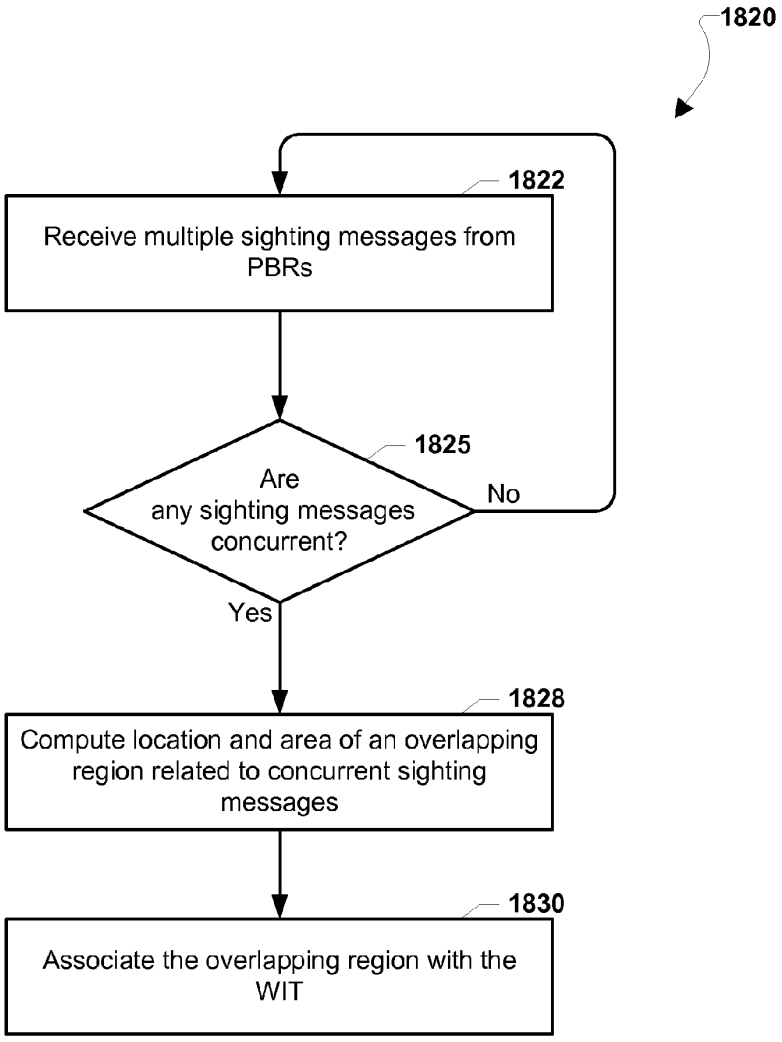

1820
1822
Receive multiple sighting messages from PBRs
1825
Are any sighting messages concurrent?
No
Yes
1828
Compute location and area of an overlapping region related to concurrent sighting messages
1830
Associate the overlapping region with the WIT

FIG. 18B

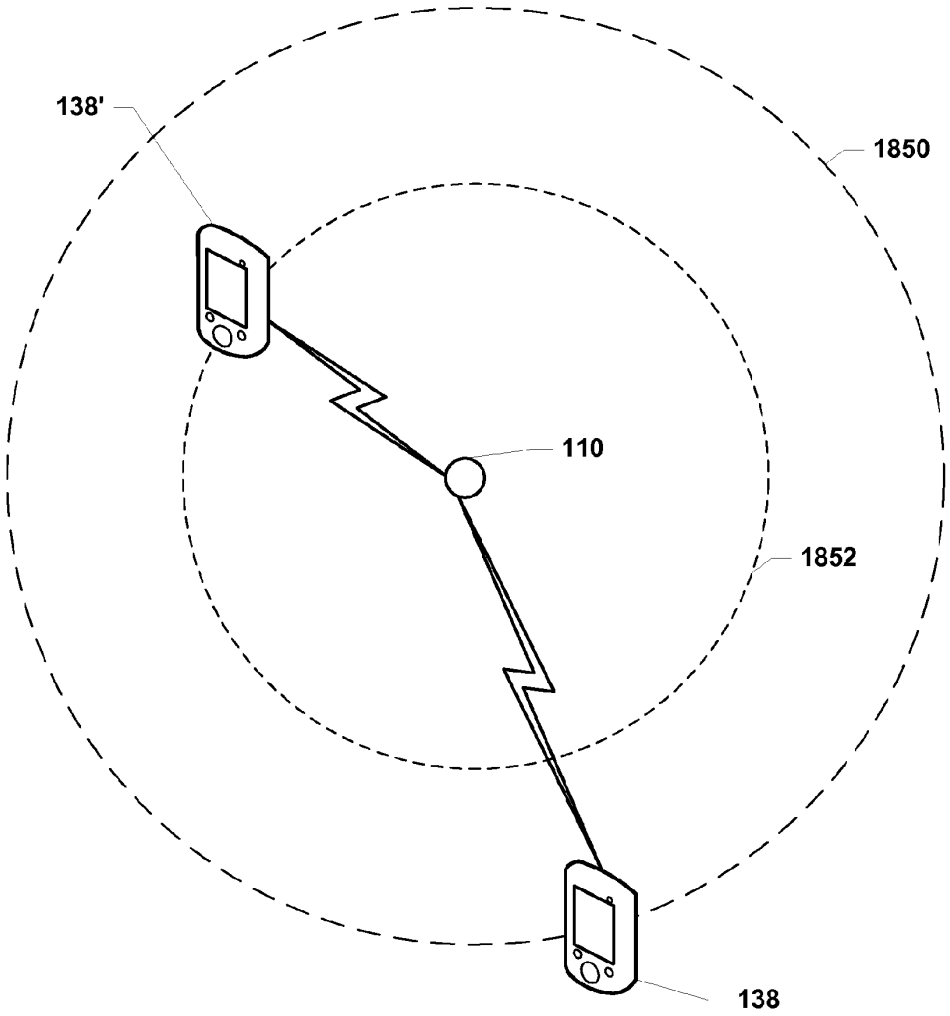


FIG. 18C

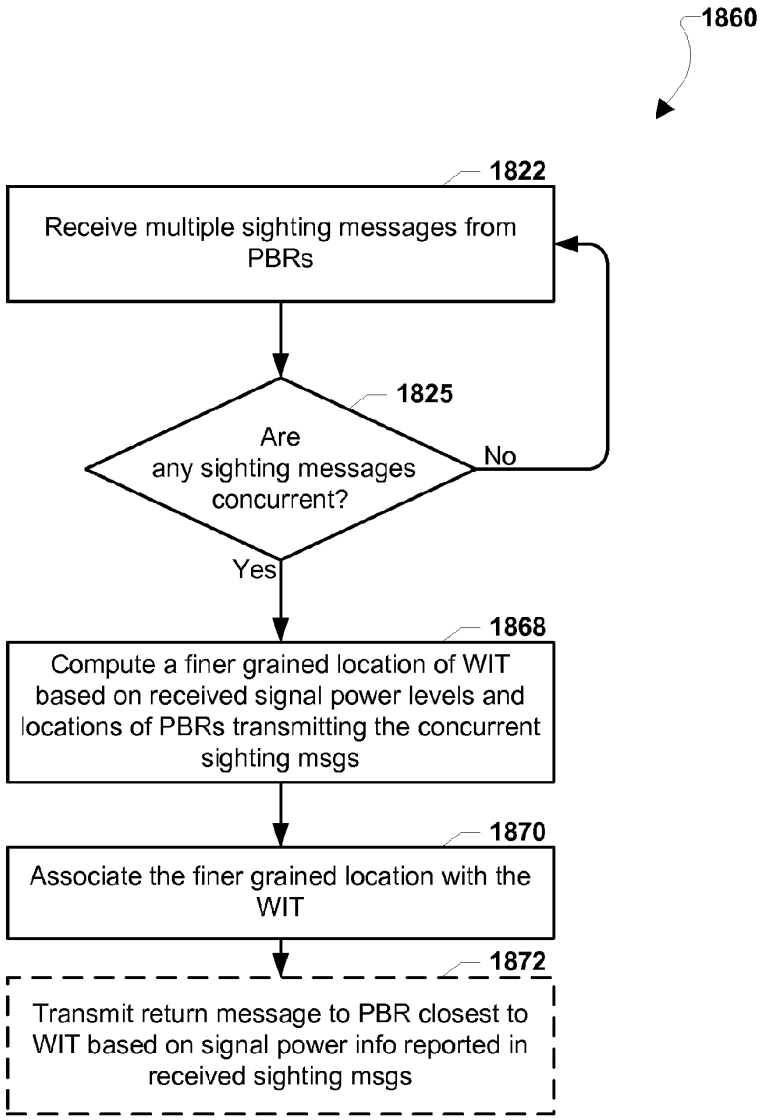

1860
1822
Receive multiple sighting messages from PBRs
1825
Are any sighting messages concurrent?
No
Yes
1868
Compute a finer grained location of WIT based on received signal power levels and locations of PBRs transmitting the concurrent sighting msgs
1870
Associate the finer grained location with the WIT
1872
Transmit return message to PBR closest to WIT based on signal power info reported in received sighting msgs

FIG. 18D

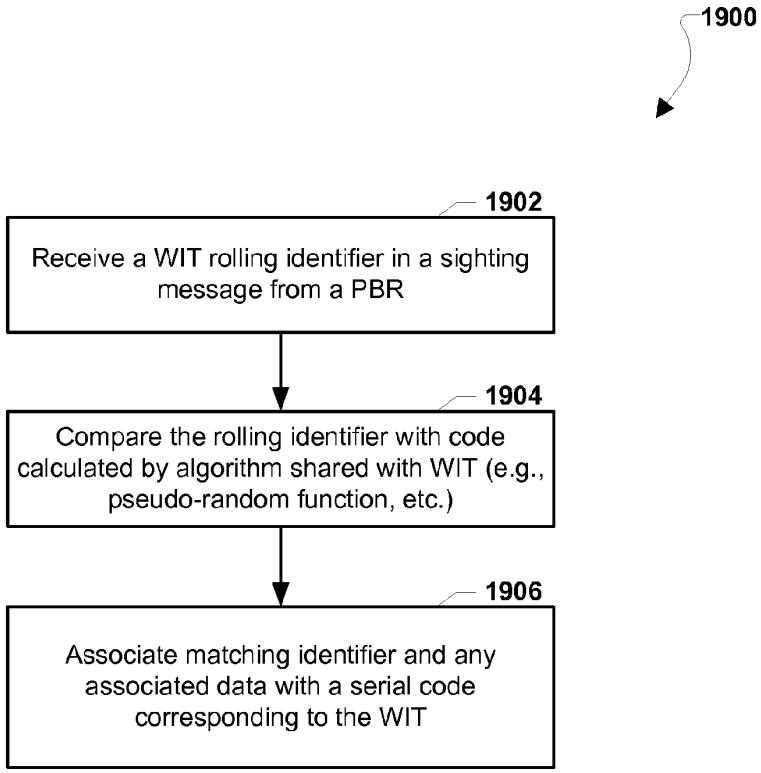

1900
1902
Receive a WIT rolling identifier in a sighting message from a PBR
1904
Compare the rolling identifier with code calculated by algorithm shared with WIT (e.g., pseudo-random function, etc.)
1906
Associate matching identifier and any associated data with a serial code corresponding to the WIT

FIG. 19

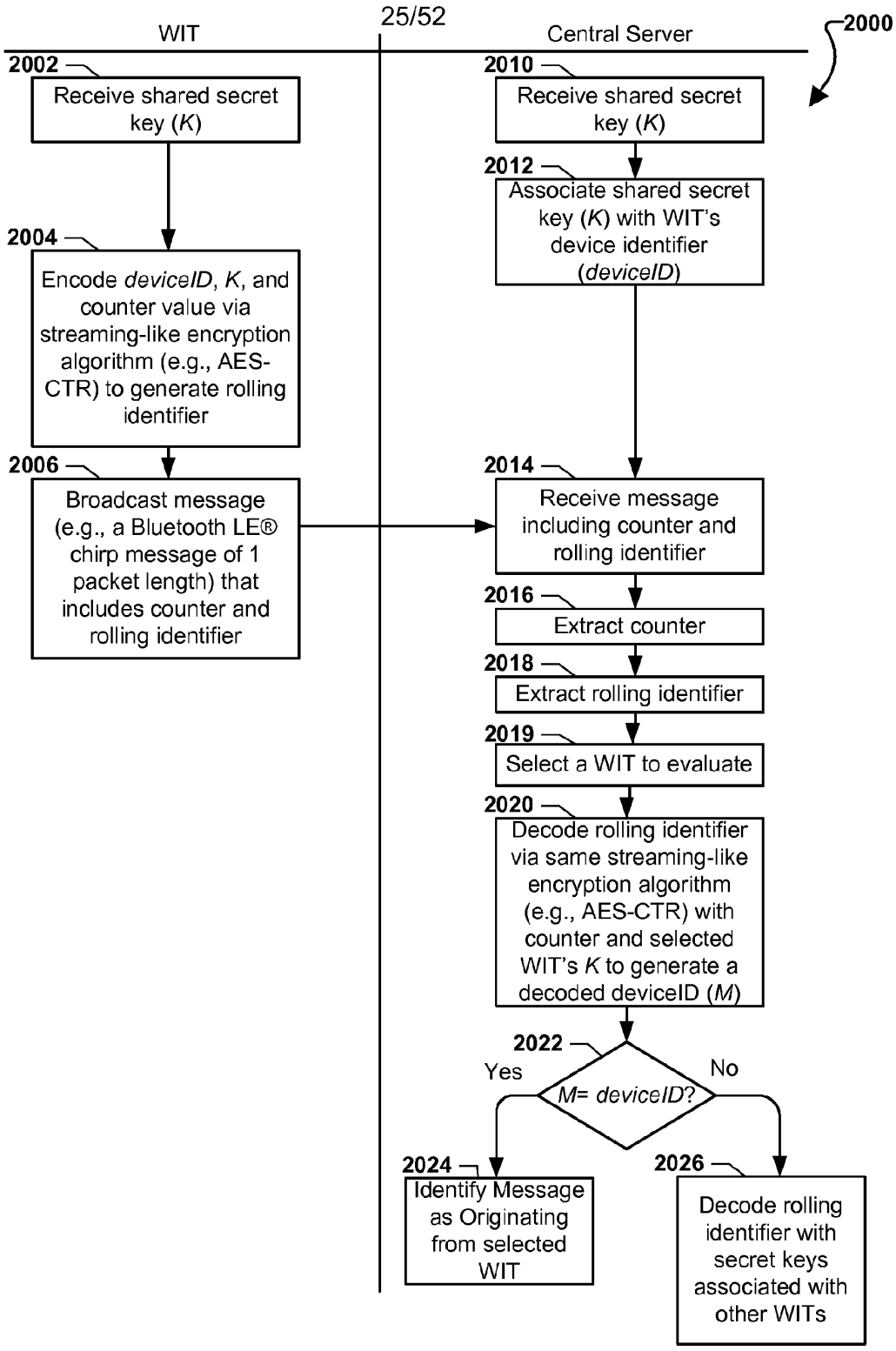


FIG. 20

Petitioner Samsung Ex-1004, 0631

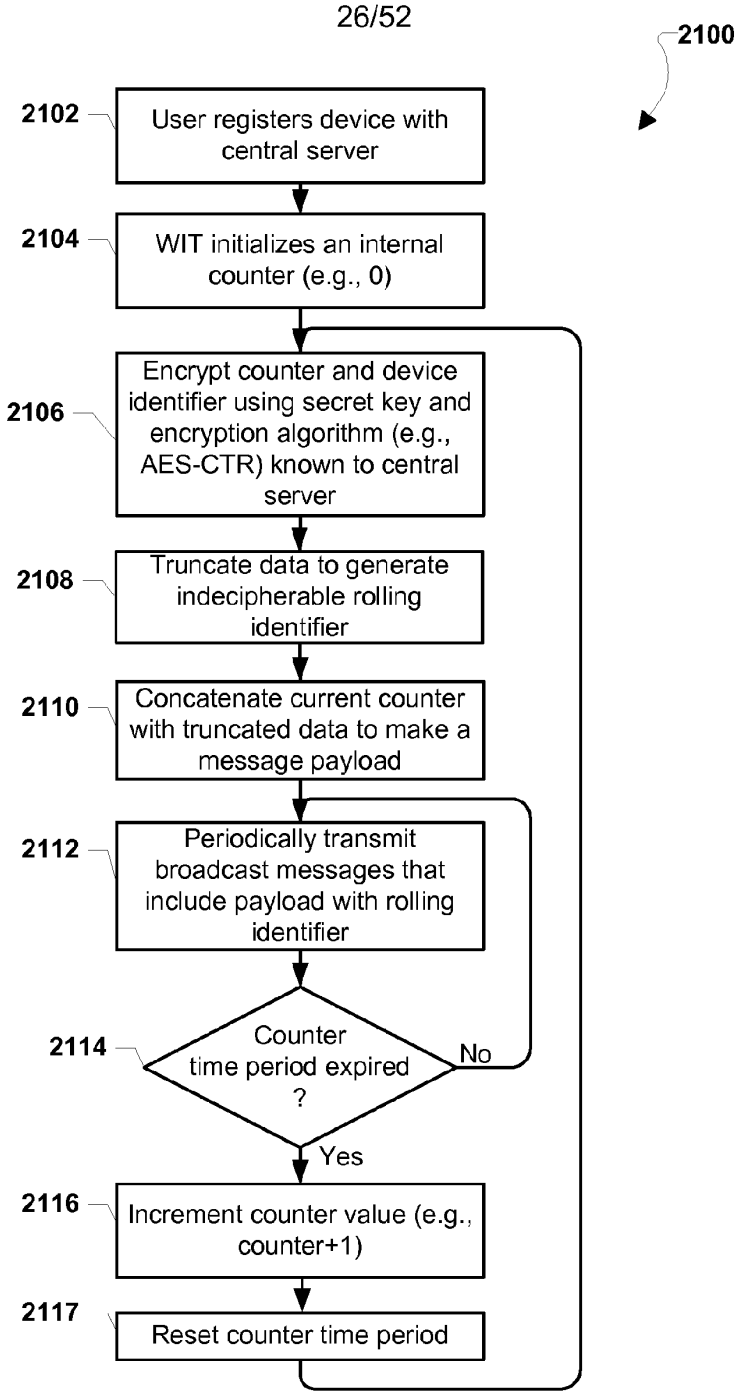

2100
2102
User registers device with central server
2104
WIT initializes an internal counter (e.g., 0)
2106
Encrypt counter and device identifier using secret key and encryption algorithm (e.g., AES-CTR) known to central server
2108
Truncate data to generate indecipherable rolling identifier
2110
Concatenate current counter with truncated data to make a message payload
2112
Periodically transmit broadcast messages that include payload with rolling identifier
2114
Counter time period expired ?
No
Yes
2116
Increment counter value (e.g., counter+1)
2117
Reset counter time period

