



- (51) International Patent Classification:
E05B 45/00 (2006.01) *G05B 19/00* (2006.01)
- (21) International Application Number:
PCT/US2017/017206
- (22) International Filing Date:
9 February 2017 (09.02.2017)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
15/041,568 11 February 2016 (11.02.2016) 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, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH,

[Continued on next page]

(54) Title: SELF-CONFIGURING SENSING DEVICE

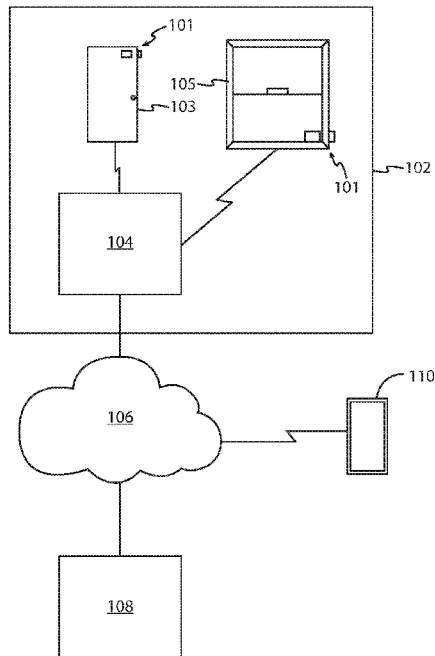


FIG. 1

(57) Abstract: A self-configuring sensor and method of operation of the sensor is described. In one embodiment, the self-configuring sensor comprises a first sub-sensor for determining a first status of a door or window, a second sub-sensor for determining a second status of the door or window, a wireless transmitter, a memory for storing processor-executable instructions, and a processor coupled to the first sub-sensor, the second sub-sensor, the wireless transmitter and the memory for executing the processor-executable instructions that cause the sensor to monitor the first and second sub-sensors for detecting changes in a first sub-sensor state and a second sub-sensor state, respectively, and determine an installation configuration based on the changes in the first sub-sensor state and the second sub-sensor state, the installation configuration comprising a type of hardware where the self-configuring sensor has been installed.

WO 2017/139475 A1

GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ,
TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU,
TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,
DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT,
LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE,

SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA,
GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

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

SELF-CONFIGURING SENSING DEVICE

BACKGROUND

I. Field of Use

[001] The present application relates generally to the field of sensing devices. More specifically, the present application relates to a self-configuring sensing device, typically used in home security systems.

II. Description of the Related Art

[002] Home security systems have been available for many years, and have been growing in popularity recently. These systems typically employ a number of door/window sensors to monitor the open/closed state of doors and windows, as well as other sensors, such as motion sensors, sound detectors, tilt sensors, etc.

[003] Wired door/window sensors have been in existence for over thirty years, typically a magnet and reed switch combination, the reed switch comprising an electrical contact or switch that opens and closes upon application/removal of a magnetic field. More recently, these sensors have incorporated RF circuitry to transmit wireless signals to a central controller located on a premises being monitored. The magnet is typically installed onto a movable part of a window or door, while the reed switch assembly is mounted to a stationary surface, such as a door or window frame. When the door or window is closed, the magnet and reed switch are in close proximity to one another, maintaining the reed switch in a first state indicative of a “no alarm” condition. If the door or window is opened, proximity is lost between the magnet and the reed switch, resulting in the reed switch changing state, e.g., from closed to open or from open to closed. When this occurs, it indicates that the door or window has been opened and, in response, the sensor sends a signal to the central controller in the home, which may send an alarm signal to a remote monitoring facility or sound a loud, audible alert.

[004] One disadvantage of typical door/window sensors is that a variety of different types are typically needed to match particular types of different windows or doors. For example, a home may have a number of double-hung windows, requiring sensors of a first type, while also having a number of casement windows, requiring sensors of a different type. Thus, professional installers must ensure that they carry enough of each

type of sensor when they install new systems, thus increasing their inventory requirements, which costs money, takes up space, etc. When a sensor fails, a technician must likewise ensure that both types of sensors are available in inventory, as there is no way of knowing which type of sensor might be installed.

[005] Thus, it would be desirable to provide security sensors that allow installers and repair professionals to minimize their inventory and to have more information pertaining to sensors that have failed.

SUMMARY

[006] The embodiments described herein relate to methods, systems, and apparatus of a sensor able to determine an installation configuration after it has been installed into a door or a window. In one embodiment, a self-configuring sensor is described, comprising a first sub-sensor for determining a first status of a door or window, a second sub-sensor for determining a second status of the door or window, a wireless transmitter, a memory for storing processor-executable instructions, and a processor coupled to the first sub-sensor, the second sub-sensor, the wireless transmitter and the memory for executing the processor-executable instructions that cause the sensor to monitor the first and second sub-sensors for detecting changes in a first sub-sensor state and a second sub-sensor state, respectively, and determine an installation configuration based on the changes in the first sub-sensor state and the second sub-sensor state, the installation configuration comprising a type of hardware where the self-configuring sensor has been installed..