FIG. 21A

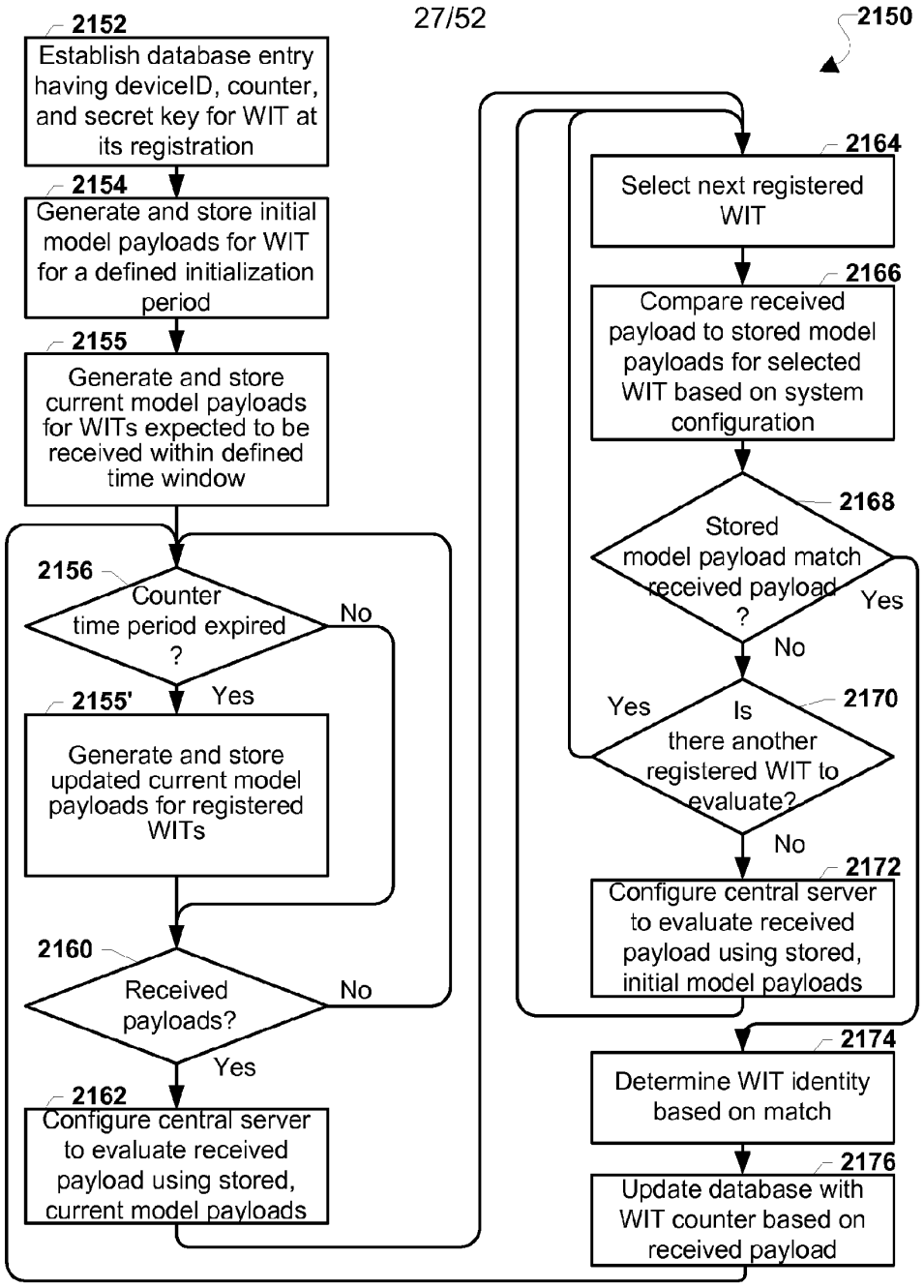

2150
2152
Establish database entry having deviceID, counter, and secret key for WIT at its registration
2154
Generate and store initial model payloads for WIT for a defined initialization period
2155
Generate and store current model payloads for WITs expected to be received within defined time window
2156
Counter time period expired ?
No
Yes
2155'
Generate and store updated current model payloads for registered WITs
2160
Received payloads?
No
Yes
2162
Configure central server to evaluate received payload using stored, current model payloads
2164
Select next registered WIT
2166
Compare received payload to stored model payloads for selected WIT based on system configuration
2168
Stored model payload match received payload ?
Yes
No
Yes
2170
Is there another registered WIT to evaluate?
No
2172
Configure central server to evaluate received payload using stored, initial model payloads
2174
Determine WIT identity based on match
2176
Update database with WIT counter based on received payload

FIG. 21B

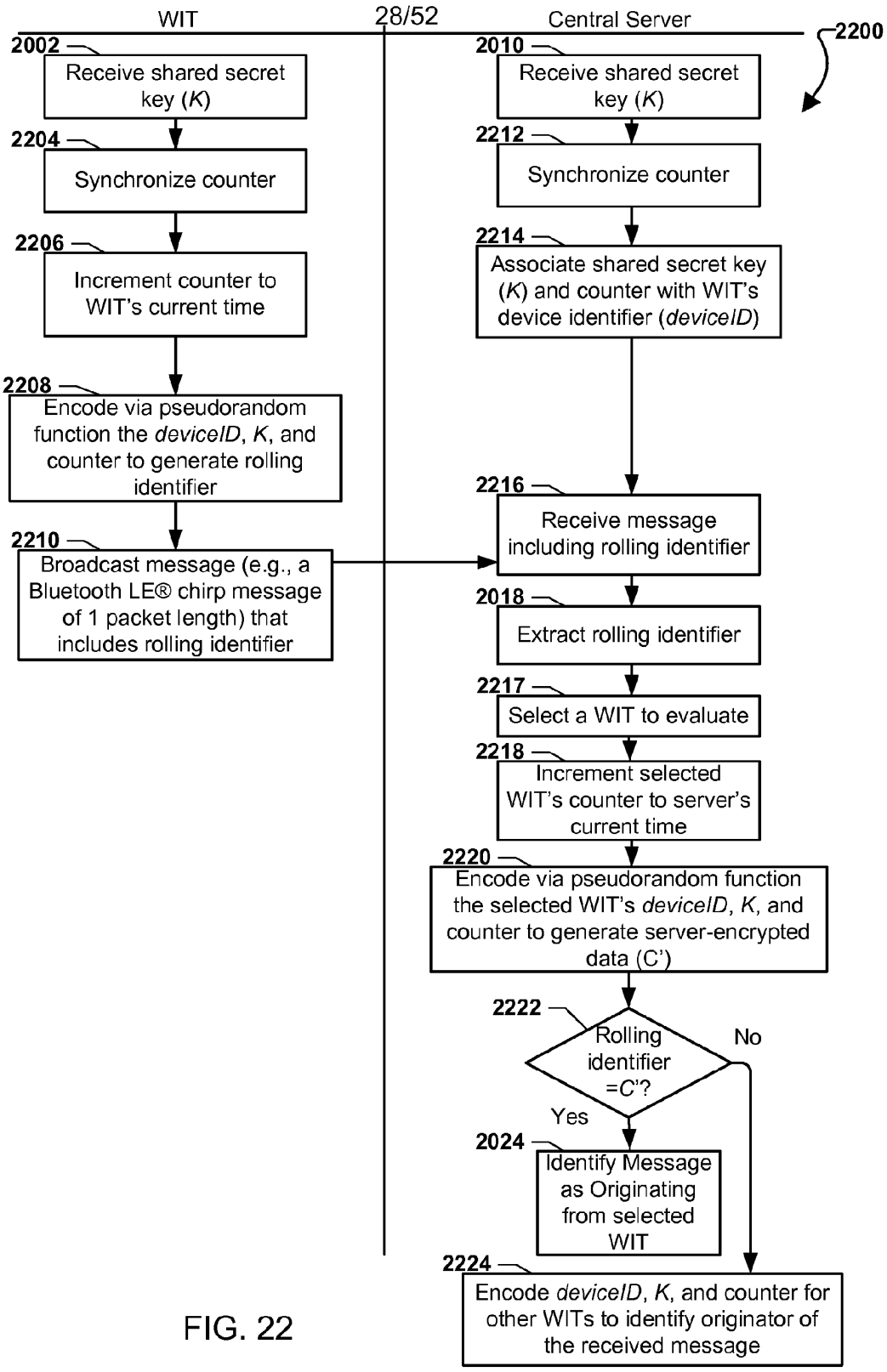

WIT
Central Server
2200
2002
Receive shared secret key (K)
2204
Synchronize counter
2206
Increment counter to WIT's current time
2208
Encode via pseudorandom function the deviceID, K, and counter to generate rolling identifier
2210
Broadcast message (e.g., a Bluetooth LE® chirp message of 1 packet length) that includes rolling identifier
2010
Receive shared secret key (K)
2212
Synchronize counter
2214
Associate shared secret key (K) and counter with WIT's device identifier (deviceID)
2216
Receive message including rolling identifier
2018
Extract rolling identifier
2217
Select a WIT to evaluate
2218
Increment selected WIT's counter to server's current time
2220
Encode via pseudorandom function the selected WIT's deviceID, K, and counter to generate server-encrypted data (C')
2222
Rolling identifier =C'?
No
Yes
2024
Identify Message as Originating from selected WIT
2224
Encode deviceID, K, and counter for other WITs to identify originator of the received message

FIG. 22

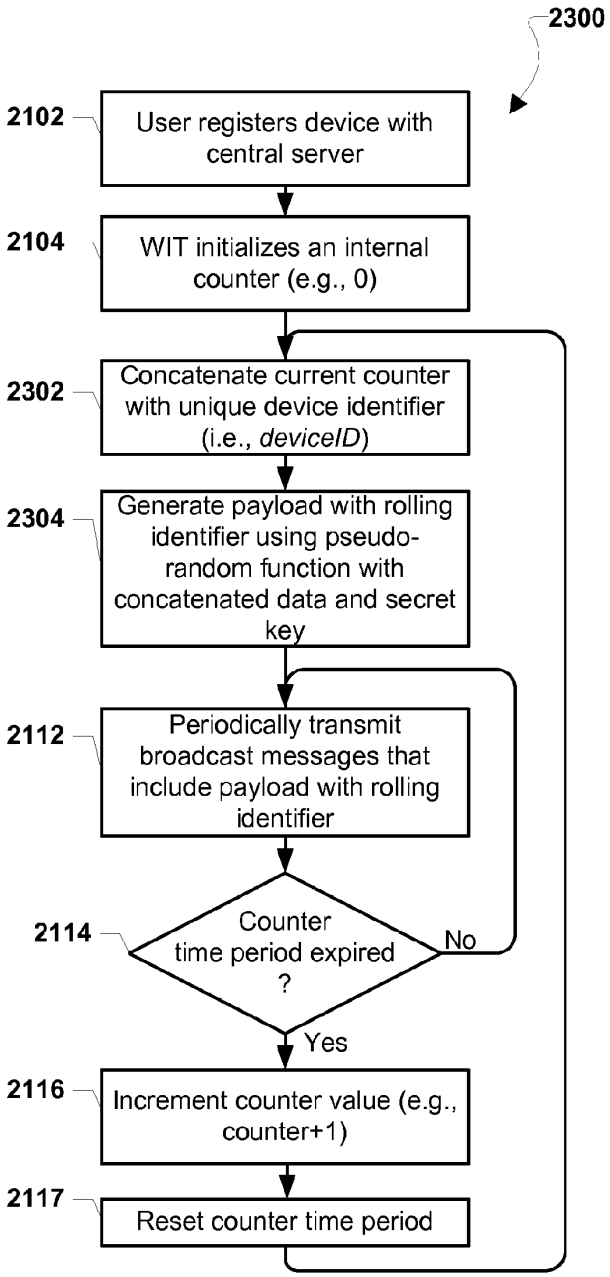

2300
2102
User registers device with central server
2104
WIT initializes an internal counter (e.g., 0)
2302
Concatenate current counter with unique device identifier (i.e., deviceID)
2304
Generate payload with rolling identifier using pseudo-random function with concatenated data and secret key
2112
Periodically transmit broadcast messages that include payload with rolling identifier
2114
Counter time period expired ?
No
Yes
2116
Increment counter value (e.g., counter+1)
2117
Reset counter time period

FIG. 23A

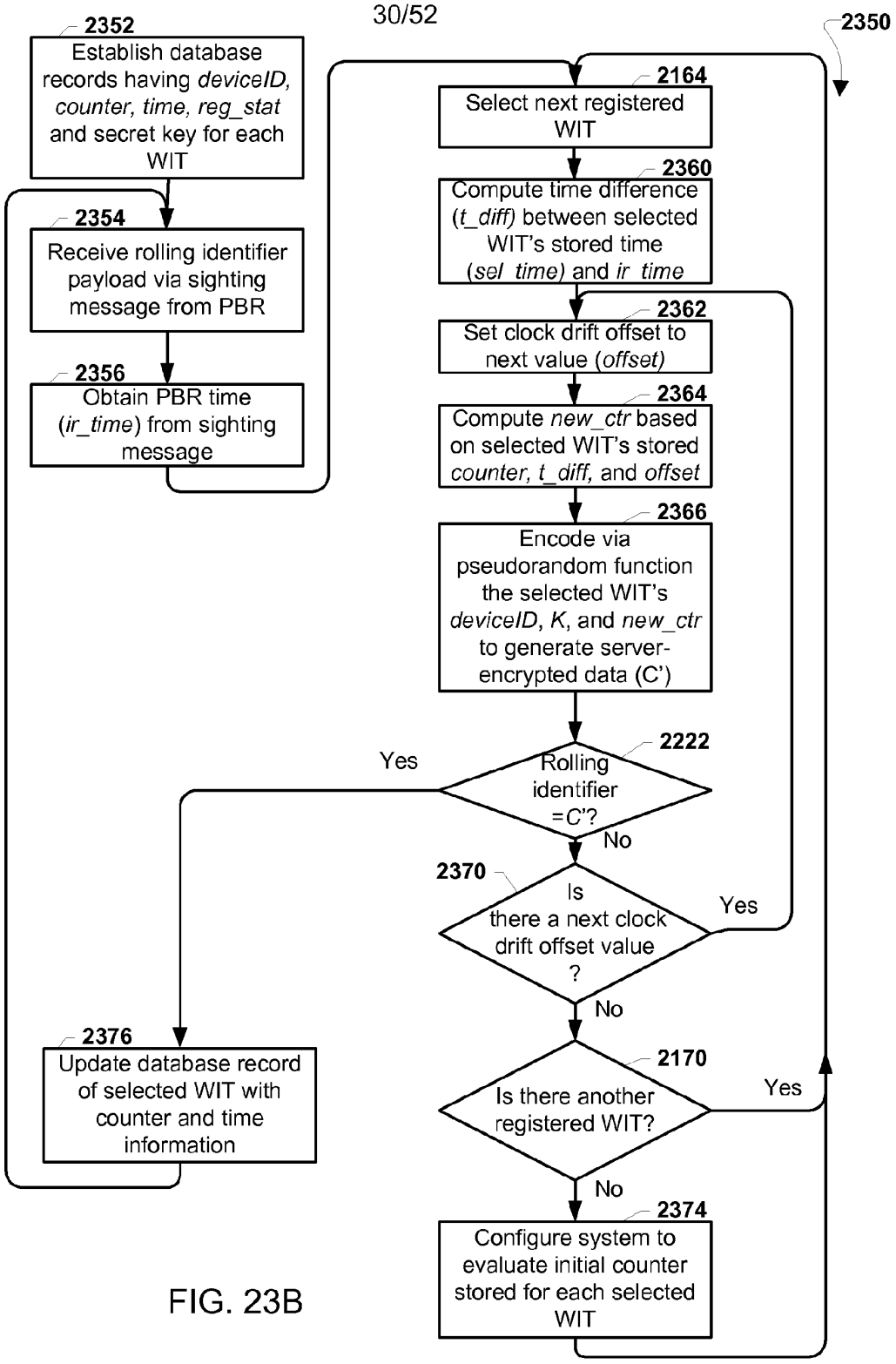

2352
Establish database records having deviceID, counter, time, reg_stat and secret key for each WIT
2354
Receive rolling identifier payload via sighting message from PBR
2356
Obtain PBR time (ir_time) from sighting message
2350
2164
Select next registered WIT
2360
Compute time difference (t_diff) between selected WIT's stored time (sel_time) and ir_time
2362
Set clock drift offset to next value (offset)
2364
Compute new_ctr based on selected WIT's stored counter, t_diff, and offset
2366
Encode via pseudorandom function the selected WIT's deviceID, K, and new_ctr to generate server-encrypted data (C')
2222
Rolling identifier =C'?
Yes
No
2370
Is there a next clock drift offset value ?
Yes
No
2170
Is there another registered WIT?
Yes
No
2374
Configure system to evaluate initial counter stored for each selected WIT
2376
Update database record of selected WIT with counter and time information

FIG. 23B

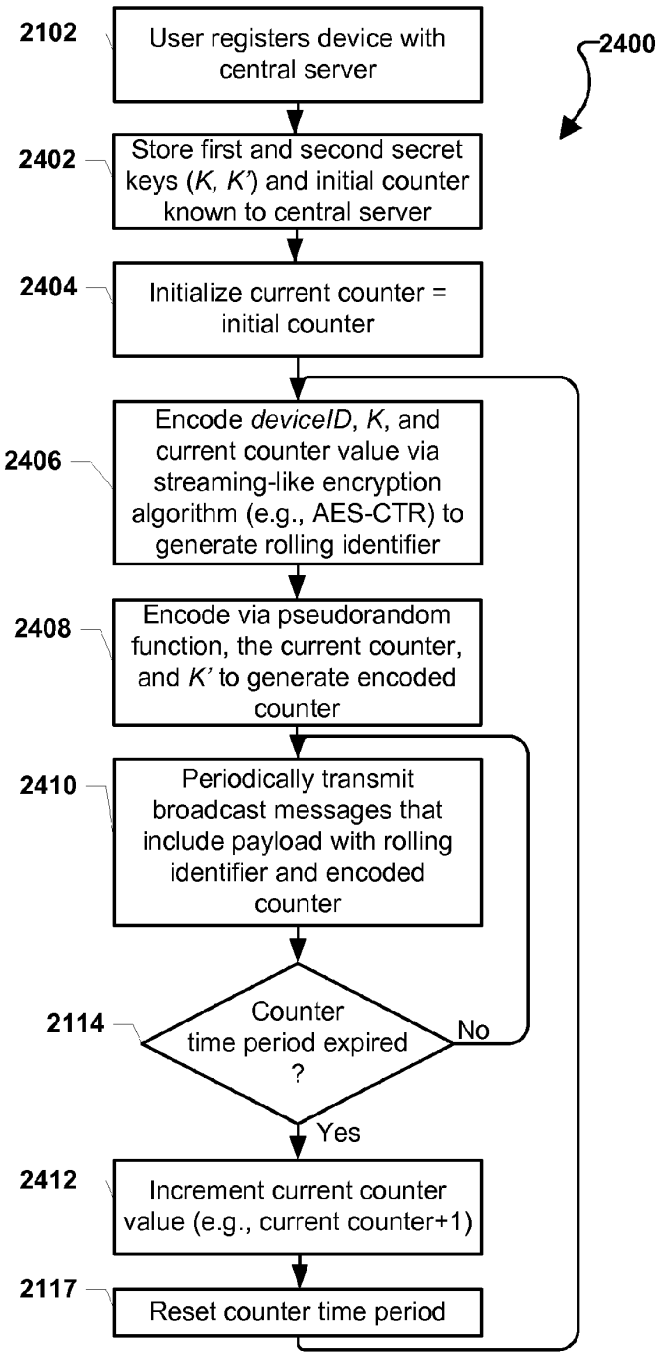

2102
User registers device with central server
2400
2402
Store first and second secret keys (K, K') and initial counter known to central server
2404
Initialize current counter = initial counter
2406
Encode deviceID, K, and current counter value via streaming-like encryption algorithm (e.g., AES-CTR) to generate rolling identifier
2408
Encode via pseudorandom function, the current counter, and K' to generate encoded counter
2410
Periodically transmit broadcast messages that include payload with rolling identifier and encoded counter
2114
Counter time period expired ?
No
Yes
2412
Increment current counter value (e.g., current counter+1)
2117
Reset counter time period

FIG. 24A

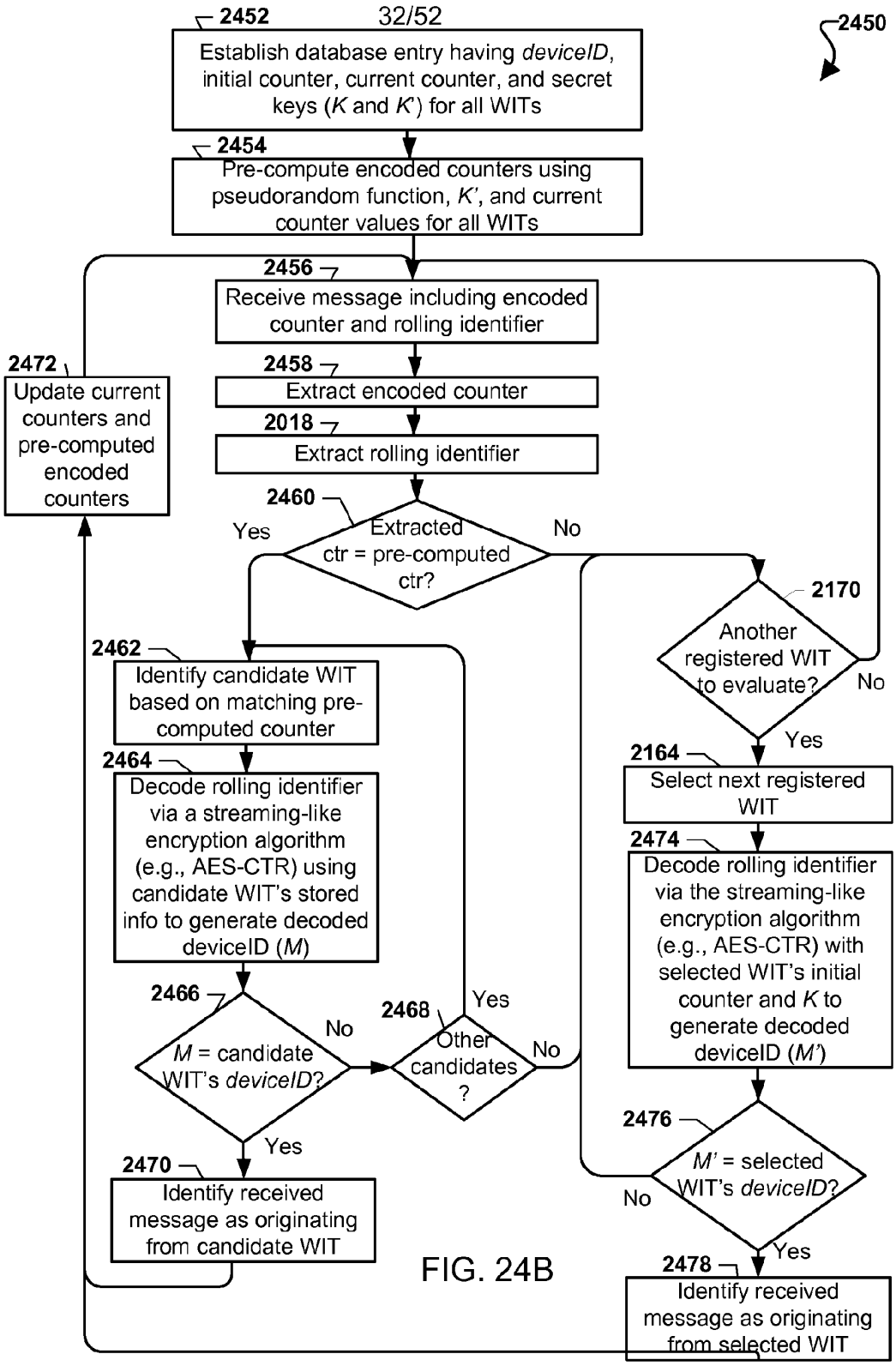

2450
2452
Establish database entry having deviceID, initial counter, current counter, and secret keys (K and K') for all WITs
2454
Pre-compute encoded counters using pseudorandom function, K', and current counter values for all WITs
2456
Receive message including encoded counter and rolling identifier
2458
Extract encoded counter
2018
Extract rolling identifier
2460
Extracted ctr = pre-computed ctr?
Yes
No
2472
Update current counters and pre-computed encoded counters
2462
Identify candidate WIT based on matching pre-computed counter
2464
Decode rolling identifier via a streaming-like encryption algorithm (e.g., AES-CTR) using candidate WIT's stored info to generate decoded deviceID (M)
2466
M = candidate WIT's deviceID?
No
Yes
2468
Other candidates ?
Yes
No
2470
Identify received message as originating from candidate WIT
2170
Another registered WIT to evaluate?
No
Yes
2164
Select next registered WIT
2474
Decode rolling identifier via the streaming-like encryption algorithm (e.g., AES-CTR) with selected WIT's initial counter and K to generate decoded deviceID (M')
2476
M' = selected WIT's deviceID?
No
Yes
2478
Identify received message as originating from selected WIT

FIG. 24B

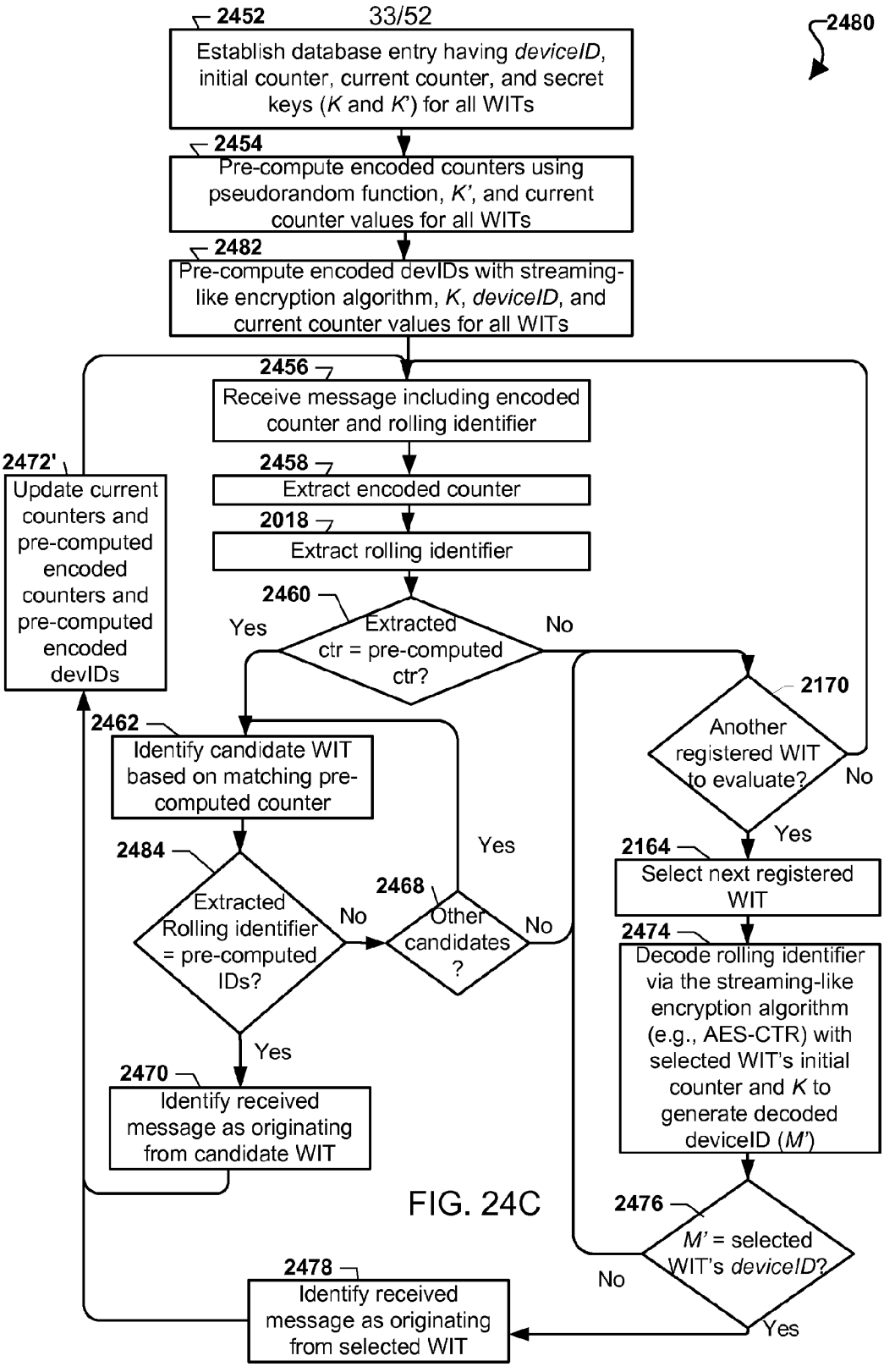


FIG. 24C

Petitioner Samsung Ex-1004, 0639

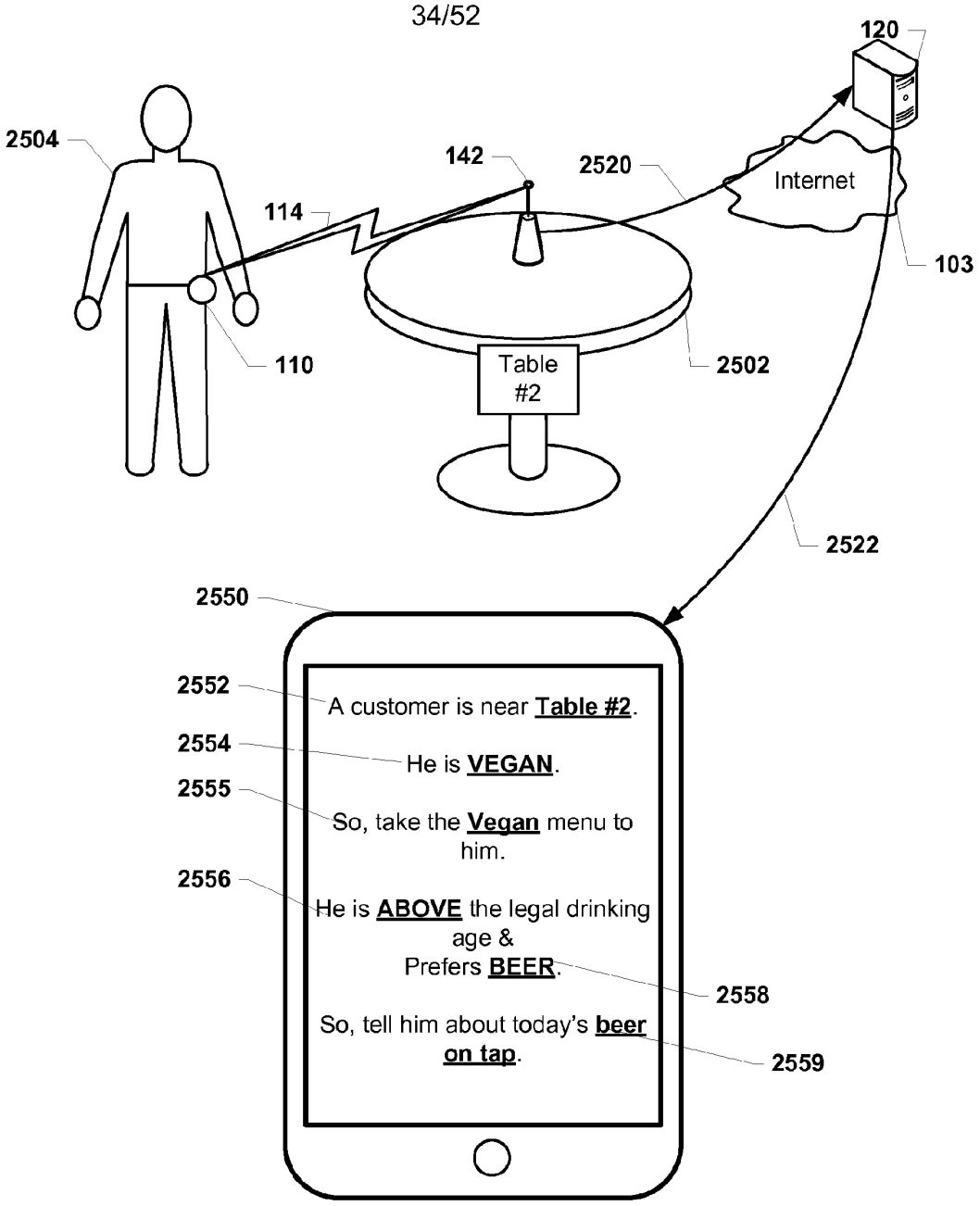

120
2504
142
2520
Internet
114
103
110
Table
#2
2502
2522
2550
2552
A customer is near Table #2.
2554
He is VEGAN.
2555
So, take the Vegan menu to
him.
2556
He is ABOVE the legal drinking
age &
Prefers BEER.
2558
So, tell him about today's beer
on tap.
2559

FIG. 25

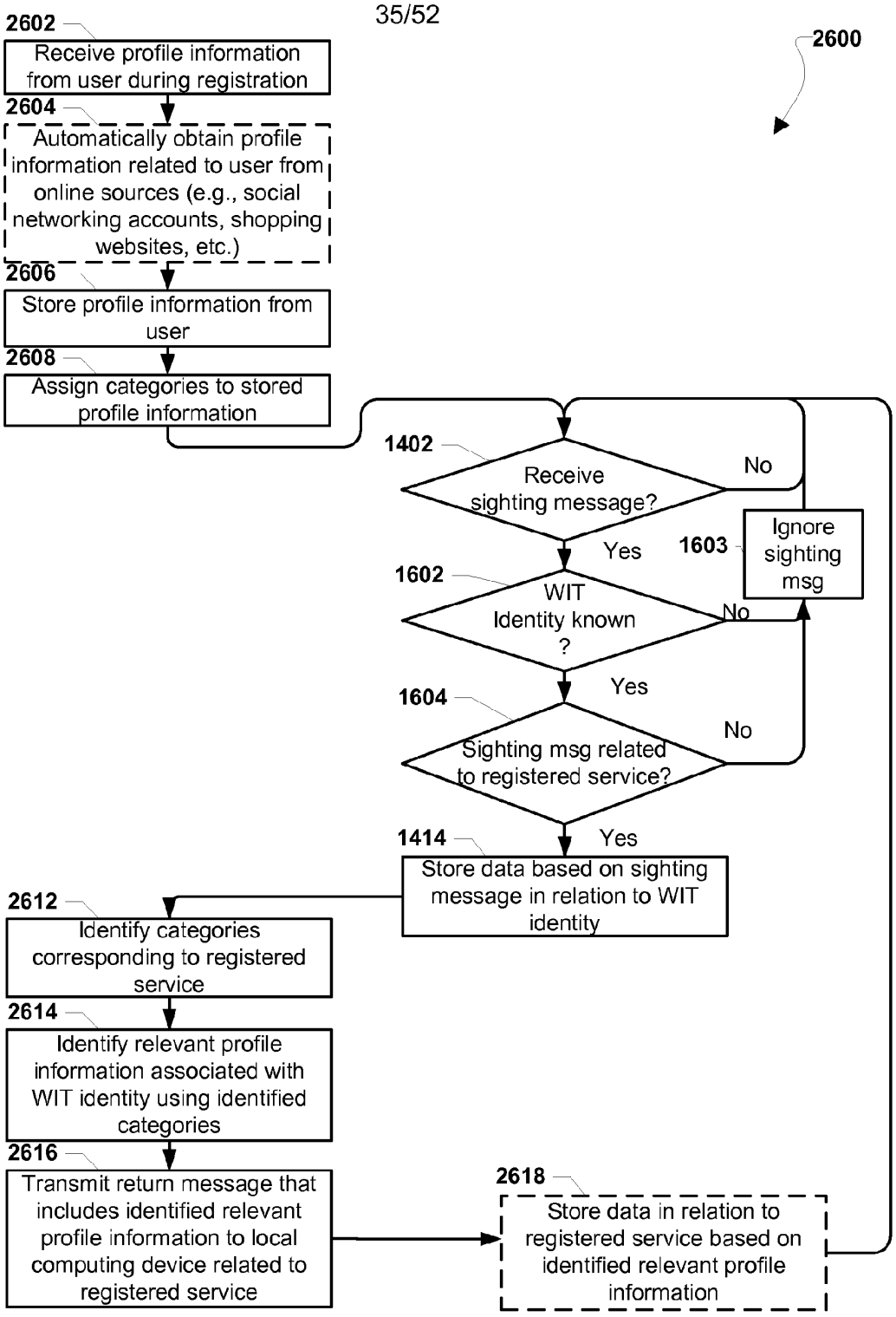

2600
2602
Receive profile information from user during registration
2604
Automatically obtain profile information related to user from online sources (e.g., social networking accounts, shopping websites, etc.)
2606
Store profile information from user
2608
Assign categories to stored profile information
1402
Receive sighting message?
No
Yes
1603
Ignore sighting msg
1602
WIT Identity known ?
No
Yes
1604
Sighting msg related to registered service?
No
Yes
1414
Store data based on sighting message in relation to WIT identity
2612
Identify categories corresponding to registered service
2614
Identify relevant profile information associated with WIT identity using identified categories
2616
Transmit return message that includes identified relevant profile information to local computing device related to registered service
2618
Store data in relation to registered service based on identified relevant profile information