[007] In another embodiment, a method is described, performed by a self-configuring sensor, comprising monitoring, by a processor, a first sub-sensor and a second sub-sensor for changes in a first sub-sensor state and a second sub-sensor state, respectively, and determining, by the processor, the installation configuration based on the changes in the first sub-sensor state and the second sub-sensor state, the installation configuration comprising a type of hardware where the self-configuring sensor has been installed.

BRIEF DESCRIPTION OF THE DRAWINGS

[008] The features, advantages, and objects of the present invention will become more apparent from the detailed description as set forth below, when taken in conjunction with

the drawings in which like referenced characters identify correspondingly throughout, and wherein:

- [009] FIG. 1 is a block diagram of one embodiment of a security system where self-configuring sensors monitor a door and a window status in accordance with the teachings herein;
- [0010] FIG. 2 is a functional block diagram of one embodiment of the server shown in FIG. 1;
- [0011] FIG. 3 is a plan view of one embodiment of one of the sensors shown in FIG. 1, shown without a cover;
- [0012] FIG. 4 is an illustration of the sensor shown in FIGS. 1 and 3 installed into a casement window, used to monitor both an open/close status and a locked/unlocked status of the window;
- [0013] FIG. 5 is an illustration of one embodiment of the sensor shown in FIGS. 1 and 3 installed into a single or double hung window;
- [0014] FIGS. 6a and 6b illustrate a close-up, top, plan, cutaway view of a slot formed into a window frame, with the sensor of FIGS. 1 and 3 about to be installed into the slot;
- [0015] FIG. 7 is a flow diagram illustrating one embodiment of a method for determining an installation configuration of a sensor, performed by the sensor shown in FIGS. 1 and 3, and;
- [0016] FIG. 8 is a flow diagram illustrating one embodiment for managing installation configuration information provided by the server shown in FIG. 1.

DETAILED DESCRIPTION

- [0017] The present description relates to an electronic sensor capable of automatically determining its installation configuration, e.g., a type of hardware, such as a door or a window, where the sensor has been installed. For example, in the home security industry, a single sensor type may be used to monitor a variety of doors and windows to detect door and window status, such as open/closed or locked/unlocked, and use that information to determine a type of window or door that it is installed in. The status of a door or window may be determined based on input from two or more sub-sensors that either reside within the sensor, or are connected to the sensor via wires or some other input. For example, a sensor may comprise two internal sub-sensors, a reed switch and a

mechanical plunger switch. After such a sensor is installed into a single-hung sliding window, for example, the sensor may automatically determine that it is, in fact, installed into a single-hung window by noting that only its reed switch changes state.

[0018] FIG. 1 is a block diagram of one embodiment of a security system where self-configuring sensors 101 monitor door 103 and window 105 status in accordance with the teachings herein. Shown are sensors 100 mounted to a variety of doors and windows in a residence 102, gateway 104, wide-area network 106, server 108, and remote device 110. The sensors 101 communicate wirelessly with gateway 104 when a change in door or window status is detected, i.e., a door or window has opened and/or has become unlocked. Gateway 104, in turn, provides a notification to server 108 via wide-area network 106, that a change in status has occurred, and server 108 may notify a person associated with residence 102, such as a homeowner, via wide-area network 106 and remote device 110.

[0019] Each of the sensors 101 comprise two or more sub-sensors, either internally and/or connected to the sensors 101, as will be discussed in greater detail below. The sensors 101 monitor doors and windows to determine state changes such as door and window open/closed and/or locked/unlocked status. When a change in status occurs, the sensors 101 transmit wireless signals to gateway 104, using conventional wireless communication techniques well known in the art.

[0020] The status signals from sensors 101 are received by gateway 104, which comprises a wireless receiver for receiving the status signals, a memory for storing information related to the sensors 101, and a network interface for communicating with server 108 via wide-area network 106. Wide-area network 106 comprises one or more wired or wireless data networks, including the Internet, local-area networks, cellular networks, satellite networks, etc.

[0021] FIG. 2 is a functional block diagram of one embodiment of server 108, comprising processor 105, memory 202, and network interface 204. Processor 105 is configured to provide general operation of sever 108 by executing processor-executable instructions stored in memory 202, for example, executable code. Processor 105 is typically a general purpose microprocessor or microcontroller, such as any one of a number of microprocessors manufactured by Intel Corporation of Santa Clara, California. Processor 105 receives status signals from sensors 101 and provides notifications to a user of remote device 110 when a change in status occurs.

[0022] Memory **202** comprises one or more information storage devices, such as RAM, ROM, EEPROM, UVPROM, flash memory, SD memory, XD memory, or virtually any other type of electronic memory device. Memory **202** is used to store the processor-executable instructions for operation of server **108** as well as information provided by sensors **101** and user account information associated with gateway **104** and the sensors **101**. Memory **202** is also used to store installation configuration description information, as will be described in greater detail below. Memory **202** may also be used to store web site information to allow users of gateway **104** to register with server **108**, to monitor sensors **101**, and to receive information pertinent to the sensors **101**, such as a historical record of dates and times that state changes have been detected.