FIG. 26A

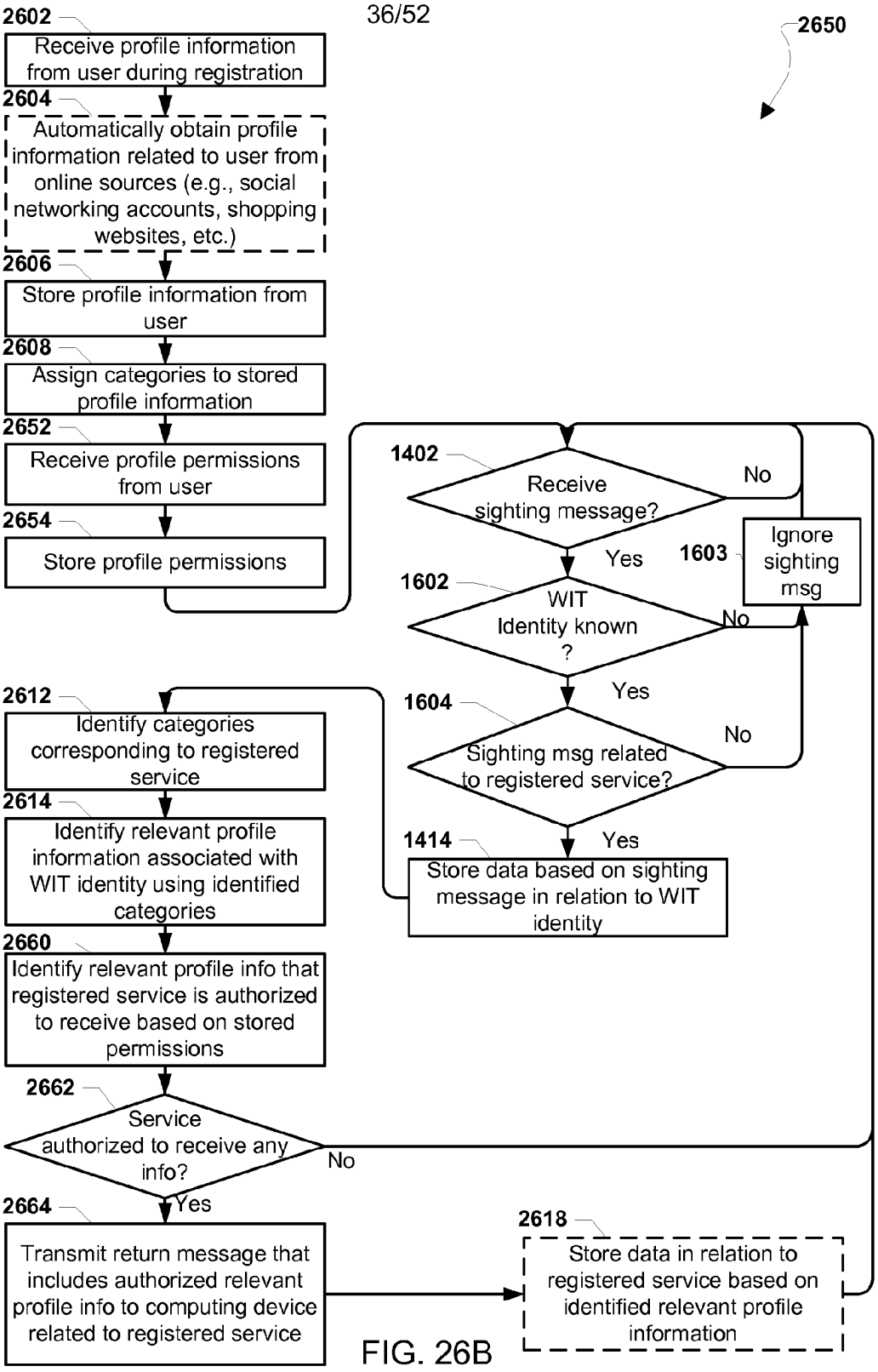

2650
2602
Receive profile information from user during registration
2604
Automatically obtain profile information related to user from online sources (e.g., social networking accounts, shopping websites, etc.)
2606
Store profile information from user
2608
Assign categories to stored profile information
2652
Receive profile permissions from user
2654
Store profile permissions
1402
Receive sighting message?
No
Yes
1603
Ignore sighting msg
1602
WIT Identity known ?
No
Yes
1604
Sighting msg related to registered service?
No
Yes
1414
Store data based on sighting message in relation to WIT identity
2612
Identify categories corresponding to registered service
2614
Identify relevant profile information associated with WIT identity using identified categories
2660
Identify relevant profile info that registered service is authorized to receive based on stored permissions
2662
Service authorized to receive any info?
No
Yes
2664
Transmit return message that includes authorized relevant profile info to computing device related to registered service
2618
Store data in relation to registered service based on identified relevant profile information

FIG. 26B

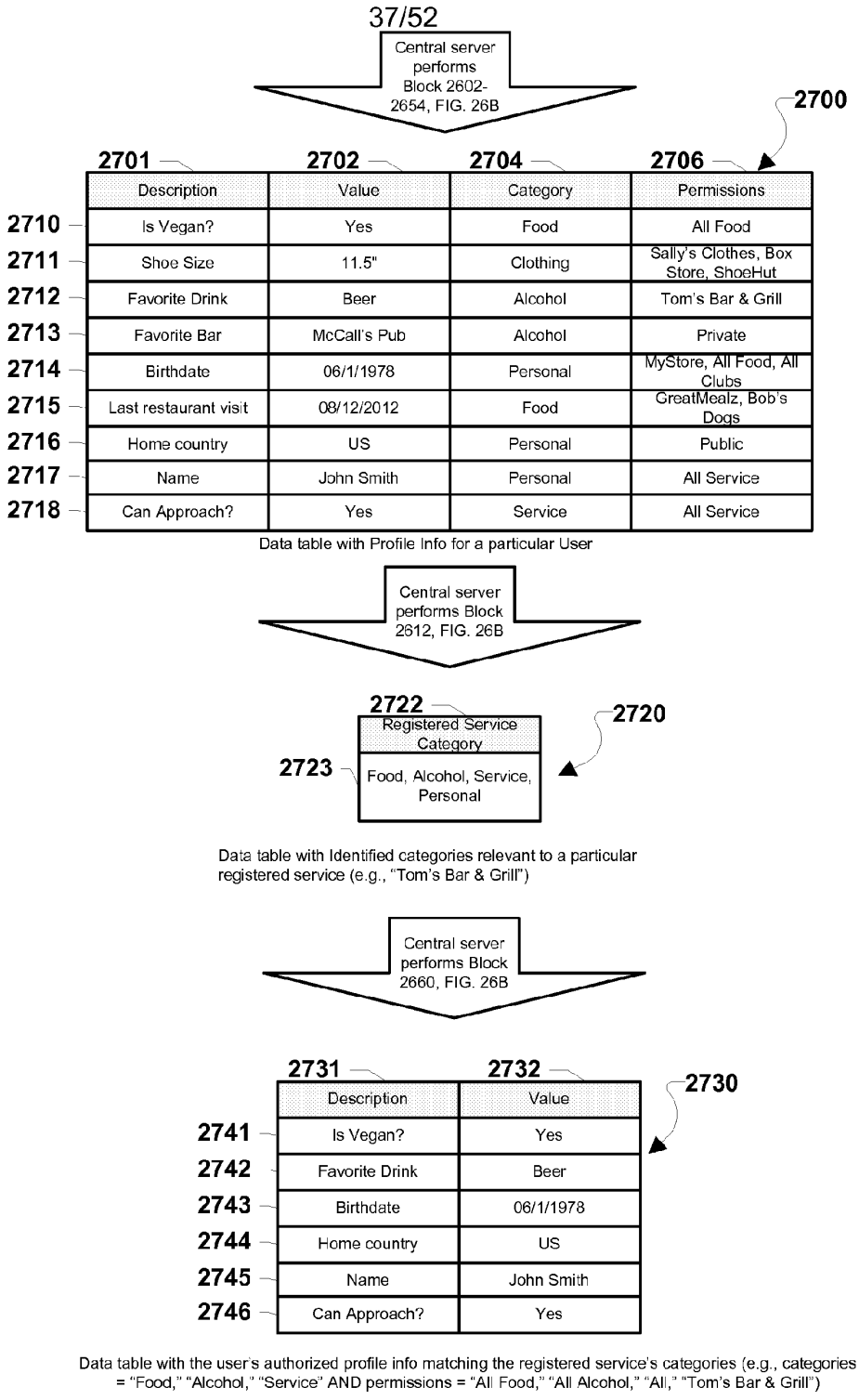

Central server performs Block 2602-2654, FIG. 26B
2700
2701
2702
2704
2706
Description
Value
Category
Permissions
2710
Is Vegan?
Yes
Food
All Food
2711
Shoe Size
11.5"
Clothing
Sally's Clothes, Box Store, ShoeHut
2712
Favorite Drink
Beer
Alcohol
Tom's Bar & Grill
2713
Favorite Bar
McCall's Pub
Alcohol
Private
2714
Birthdate
06/1/1978
Personal
MyStore, All Food, All Clubs
2715
Last restaurant visit
08/12/2012
Food
GreatMealz, Bob's Dogs
2716
Home country
US
Personal
Public
2717
Name
John Smith
Personal
All Service
2718
Can Approach?
Yes
Service
All Service
Data table with Profile Info for a particular User
Central server performs Block 2612, FIG. 26B
2722
Registered Service Category
2720
2723
Food, Alcohol, Service, Personal
Data table with Identified categories relevant to a particular registered service (e.g., "Tom's Bar & Grill")
Central server performs Block 2660, FIG. 26B
2731
2732
2730
Description
Value
2741
Is Vegan?
Yes
2742
Favorite Drink
Beer
2743
Birthdate
06/1/1978
2744
Home country
US
2745
Name
John Smith
2746
Can Approach?
Yes
Data table with the user's authorized profile info matching the registered service's categories (e.g., categories = "Food," "Alcohol," "Service" AND permissions = "All Food," "All Alcohol," "All," "Tom's Bar & Grill")

FIG. 27A

2750

Info	Value	Category	Permissions
Clothing Sizes: Shirt	XXL, 17.5, 34-35	Clothing	The Nice Shop, Dr. Mens
Clothing Sizes: Shoe	11.5"	Clothing, Shoes	Sally's Clothes, Box Store, ShoeHut
Clothing Sizes: Waist	34	Clothing	PRIVATE
Clothing Sizes: Inseam	32	Clothing	Dr. Mens
Food Preference: Meat	None	Food	All Food
Beverage Preference: Beer	IPA, BrandX, "TopShelf" Brewery	Food, Beverage, Alcohol	All Food, All Bars
Beverage Preference: Wine	Merlot, "Tbird" Wineries	Food, Beverage, Alcohol	MyStore, All Food, All Clubs
Beverage Preference: Hot Drinks	Chai Latte w/ soy	Food, Beverage	GreatMealz, Bob's Dogs
Food Alergies	Chocolate	Food	All Food, Medical
My Interests for matching purposes	Sports, anime, history	Interests	PUBLIC

FIG. 27B

FIG. 28A

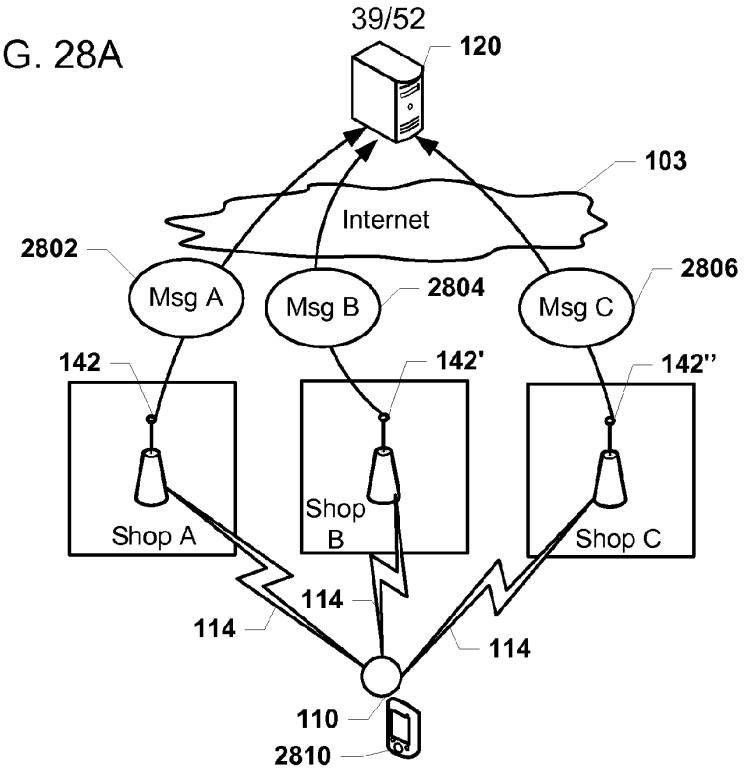
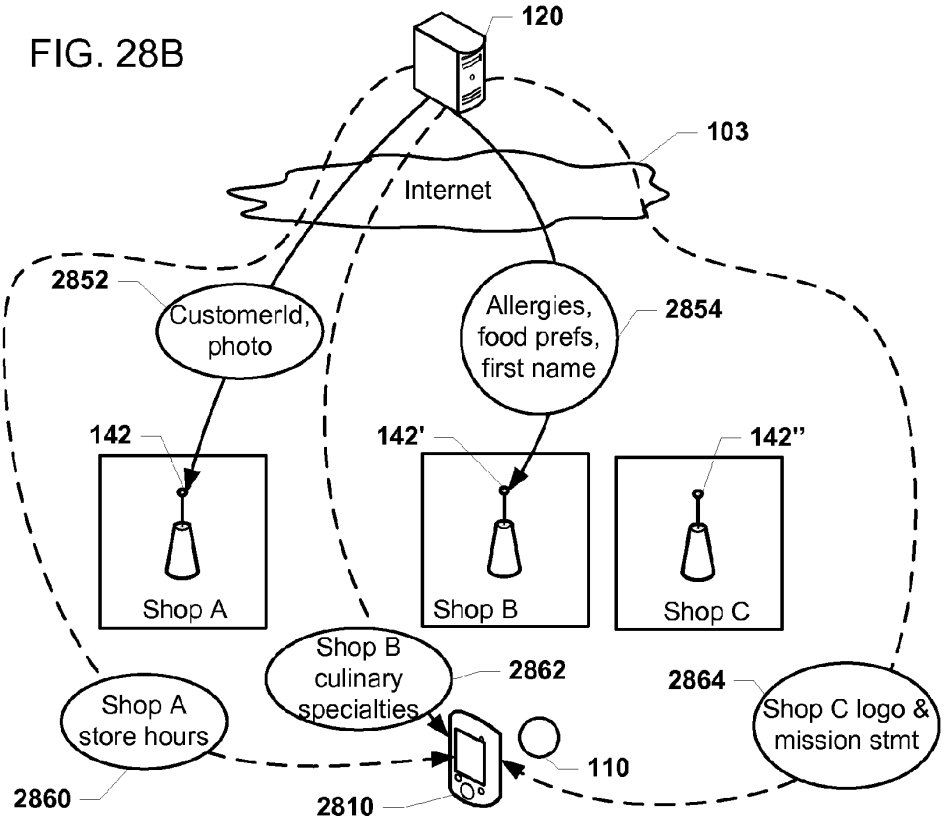


FIG. 28B



Petitioner Samsung Ex-1004, 0645

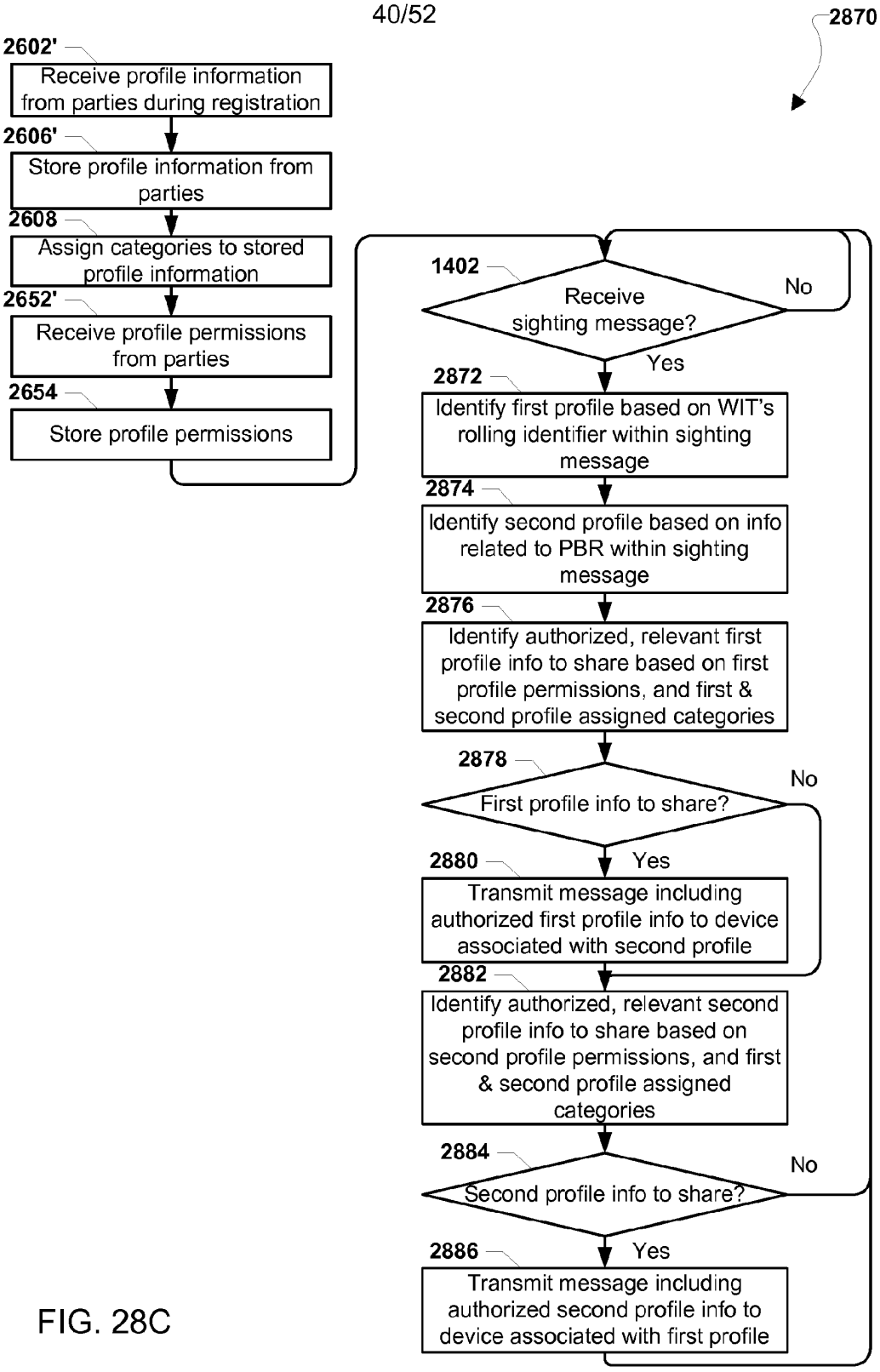

2870
2602'
Receive profile information from parties during registration
2606'
Store profile information from parties
2608
Assign categories to stored profile information
2652'
Receive profile permissions from parties
2654
Store profile permissions
1402
Receive sighting message?
No
Yes
2872
Identify first profile based on WIT's rolling identifier within sighting message
2874
Identify second profile based on info related to PBR within sighting message
2876
Identify authorized, relevant first profile info to share based on first profile permissions, and first & second profile assigned categories
2878
First profile info to share?
No
Yes
2880
Transmit message including authorized first profile info to device associated with second profile
2882
Identify authorized, relevant second profile info to share based on second profile permissions, and first & second profile assigned categories
2884
Second profile info to share?
No
Yes
2886
Transmit message including authorized second profile info to device associated with first profile

FIG. 28C

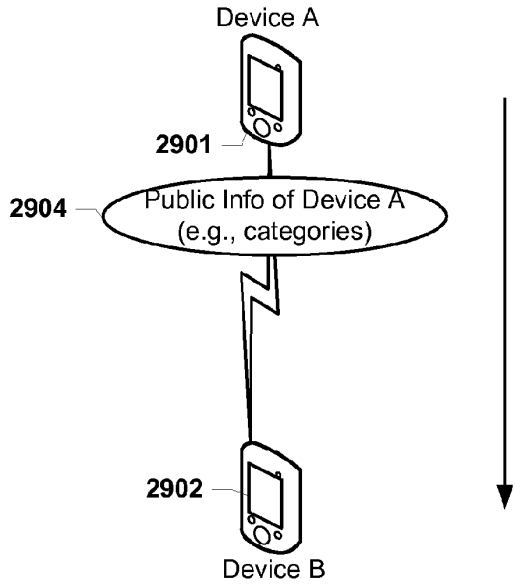


FIG. 29A

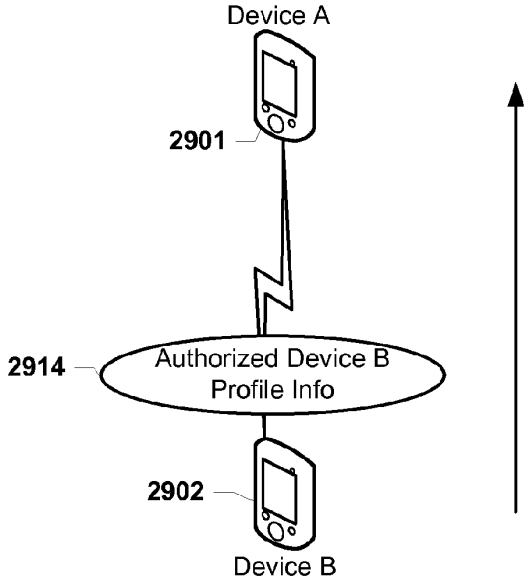


FIG. 29B

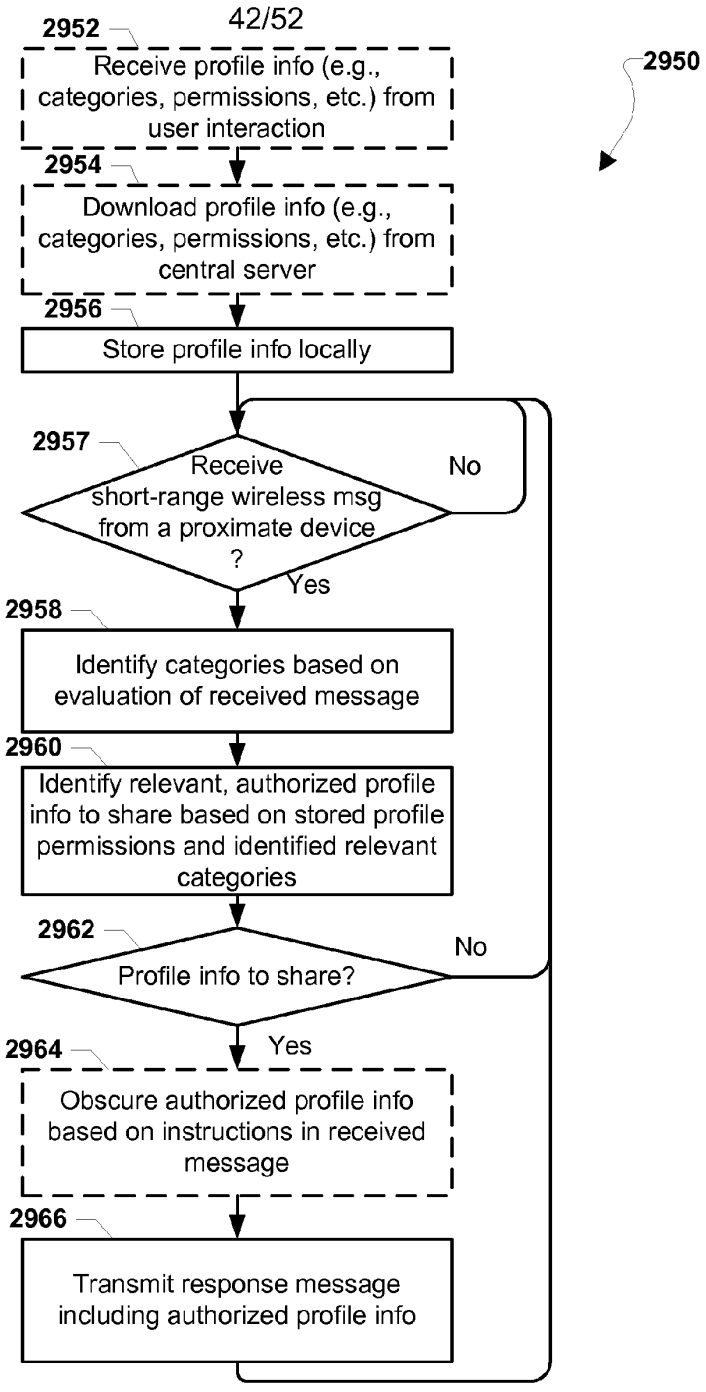

2950
2952
Receive profile info (e.g., categories, permissions, etc.) from user interaction
2954
Download profile info (e.g., categories, permissions, etc.) from central server
2956
Store profile info locally
2957
Receive short-range wireless msg from a proximate device ?
No
Yes
2958
Identify categories based on evaluation of received message
2960
Identify relevant, authorized profile info to share based on stored profile permissions and identified relevant categories
2962
Profile info to share?
No
Yes
2964
Obscure authorized profile info based on instructions in received message
2966
Transmit response message including authorized profile info

FIG. 29B

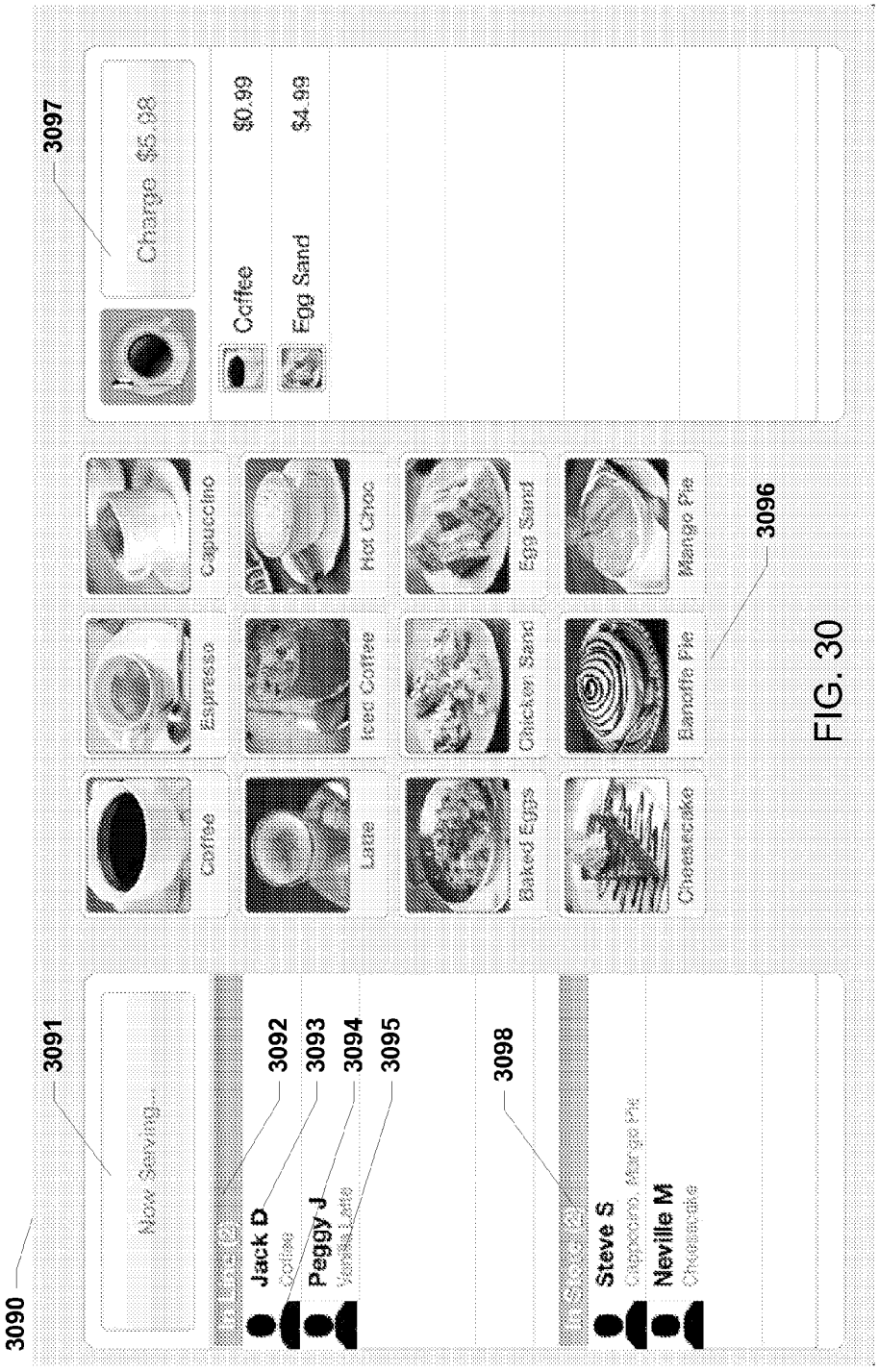

3090
3091
3092
3093
3094
3095
3096
3097
3098
Now Serving...
Jack D
Coffee
Peggy J
Vanilla Latte
Steve S
Cappuccino, Mango Pie
Neville M
Cheesecake
Coffee
Espresso
Cappuccino
Latte
Iced Coffee
Hot Choc
Baked Eggs
Chicken Sand
Egg Sand
Cheesecake
Banoffe Pie
Mango Pie
Charge $5.98
Coffee $0.99
Egg Sand $4.99

FIG. 30

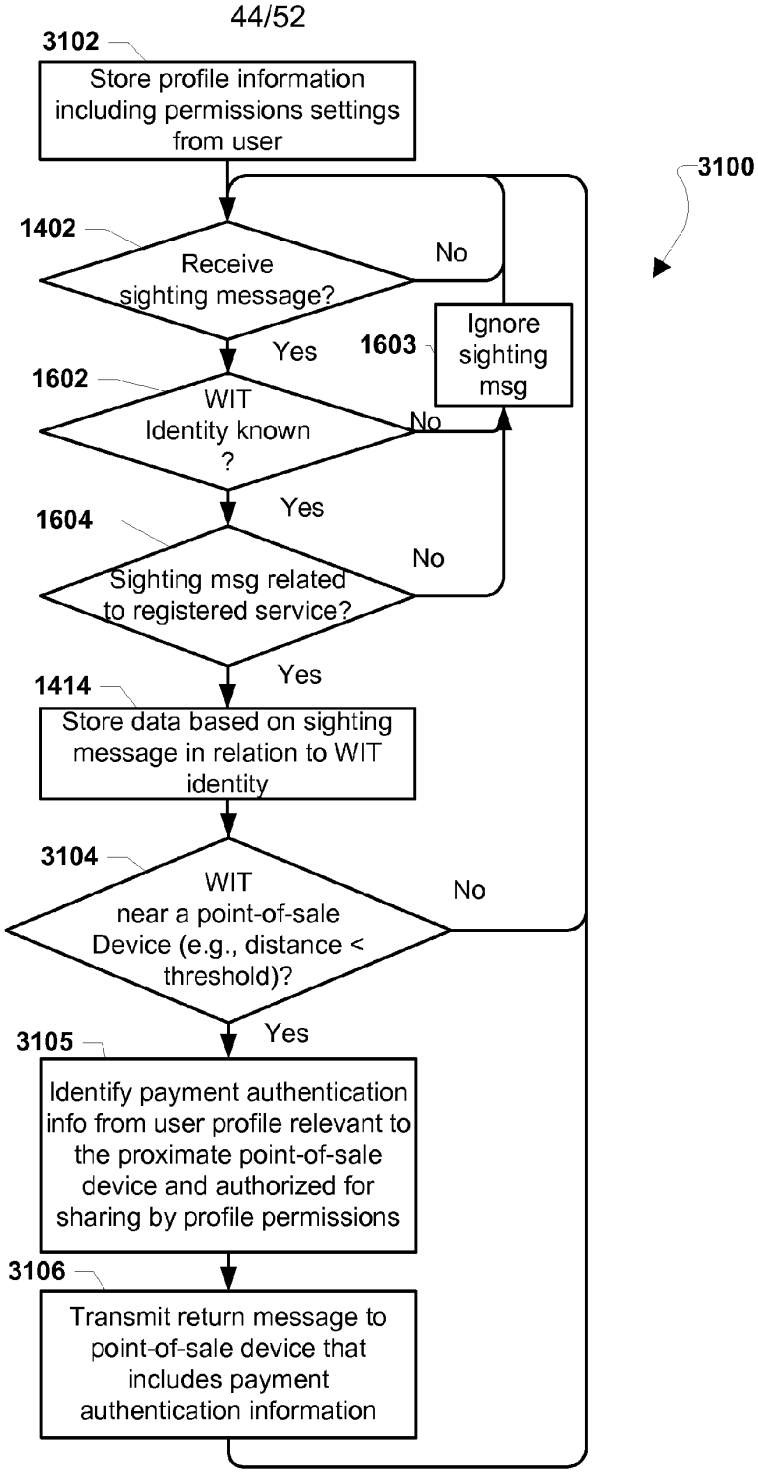

3102
Store profile information including permissions settings from user
3100
1402
Receive sighting message?
No
Yes
1603
Ignore sighting msg
1602
WIT Identity known ?
No
Yes
1604
Sighting msg related to registered service?
No
Yes
1414
Store data based on sighting message in relation to WIT identity
3104
WIT near a point-of-sale Device (e.g., distance < threshold)?
No
Yes
3105
Identify payment authentication info from user profile relevant to the proximate point-of-sale device and authorized for sharing by profile permissions
3106
Transmit return message to point-of-sale device that includes payment authentication information

FIG. 31

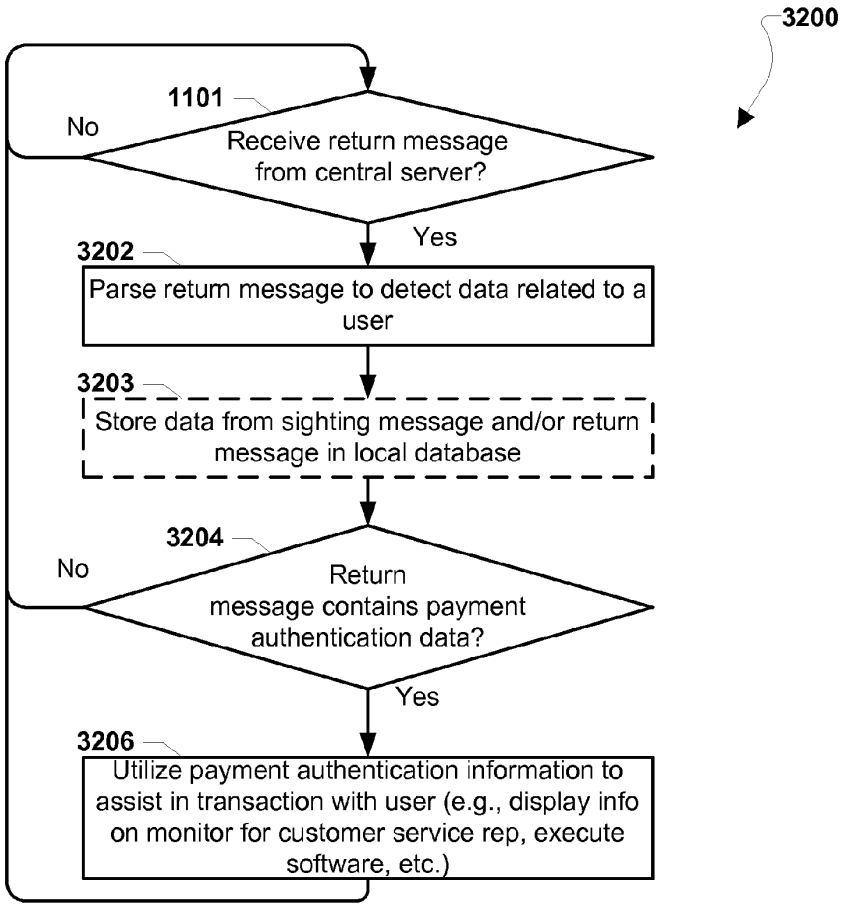

3200
1101
No
Receive return message from central server?
Yes
3202
Parse return message to detect data related to a user
3203
Store data from sighting message and/or return message in local database
3204
No
Return message contains payment authentication data?
Yes
3206
Utilize payment authentication information to assist in transaction with user (e.g., display info on monitor for customer service rep, execute software, etc.)

FIG. 32A

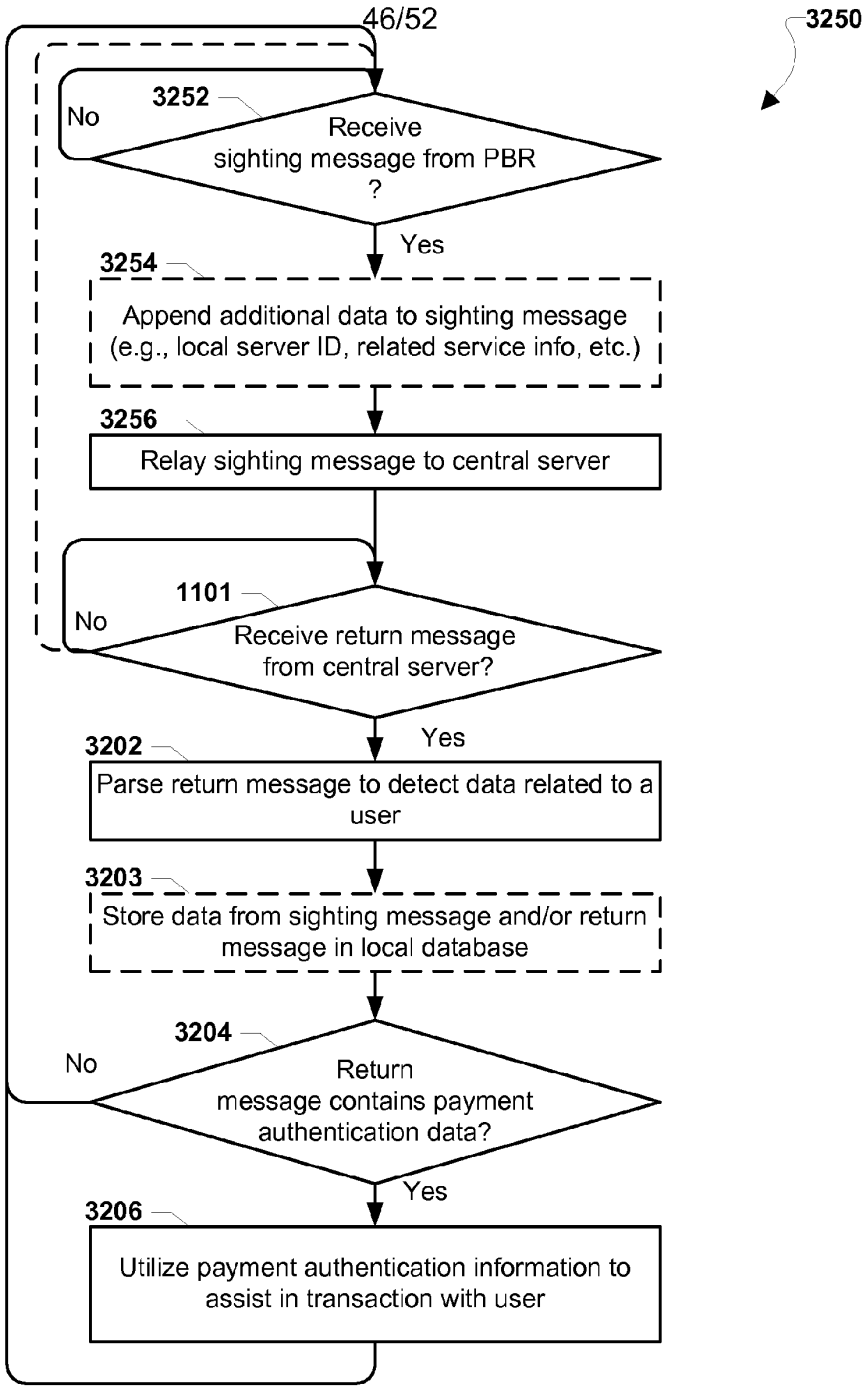

3250
3252
No
Receive sighting message from PBR ?
Yes
3254
Append additional data to sighting message (e.g., local server ID, related service info, etc.)
3256
Relay sighting message to central server
1101
No
Receive return message from central server?
Yes
3202
Parse return message to detect data related to a user
3203
Store data from sighting message and/or return message in local database
3204
No
Return message contains payment authentication data?
Yes
3206
Utilize payment authentication information to assist in transaction with user

FIG. 32B

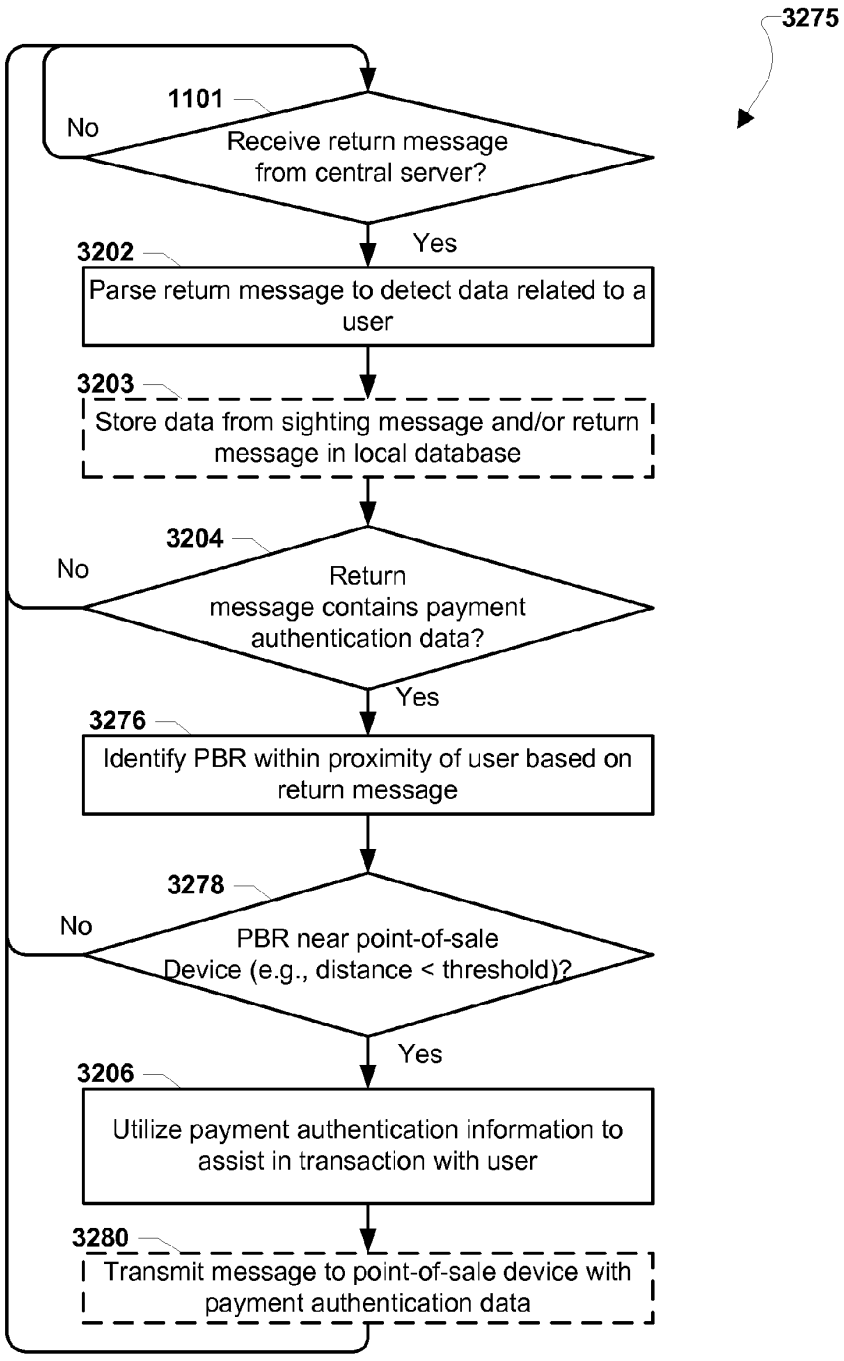

3275
1101
No
Receive return message from central server?
Yes
3202
Parse return message to detect data related to a user
3203
Store data from sighting message and/or return message in local database
3204
No
Return message contains payment authentication data?
Yes
3276
Identify PBR within proximity of user based on return message
3278
No
PBR near point-of-sale Device (e.g., distance < threshold)?
Yes
3206
Utilize payment authentication information to assist in transaction with user
3280
Transmit message to point-of-sale device with payment authentication data

FIG. 32C

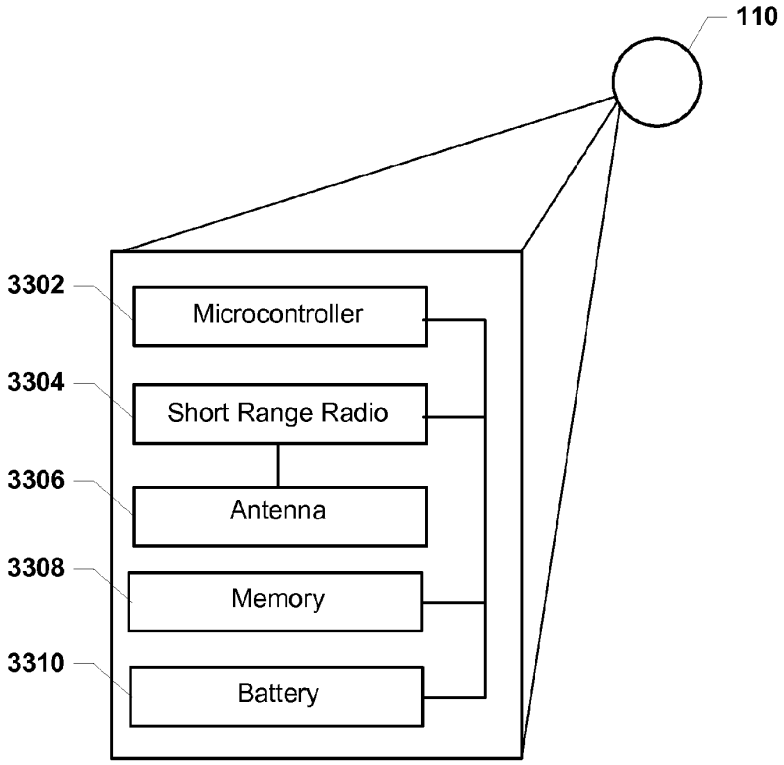

110
3302
Microcontroller
3304
Short Range Radio
3306
Antenna
3308
Memory
3310
Battery

FIG. 33A

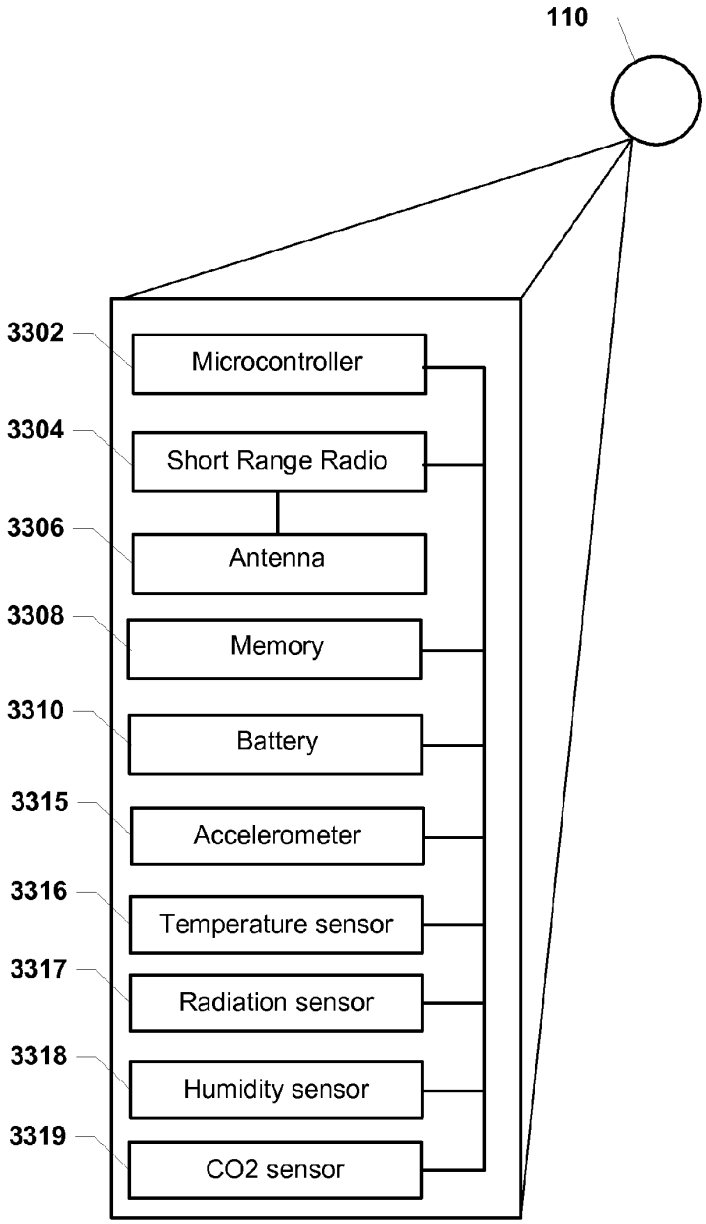

110
3302
Microcontroller
3304
Short Range Radio
3306
Antenna
3308
Memory
3310
Battery
3315
Accelerometer
3316
Temperature sensor
3317
Radiation sensor
3318
Humidity sensor
3319
CO2 sensor

FIG. 33B

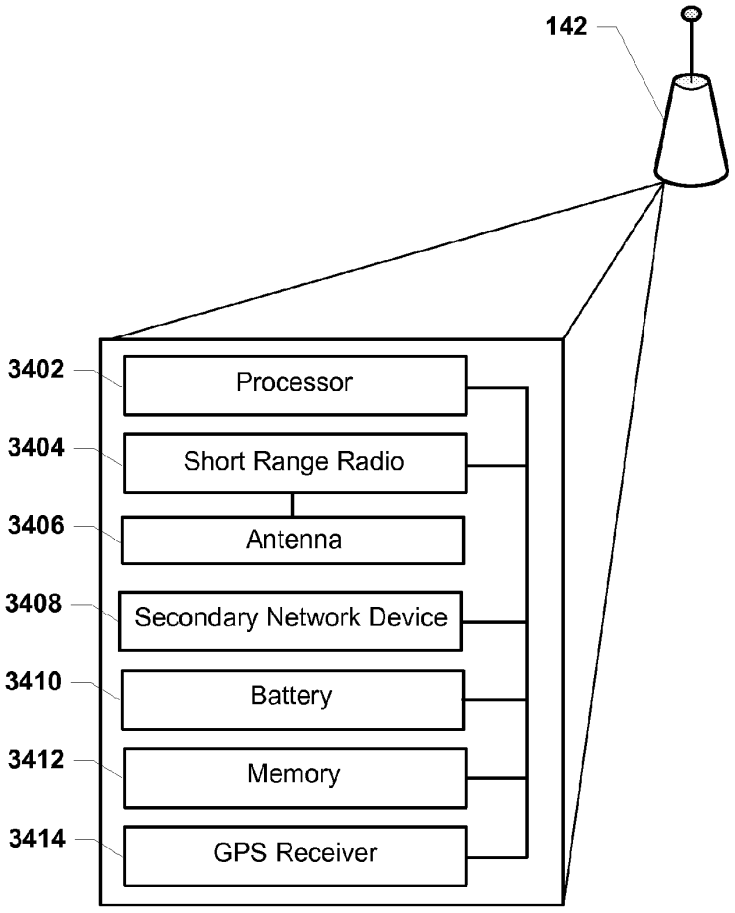

142
3402
Processor
3404
Short Range Radio
3406
Antenna
3408
Secondary Network Device
3410
Battery
3412
Memory
3414
GPS Receiver

FIG. 34A

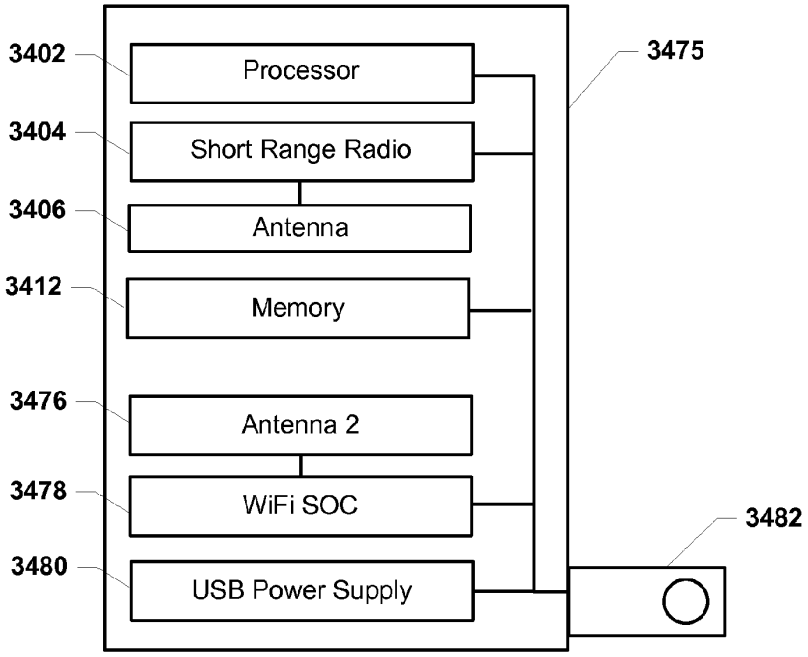

3402
Processor
3475
3404
Short Range Radio
3406
Antenna
3412
Memory
3476
Antenna 2
3478
WiFi SOC
3482
3480
USB Power Supply

FIG. 34B

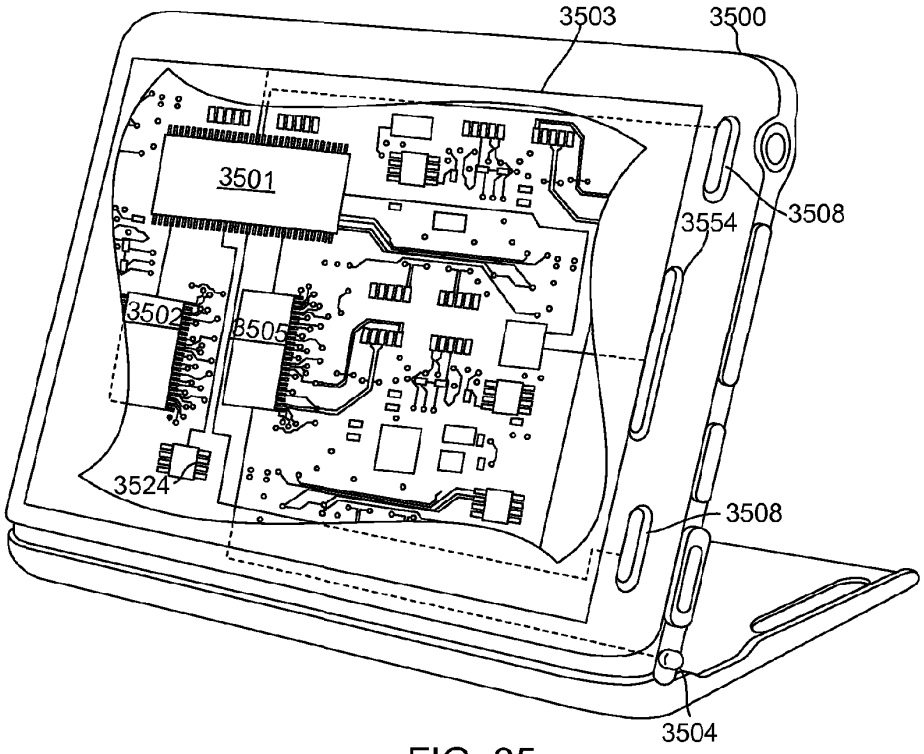

3503
3500
3501
3554
3508
3502
3505
3524
3508
3504

FIG. 35

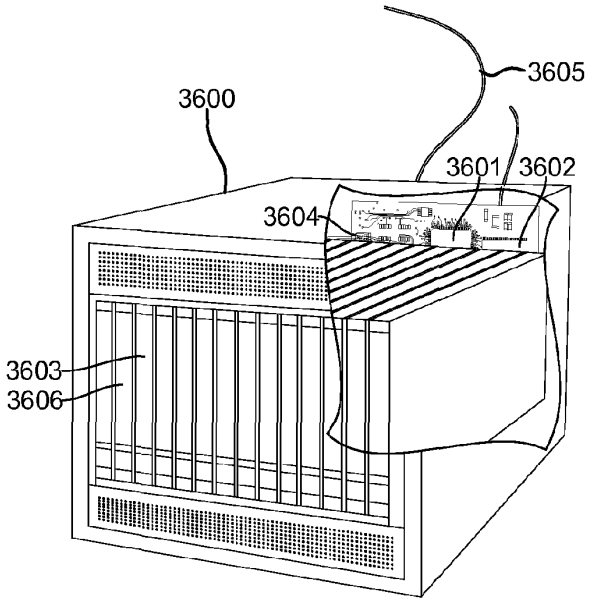

3605
3600
3601
3602
3604
3603
3606

FIG. 36

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/038038

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L29/08 H04W4/00 G06Q30/00
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04L G06Q H04W

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2009/254416 A1 (NOMULA JAGADESHWAR R [US]) 8 October 2009 (2009-10-08) abstract page 1, paragraph 16 - page 2, paragraph 20 page 3, paragraphs 28,29	1-50
A	WO 2012/035149 A1 (CONNECTED ZINKING S L [ES]; PANE ARREGUI JUAN [ES]; SALVADOR GARCIA GU) 22 March 2012 (2012-03-22) page 1, lines 13-20 page 4, last paragraph - page 5, last paragraph page 9, last paragraph - page 11, paragraph 3	10, 20-30, 40,50

-/--

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

[X] See patent family annex.

* Special categories of cited documents :

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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
3 October 2013	10/10/2013

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

3

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

Petitioner Samsung Ex-1004, 0659

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/038038

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 02/073864 A2 (KARGO INC [US]) 19 September 2002 (2002-09-19) abstract page 1, last paragraph - page 2, last paragraph page 4, lines 17-29	1-50
A	SCHNEIDER M A ET AL: "Efficient commerce protocols based on one-time pads", COMPUTER SECURITY APPLICATIONS, 2000. ACSAC '00. 16TH ANNUAL CONFERENC E NEW ORLEANS, LA, USA 11-15 DEC. 2000, LOS ALAMITOS, CA, USA,IEEE COMPUT. SOC, US, 11 December 2000 (2000-12-11), pages 317-326, XP010529829, DOI: 10.1109/ACSAC.2000.898886 ISBN: 978-0-7695-0859-7 abstract page 319, right-hand column, paragraph 1 page 322, right-hand column, last paragraph - page 323, left-hand column, paragraph 1	1,10,11, 20,30, 31,40, 41,50
X	US 2008/123683 A1 (CHENG TSZ S [US] ET AL CHENG TSZ SIMON [US] ET AL) 29 May 2008 (2008-05-29) abstract page 2, paragraph 21 page 3, paragraphs 33,37	51-54
X	US 2011/179064 A1 (RUSSO ANTHONY PETER [US]) 21 July 2011 (2011-07-21) page 4, paragraphs 53,54 and 57 page 6, paragraphs 71,72	51-54

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Petitioner Samsung Ex-1004, 0660

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/038038

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

Petitioner Samsung Ex-1004, 0661

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-50

   Method, server and system where a server provides profile information based on a received message including a rolling wireless transmitter identifier and information related to a proximity broadcast receiver

   ---

2. claims: 51-54

   Method and mobile device providing profile information via a short-range wireless message

   ---

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2013/038038

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009254416 A1	08-10-2009	NONE	
WO 2012035149 A1	22-03-2012	NONE	
WO 02073864 A2	19-09-2002	AU 2002250326 A1	24-09-2002
		CA 2441217 A1	19-09-2002
		CN 1552021 A	01-12-2004
		EP 1415228 A2	06-05-2004
		HK 1071453 A1	04-12-2009
		JP 2004530195 A	30-09-2004
		US 2002143961 A1	03-10-2002
		WO 02073864 A2	19-09-2002
US 2008123683 A1	29-05-2008	CN 101127684 A	20-02-2008
		US 2008123683 A1	29-05-2008
US 2011179064 A1	21-07-2011	NONE	

Petitioner Samsung Ex-1004, 0663

Oximeter

List of publications

Publication date

PCT Application number 2013WO-EP50230 Date 2013-01-08 Register

WO2013/104629 A1 Published application with search report2013-07-18

English Title

Oximeter

French Title

Oxymètre

Abstract - French

L'invention concerne un oxymètre (100) comportant une bague (102) et un module électronique (401) fixé à la bague (102), - le module électronique (401) comportant au moins une diode électroluminescente (403) et un photorécepteur (405), - la bague (102) présentant un logement (104) dans lequel loge le module électronique (401) et un anneau (106) destiné à s'enfiler sur un doigt d'un patient, ledit anneau (106) étant réalisé dans un matériau souple, l'anneau (106) présentant deux évidements (402a, 402b), chacun s'étendant entre le logement (104) et une fenêtre (404a, 404b) réalisée sur la face intérieure de l'anneau (106), l'un des évidements (402a) étant destiné à loger la ou les diodes (403), et l'autre évidement (402b) étant destiné à loger le photorécepteur (405), la fenêtre (404a) associée à la ou les diodes (403) étant disposée de manière à ce que la ou les diodes (403) émettent des faisceaux lumineux à travers elle, et la fenêtre (404b) associée au photorécepteur (405) étant disposée de manière à ce que le photorécepteur (405) reçoive les faisceaux lumineux émis par la ou les diodes (403) après qu'ils ont traversé le doigt, l'anneau (106) étant scindé en deux arcs (208a, 208b) et l'extrémité libre de chaque arc (208a, 208b) étant recourbée vers l'intérieur de l'anneau (106).

English Abstract (Native or MT)

The invention relates to an oximeter (100) comprising a ring (102) and an electronic module (401) attached to the ring (102), said electronic module (401) comprising at least one light-emitting diode (403) and a photoreceptor (405). The ring (102) includes a cavity (104) in which the electronic module (401) is housed and a ring band (106) to be slipped onto the finger of a patient, said band (106) being

made from a flexible material. The band (106) includes two recesses (402a, 402b), each of which extends between the cavity (104) and a window (404a, 404b) provided on the inner surface of the band (106), wherein one (402a) of the recesses is intended to house the diode(s) (403) and the other recess (402b) is intended to house the photoreceptor (405). The window (404a) associated with the diode(s) (403) is arranged such that the diode(s) (403) emit light beams therethrough, and the window (404b) associated with the photoreceptor (405) is arranged such that the photoreceptor (405) receives the light beams emitted by the diode(s) (403) after said light beams have passed through the finger. The band (106) is split into two arcs (208a, 208b) and the free end of each arc (208a, 208b) is curved toward the inside of the ring band (106).

Application Language FRENCH (FRE)

Inventor(s) RENAUDIN PHILIPPE [FR]

DUMAND JEAN-BERNARD [FR]

SAAB CEDRIC [FR]

GASCHET CLEMENT [FR]

RENAULT ADRIEN [FR]

Applicant/Assignee

KAPTALIA [FR]

owned by ESTARIS MONITORING

Applicant/Assignee Address KAPTALIA MONITORING 10 rue Raoul Follereau F-56000 Vannes , FR

Patent Assignee History KAPTALIA MONITORING [FR]

Representative MAILLET, Alain [FR]

Representative Address MAILLET, Alain 5 place Newquay B.P 70250 F-35802 DINARD Cedex , FR

Application Numbers & Dates WOEP2013/050230 2013-01-08 [2013WO-EP50230]

Priority Numbers & Dates FR1250332 2012-01-13 [2012FR-0050332]

Technology domain Medical technology

US codes history

IPC codes

A61B-005/1455*

IPC codes history

A61B-005/1455*

CPC codes

A61B-005/1455/2* A61B-005/6826 A61B-2562/0238

CPC codes history

A61B-005/1455/2* A61B-005/6826 A61B-2562/0238

Notes Number of Claims: 3

Extended kind: x

Cited Patents International Search Report [Examiner]

-US2008171915 (A1) (Cat. X) [US20080171915] KAWAJIRI MOMOE, et al; -WO9817172 (A2) (Cat. A) [WO9817172] MASSACHUSETTS INST TECHNOLOGY; -US6253097 (B1) (Cat. A) [US6253097] ARONOW KURT A, et al; -US2010168531 (A1) (Cat. A) [US20100168531] SHALTIS PHILLIP ANDREW, et al; -WO03077761 (A1) (Cat. A) [WO200377761] CITIZEN WATCH CO LTD, et al;

Description

[0001] Oximeter

[0002] The present invention relates to an oximeter, also called a saturometer.

[0003] Pulse oximetry makes it possible to measure the arterial oxygen saturation of hemoglobin non-invasively and continuously. It makes it possible to rapidly detect oxygen deficiencies before the appearance of clinical signs.

[0004] The oximetry measurement may be performed at various organs of the patient, and more particularly at the tip of a finger, a toe, an earlobe, etc

[0005] An oximeter comprises two light-emitting diodes, one emitting a light beam of red light and the other emitting a light beam of infrared light (660 and 994 nm respectively), and a photoreceptor which measures the absorption of these light beams by the pulsatile flux. The absorptions of the red and infrared light beams are variable depending on whether the red and infrared light beams encounter non-oxygenated reduced hemoglobin (Hb) or oxyhemoglobin ($Hb0_2$).

[0006] The information recorded by the photoreceptor is then transmitted to a monitoring center, such as a medical monitoring apparatus for example. There are currently various oximeter models. The most widespread patterns attach to the distal end of a finger.

[0007] A first oximeter model is in the form of a finger clamp for clamping the tip of the patient's finger. Such an oximeter is bulky and remains difficult to put in place if the patient is agitated.

[0008] A second oximeter model takes the form of two plasters. The light-emitting diodes are integrated into the first plaster and the photoreceptor is integrated into the second plaster. Such an oximeter is more stable but cannot be used several times.

[0009] Oximeters in the form of rings are also known.

[0010] An object of the present invention is to propose an oximeter that remains in place on the patient even if the patient is stirred, that can be reused, and that presents better performance.

[0011] To this end, an oximeter is proposed comprising a ring and an electronic module fixed to the ring,

[0012] - the electronic module comprising at least one light-emitting diode and a photoreceptor,

[0013] - the ring having a housing in which the electronic module is housed and a ring intended to be slipped over a finger of a patient, said ring being made of a flexible material,

[0014] the ring having two recesses, each extending between the housing and a window made on the inner face of the ring, one of the recesses being intended to house the diode (s), and the other recess being intended to house the photoreceptor, the window associated with the one or more diodes being disposed such that the one or more diodes emit light beams therethrough, and the window associated with the photoreceptor being disposed such that the photoreceptor receives the light beams emitted by the one or more diodes after they have passed through the finger,

[0015] the ring is divided into two arcs and the free end of each arc is curved towards the inside of the ring.

[0016] Advantageously, the windows are placed facing each other along a left-right transverse axis of the finger.

[0017] Advantageously, splitting is performed at the bottom portion of the ring in the plane of symmetry of the oximeter passing through the axis of the ring. Advantageously, each window is closed by a plate that is transparent in the wavelengths used.

[0018] The characteristics of the invention mentioned above, as well as others, will appear more clearly on reading the following description of an exemplary embodiment, said description being made in relation to the accompanying drawings, among which:

[0019] fig. 1 shows an oximeter according to the invention,

[0020] fig. 2 is a side view of the oximeter of Fig. 1,

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[0021] fig. 3 is a bottom view of the oximeter of Fig. 1, and

[0022] Fig. 4 is a section along line IV--IV of Fig. 3.

[0023] Fig. 1 shows an oximeter 100 which comprises a ring 102 and an electronic module (401, Fig. 4) and which is fixed to the ring 102.

[0024] The ring 102 has a ring 106 intended to be slipped over the finger of a patient and a housing 104 in which the electronic module 401 is housed.

[0025] Fig. 2 shows the oximeter 100 in side view, that is to say in the axis of the ring 102, and Fig. 3 shows the oximeter 100 in bottom view. Fig. 4 is a cross-sectional side view of the oximeter 100.

[0026] The electronic module 401 has two light-emitting diodes 403, one emitting a red light beam and the other emitting an infrared light beam (respectively 660 and 994 nm) and a photoreceptor 405. The electronic module 401 also comprises means necessary for controlling the diodes, means necessary for receiving the information emitted by the photoreceptor, as well as means necessary for transmitting this information to a monitoring center, such as a medical monitoring apparatus for example. The electronic module 401 also comprises an energy source and the means necessary for transmission are, for example, wireless communication means.

[0027] The ring 106 is made of a flexible material such as silicone in order to adapt to the shape of the finger of the patient on which it is slipped.

[0028] The ring 106 has two recesses 402 a and 402 b. One of the recesses 402 a is intended to house the two diodes 403, and the other recess 402 b is intended to house the photoreceptor 405. Each recess 402 a, 402 b extends in the ring 106 and opens out firstly into the housing 104, and secondly into the inside face of the ring 106 via a window 404 a, 404 b.

[0029] The openings between the recesses 402 a and 402 b and the housing 104 allow the two diodes 403 and the photoreceptor 405 to pass through when the electronic module 401 is installed.

[0030] The window 404 a is arranged so that the diodes 403 emit the light beams through it, and the window 404 b is arranged so that the photoreceptor 405 receives the light beams passing through it. In addition, the windows 404 a and 404 b are disposed in such a manner that when the oximeter 100 is put on as far as the proximal phalange of the patient's finger, the light beams emitted by the diodes 403 pass through the finger and are picked up by the photoreceiver 405, thereby enabling oximetry to be measured.

[0031] Such an oximeter 100 is therefore reusable and is held very well in place because of the presence of the ring 106.

[0032] For better measurement of the oximetry, the windows 404 a and 404 b and consequently the diodes 403 and the photoreceiver 405 are placed facing each other along a left-right transverse axis of the finger.

[0033] The light beams are thus recovered in the vicinity of the proximal phalange without distinguishing the fingers. This zone is less irrigated than the pulp of the finger, which is an excellent pulsatile vascular bed, but it is less subject to the phenomenon of vasoconstriction of the vessels, which is a limiting factor in the measurement of oximetry.

[0034] To facilitate the adaptation of the ring 106 to most of the fingers, the ring 106 is divided into two arcs 208 a and 208 b. The ring 106 is split at the lower part of the ring 106, that is to say the part which is under the finger when the oximeter 100 is in place. The splitting is carried out in the plane of symmetry of the oximeter 100 passing through the axis of the ring 106.

[0035] Because of the flexibility of the material used, each arc 208 a, 208 b of the ring 106 can move freely apart and thus follow the shape of the finger without risk of ischemia for the finger, whatever the dimensions of the latter, as long as they are greater than the internal dimensions of the ring 106.

[0036] In order to facilitate adhesion of the arcs 208 and 208 b to the finger, they are thinned at their free ends in order to soften them. As specified above, the material constituting the ring 106 is flexible and is preferably a silicone since it is biocompatible, transparent, or possibly colorable, and it can receive additives. The silicone is also a thermal and electrical insulator and it withstands heat while retaining its physicochemical properties.

[0037] In addition, the flexibility of the silicone can be varied as needed. In a preferred embodiment of the invention, the silicone has a hardness of the order of 50 Sh A which may vary by + or - 20 Sh a. such an order of magnitude is adapted to the comfort of the patient since the finger is not too tight and the arterial pulsation signal is not reduced, and when the oximeter 100 is properly held on the finger so that the diodes 403 and the photoreceptor 405 remain correctly positioned despite the movements of the patient.

[0038] In order to ensure that the skin of the finger is indeed in contact with the diodes 403 and the photoreceiver 405 and thus to avoid light interference due, for example, to the photoreceiver 405 receiving light beams that have not passed through the finger, the free end of each arc 208 a, 208 b is curved towards the inside of the ring 106, i.e. towards the top portion of the oximeter 100 carrying the electronic module 401.

[0039] Thus, each free end exerts a pressure on the flesh of the finger and tends to raise this flesh in order to fill the inside of the ring 106 and press it against the diodes 403 and the photoreceptor 405 in order to improve the measurement.

[0040] The diodes 403 are housed in one of the arcs 208 a and the photoreceptor 405 is housed in the other arc 208 b.

[0041] The angular orientations of the diodes 403 and of the photoreceptor 405 are such that, on the fingers of small volume, the light beams emitted converge towards the flesh of the finger, and for the fingers of larger volume, the spacing between the two arcs 208 a and 208 b enables the angular orientations of the diodes 403 and of the photoreceptor 405 to be adapted so that the emitted light beams remain centered on the flesh.

[0042] To prevent soil from depositing on the diodes 403 and photoreceptor

[0043] 405, each window 404 a, 404 b is closed by a plate that is transparent in the wavelengths used. The transparent plate may be a veil derived from the material constituting the ring 106 if it is transparent, or a plexiglass plate bonded into the window 404 a, 404 b. Of course, the present invention is not limited to the examples and embodiments described and shown, but is capable of numerous variants accessible to those skilled in the art.

Description

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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 September 2004 (16.09.2004)

PCT

(10) International Publication Number
WO 2004/078028 A2

(51) International Patent Classification[7]: A61B

(21) International Application Number:
PCT/US2004/006014

(22) International Filing Date: 27 February 2004 (27.02.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

60/451,009	28 February 2003 (28.02.2003)	US
60/516,101	30 November 2003 (30.11.2003)	US

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

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 2004/078028 A2

(54) Title: FLASHING JEWELRY HEARTBEAT MONITOR WITH MULTIPLE LIGHTS

(57) Abstract: Jewelry, such as finger rings and earrings, which flash in synchronism with the wearer's heartbeat. A pulsed IR signal is directed into the wearer's tissue and a reflected or transmitted signal is monitored to determine when the wearer's heart beats at which time one or more light emitting sources in the jewelry flashes. The monitored signal is utilized to determine the wearer's heart rate. At least two light emitting sources are provided one of which flashes with each heart beat and the other flashes when the heart rate reaches or exceeds a predetermined range or increases faster than a predetermined rate. Preferred embodiments include three visible LED's (red, green and blue) and a micro-processor which calculates pulse rate and causes the red LED to blink on each pulse, the green LED to blink on each pulse when the wearer's pulse rate is greater a first threshold and the blue LED to blink on each pulse when the wearer's pulse rate is greater than a second threshold corresponding to extreme excitement. These threshold values may correspond to increased heart rates of typical persons engaged in exercise and love-making. The monitor may also be self calibrating to adjust the thresholds based on measurements of the wearer's heart rate over extended periods which would include periods of rest as well as periods of exertion or excitement. Other preferred embodiments vary the brightness of the LED's depending on the estimated blood pressure that also increases by about the same degree as pulse rate.

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FLASHING JEWELRY HEARTBEAT MONITOR WITH MULTIPLE LIGHTS

This application claims the benefit of Provisional Applications SN 60/516,101 filed 11/3/2003 and SN 60/451,009 filed 2/28/2003. The present invention relates to jewelry and heartbeat monitors.

BACKGROUND OF THE INVENTION

US Patent No. 6,277,079 issued to the present inventors discloses a flashing earring heartbeat monitor. The '079 patent is incorporated herein by reference. In the background section of that patent is disclosed a well-known technique for monitoring heartbeat. Infrared light is transmitted into tissue and the reflected light is monitored to determine heart beat. This works because changing quantities of blood in the tissue with each heartbeat will affect the amount of light reflected from the tissue. In that patent Applicants described an earring (see FIGS. 1and 2, which were FIGS. 2 and 3 in the '079 patent) which used that basic technique to make an earring which would flash with each heartbeat. Applicants summarized the invention as follows:

"The ... invention provides an earring that flashes in synchronism with the wearer's heartbeat. A pulsed IR LED/photocell combination is built into an earring along with a comparator and a visible light-emitting source. The comparator determines when the heart has beat from the variation in the signal from the photocell and transmits a signal to a solid state switch to turn on the visible light-emitting source. Thus, the light emitting source flashes once for each heart beat. In a preferred use of the ... invention a lover is able to determine when his or her partner is excited by observing the rate at which the partner's earring flashes. The invention may also be used for medical monitoring of patients."

Heart rates are known to vary substantially with age and activity. Resting heart rates are typically in the range of about 50 to 70 beats per minute. A rule of thumb is: Maximum Heart Rate = 220 – Age. The range of variation gets smaller with age. The maximum heart rate ranges from about 100 to 200 for 20 year old people and from about 75 to about

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150 for 70 year old people. Heart rates increase toward the maximum rates during strenuous exercise and during periods of excitement including sexual excitement. FIGS. 4A and 4B are graphs extracted from page 596 of Sexual Behavior in the Human Female by the Staff of the Institute for Sex Research, Indiana University, Alfred C. Kinsey et al Research Associates, Published by W. B. Sanders, Philadelphia. The subjects were a married couple. The graphs show heart rate ranges for the female from about 90 during the period preceding love making to 140 during lovemaking down to about 75 during sleep. For the male the corresponding ranges were about 90, 140 and 72. The female experienced four periods of extreme excitement. The male experienced only one.

Applicants have been informed that the potential market for these flashing earring heartbeat monitors may be in the many millions and that other jewelry monitoring heartbeat my also be very popular. What is needed are an improved versions of the earring described in the '079 patent and other jewelry applications of improved versions of that invention.

SUMMARY OF THE INVENTION

The present invention provides jewelry, such as finger rings and earrings, which flash in synchronism with the wearer's heartbeat. A pulsed IR signal is directed into the wearer's tissue and a reflected or transmitted signal is monitored to determine when the wearer's heart beats at which time one or more light emitting sources in the jewelry flashes. The monitored signal is utilized to determine the wearer's heart rate. At least two light emitting sources are provided one of which flashes with each heart beat and the other flashes when the heart rate reaches or exceeds a predetermined range or increases faster than a predetermined rate. Preferred embodiments utilize inexpensive off-the-shelf reflection sensors developed for card readers each of which includes both an IR emitter and a phototransistor IR detector. Preferred embodiments include a power-up-on-skin-contact feature to preserve battery power. Embodiments include a variety of color LED's and a variety of types of jewelry are proposed as heartbeat monitors. Disclosed are detailed instructions describing working prototype earrings built by Applicants and their licensees and descriptions for low cost fabrication of embodiments of the present

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invention using application specific integrated circuit (ASIC) technology and surface mount technology. Preferred embodiments include three visible LED's (red, green and blue) and a micro-processor which calculates pulse rate and causes the red LED to blink on each pulse, the green LED to blink on each pulse when the wearer's pulse rate is greater a first threshold and the blue LED to blink on each pulse when the wearer's pulse rate is greater than a second threshold corresponding to extreme excitement. These threshold values may correspond to increased heart rates of typical persons engaged in exercise and love making. The monitor may also be self calibrating to adjust the thresholds based on measurements of the wearer's heart rate over extended periods which would include periods of rest as well as periods of exertion or excitement. Other preferred embodiments vary the brightness of the LED's depending on the estimated blood pressure that also increases by about the same degree as pulse rate. Also described is a special technique for providing power to the heartbeat monitor that consists of a small diameter pin for providing an electrical connection between a battery and a circuit board comprising an IR transmitter and an IR receiver and one or more LED's. The battery unit is preferably on the inside of the earlobe and the circuit board is preferably on the outside of the earlobe. Also disclosed is a technique for charging the battery unit.

BRIEF DESCRIIPTION OF THE DRAWINGS

FIGS. 1 and 2 are drawings from the '079 patent referred to above showing feature disclosed in that prior art patent.

FIG. 3 is a circuit diagram showing features of a working prototype of the present invention.

FIG. 3A is a version of FIG.3 showing sections of the circuits shown enlarged in FIGS. 3A(1) through 3A(7)

FIGS. 3A(1) through 3A(7) each show a portion of the FIG. 3 circuit.

FIGS. 4A and 4B are prior art graphs that show heart rates of a female and male human engaged in love making.

FIGS. 5A and 5B show block diagrams of control circuits and logic for controlling a three-light embodiment of the present invention.

FIG. 6 is a drawing of an inexpensive IR transmitter and detector.

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FIGS. 7A and 7B discloses a battery unit for providing power for the IR transmitter and the IR receiver and for one or more LED's.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Prototype Embodiments

Applicants and their licensee have built and tested prototype-flashing earring that has demonstrated excellent performance of features of the present invention. A prototype earring was fabricated by modifying an earring having a magnetic clasp purchased from a Target department store and using inexpensive reflection IR emitter-sensors developed for card readers. Two magnets attract each other on both sides of a wearer's ear lobe. An IR transmitter, and IR receiver of the emitter-sensor and an on/off skin contact switch was mounted along with one of two magnets on one side of the ear lobe. The electronic parts for the earring are mounted on two small circuit boards contained in a heart shaped box hanging from the attaching magnetic clasps. The box has dimensions of about 1 inch X 1 inch X ¾ inch. The earring is fitted with a red Valentine shaped heart cover in which a visible light (red) emitting diode is mounted. Three hearing aid batteries also contained in the heart shaped box power this prototype earring. Only only a single battery powers other embodiments.

Circuit Diagram

An electric circuit diagram of the prototype embodiment of the present invention actually built and tested by Applicants is shown in FIG. 3. This circuit diagram is also broken into seven parts as shown in FIG. 3A and FIGS. 3A(1) through 3A(7).

As shown in FIG. 3A(1) timer integrated circuit U1 with its associated components shown at 20 produces a pulse train of 500 microseconds pulse width pulses at a 200 Hz rate. These pulses activate the switch in IC U2 (a dual analog switch) 22 which permits current to flow in IR LED 24.

As shown in FIG. 3A(2), the emitted IR pulses enter the earlobe tissue and the light scattered back into the phototransistor 26 and is detected production a pulse amplitude

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modulated signal across R3 28. The network of D1, D2, C2 and R4 form a "track and hold" amplitude insulator 30.

As shown in FIG. 3A(3), integrated circuit U3 is a quad, OP Amp 32. The first amplifier is used as a voltage follower with high input impedance and a low output impedance which isolates the track and hold circuit from the following amplifier. R5 and C3 form a low pass filter 34 to reduce the high frequency noise from the pulse signal.

In FIG. 3A(4) R6 and C4 form a high pass filter 36 and OP amp 38 provides a gain of about 500 at the frequency range centered at about 2.5 Hz which is the frequency of interest. C5 along with the feedback resistor R7 forms another low pass filter 40. All the filters together form a narrow pass band filter centered at 2.5 Hz. The pass band is wide enough to detect heart rates between 40 pulses per minute and about 250 pulses per minute. The signal at pin 8 of OP amp is now the recovered heartbeat waveform.

In FIG. 3A(5) the recovered heartbeat waveform is AC coupled into the last OP Amp 42 which acts as a threshold detector. The network 44 of R10, R11and R12 sets a threshold of about 0.2V. A signal above this amplitude causes the output (pin 14) 46 to go from 5 V to 0 V.

As shown in FIG. 3A(6) the second switch in U2 48 is closed upon detection of a beat, which causes current to flow in the visible LED 50. The decoupling network 52 comprising R14, C9 and R 16, C12 isolates the LED current transmits from the 08 Am PS.

In FIG. 3A(7) U4 is a DC-DC converter 54. A 1.4 V battery 56 is converted to a regulated 5V as shown at 60 to power the circuitry. It has a shutdown feature used to automatically turn on power upon skin contact as shown at 58.

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Components of Prototype Are Off-the-Shelf

All of the electronic components of the above described prototype are off-the-shelf components available from vendors such as Radio Shack and Target with many locations, Allied Electronics with offices in Fort Worth Texas and Digi-Key with offices in Thief River Falls, MN. The IR transmitter and detector in the above embodiment is a very inexpensive device used for card reading an sells for $1.37 in quantities of 100. The unit operates at a wavelength of 940 nm which scatters well in and easily penetrates tissue as thick as the earlobe. Applicants have adopted it for their monitor with excellent results. A drawing of the IR transmitter and detector is shown in FIG. 6. Other parts are also very inexpensive so that Applicants expect to be able to produce their monitor for about $20 or less in large quantities. Therefore, Applicants expect enormous markets for the products of the present invention for medical, exercise, sports of all types and many other uses. As suggested above Applicants expect that their biggest market will be lovers.

Testing

The prototype earring has been thoroughly tested by Applicants and its excellent performance has been confirmed. One of the Applicants has tested the earring at a wide range of heart rates comparing the blinking of the LED with his own pulse with perfect match throughout the range.

Types of Jewelry Other than Earrings

Experimentation by Applicants have proven that the principals of the invention claimed in the '079 patent can be extended to other types of jewelry. Applicants have determined that heartbeat rings worn at other locations of the body perform just as well or better as compared to the earlobe. Other potential locations include the fingers, belly button, nose, toes, breast, and parts of the breast. Applicants have also determined that the flashing heartbeat monitor can be attached to skin as a patch with excellent performance. For example a heart shaped patch containing the electronic components described above can be applied on a skin region corresponding to the region of a person's heart.

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Miniaturization

Although the prototype version of the invention actually built by Applicants is small enough to make a practical earring having substantial appeal, Applicants expect that much smaller earrings will have much greater appeal. Therefore, Applicants expect to have the electronics described converted to an application specific integrated circuit chip (an ASIC chip). These chips can be produced in volume production for less than $2 so that the cost of the heart monitoring jewelry could be as low a few dollars. Many ASIC manufacturers/designers are available which could convert the circuit shown in FIG. 3 into an ASIC chip mass producible for less than $2. These include Intrinsix Corp with offices in Westboro, MA; System to ASIC with offices in Bothell WA ASIC Northwest with offices in Portland, OR and Arizona Microtek, Inc with offices in Mesa, AZ. Another technique to miniaturize the jewelry of the present invention is by utilizing so called "surface mounting" techniques. These components are typically only about one-tenth to one fifth the size of conventional components. Thus, the prototype earring built and tested by applicants using off-the-shelf components, which is somewhat smaller than 1 inch cube, could be reduced in size to about one tenth or one fifth this volume using these surface mount techniques. Greater reductions are possible using the ASIC techniques but the surface mount approach generally requires a smaller front-end investment. Therefore, earrings of the present invention will be in sizes that are typical for earrings currently worn.

Three-Light Model

A preferred embodiment of the present includes an earring with three visible LED's, (red, green and blue) and a micro-processor which calculates pulse rate and causes the red LED to blink on each pulse, the green LED to blink on each pulse when the wearer's pulse rate is greater than a first threshold rate (such as 115% of normal) and the blue LED to blink on each pulse when the wearer's pulse rate reaches a second threshold corresponding to extreme excitement (such as 130% of normal). These ranges would correspond to increased heart rates of typical persons engaged in exercise and love-making. In preferred embodiments the example percentages may be adjusted to span a wider range for persons such as younger persons and athletes who have a much greater

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range of heart rate. The monitor may also be self calibrating based on measurements of the wearer's heart rate over extended periods which would include periods of rest as well as periods of extreme exertion or excitement. FIG. 5A is a block diagram showing additional circuitry for the green and blue lights at 50, and FIG. 5B shows a simplified block diagram of the logic 52 for turning on the green and blue lights. In another preferred embodiment the earring is programmed to turn on the blue light when the heart rate increases by at least 15 percent within a period of 3 minutes or less. The reason for this approach will be obvious to the reader from a review of FIGS 4A and 4B.

Blood Pressure Estimation and Indication

Blood pressure in humans varies in about the same degree as heart rate. Other preferred embodiments vary the brightness of the LED's (or other visible light) depending on the estimated blood pressure which also increases by about the same degree as pulse rate. In order to do this the detector monitors the intensity of measured light transmitted through tissue or reflected out of the tissue. The light transmitted or reflected is dependent on the amount of blood in the tissue which is in turn dependent on the blood pressure. In these preferred embodiment the LED will therefore not only blink with each heart beat but the intensity of the light will be roughly proportional to the blood pressure.

Battery Unit

FIGS. 7A and 7B describe a technique for providing power to an earring heartbeat monitor. A circuit board 60 comprises an IR transmitter Tx and an IR receiver Rx and one or more LED light sources 61 as described above. The board 60 includes cylindrical pin 62 comprised of cylindrical conductor 64 having a diameter small enough to fit through the pierced ear of typical persons with pierced ears. Conductor 64 is treated as ground. The pin includes central conductor 66 that is connected to the positive terminal 68 of battery unit 70 as shown in FIG. 7A. Preferably, the board unit 60 is positioned on the outside of the earlobe and the battery unit 70 is positioned on the inside of the earlobe (i.e., between the user's earlobe and her neck). The reader should note that an advantage of this design is that power is drawn from the battery unit only when the earring is being worn. When the earring is not being worn (assuming that the battery is a rechargeable

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battery) the battery unit may be recharged as shown in FIG. 7B. The reader should note that the pin element could be a part of the battery unit instead of the board unit. The pin 62 could be held in place by a pressure fit or threads could be provided so that the battery unit 70 is threaded on to pin 62. Battery 69 could be a re-chargeable battery in which case a battery charge unit could be provided with a fitting similar to pin 62 for charging battery 69 with wall power as shown in FIG. 7B. Also, techniques could be added to accommodate various thicknesses of earlobes.

Although the present invention has been described in terms of particular embodiments, persons skilled in the art will recognize that many other embodiments using the principals of the invention are possible. Such variations include IR transmitters and receivers operating at different wavelengths which penetrate tissue and are absorbed in blood to a lesser or greater extent than the 940 nm light. Visible light components other than LED's could be used so long as they are small and efficient. The earring could include a tiny transmitter to transmit a signal to a nearby receiver. In a preferred embodiment the signal energizing the blue light could be transmitted to a nearby receiver that would then activate an audio receiver that would produce sounds such as church bells. Applicants have learned through testing of prototype earrings that bright sunlight adversely affects performance of the heartbeat earrings. Placing an infrared absorber between the earlobe and the clamp on the inside of the earlobe minimizes these adverse effects. Another solution to the sunlight problem is to design the earring so that the optical components of the earring are shielded from direct or reflected rays from the sun. Therefore, the scope of the invention should be determined by the appended claims and their legal equivalents.

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