[0023] Network interface **204** comprises circuitry necessary for processor **105** to communicate with gateway **104**, as well as remote devices, such as remote device **110** using techniques well-known in the art.

[0024] Remote device **110** comprises a smart phone, personal computer, tablet, or other personal computing device able to communicate with server **108** via wide-area network **106**. Remote device **110** may execute a software application or “app”, downloaded from an software application repository, such as Apple Incorporated’s “App Store” or Google Incorporated’s “Google Play Store”, that allows a user of remote device **110** to receive notifications from gateway **104** when a change in door/window status is detected and, generally, to monitor the status of sensors **101** and, hence, the status of door **103** and window **105**. Alternatively, remote device **110** is capable of presenting web pages to a user, such as a website provided by server **108**, in order for the user to manage gateway **104** and the sensors **101**, and to receive information pertinent to gateway **104** and the sensors **101**.

[0025] FIG. 3 is a plan view of one embodiment of sensor **101**, shown without a cover that is normally used to conceal the components that comprise sensor **101**. The components of sensor **101**, in this embodiment, comprise processor **300**, memory **302**, transmitter **304**, first sub-sensor **306**, second sub-sensor **308**, port **310**, battery **312**, housing **314**, circuitry board **316**, and external sensor **318**. Processor **300** is coupled to first sub-sensor **306**, second sub-sensor **308**, and port **310** to determine the installation configuration of sensor **101**, i.e., whether sensor **101** is installed into a door or a window, and/or a type of door or window that sensor **101** is installed.

[0026] The sensor **101** is capable of being installed onto or into several different types of doors and windows, due to the number and positioning of the sub-sensors, as will be

explained in further detail below. Each of the sub-sensors is used to detect a state or status, or a change in the state or status, of a door or window, wherein a state or status of a door or window may comprise “open”, “closed”, “locked”, “unlocked”, “closed and locked”, “open and locked”, “closed and unlocked” and “open and unlocked”.

[0027] The processor, memory transmitter, port and sub-sensors are typically mounted on circuit board **316**. Battery **312** typically comprises a “coin cell” battery due to the size constraints typical of sensor **101** and may be held in place to circuit board **316** via retaining clips or other mechanical means. Battery **312** is used to provide a DC voltage to the components. It should be understood that in other embodiments, a fewer or a greater number of sub-sensors and/or ports may be used. It should also be understood that while the present description describes sensor **101** as a door/window sensor for use in home security applications, sensor **101** could be used in other applications other than home security, such as in industrial applications.

[0028] Processor **300** provides general operation of sensor **101**, for detecting state or status changes in a door or window, for transmitting an alarm signal to a nearby gateway **104**, for determining an installation configuration of sensor **101**, and for taking one or more actions based on the determination. Processor **300** performs these functions by executing processor-executable code stored in memory **302**, for example, executable code. Processor **300** typically comprises a general purpose processor, such as an ADuC7024 analog microcontroller manufactured by Analog Devices, Inc. of Norwood Massachusetts, although any one of a variety of microprocessors, microcomputers, and/or microcontrollers may be used alternatively, selected to meet the requirements of a small, battery-powered sensor such as low power usage and small size.

[0029] Memory **302** comprises one or more information storage devices, such as RAM, flash memory, SD memory, XD memory, or other type of electronic, optical, or mechanical memory device. Memory **302** is used to store the processor-executable instructions that cause sensor **101** to perform its functions as listed above. Memory **302** may additionally store certain operational information, such as a serial number, node number or house code (assigned by the gateway **104**, in one embodiment), one or more predetermined time thresholds, and/or current or previous door or window status information.

[0030] Sub-sensor **306**, in this embodiment, comprises a reed switch mounted to circuit board **316**, positioned at a top edge of circuit board **316** for use in configurations of sensor **101** that utilizes a magnet for detecting a status of a door or window, for example,

whether a door or window is open or closed. In other embodiments, a magnetoresistive sensor could be used in place of the reed switch, which also detects the presence of magnetic fields.

[0031] Sub-sensor **308** in this embodiment comprises a mechanical switch activated by, for example, a mechanical plunger, lever, pushbutton or other mechanical device, wherein the switch is opened and closed as a door or window, or components thereof, are opened, closed, locked, and/or unlocked.

[0032] External sub-sensor **318** in this embodiment comprises a second mechanical switch and can be the same switch type as sub-sensor **306** or a different mechanical type. External sub-sensor **318** can be used to detect changes in a door or window status by detecting changes in a door or window position, a lever position, a deadbolt position, a door or window handle position, cam, shaft, or some other mechanical component of a door or window. External sub-sensor **318** is typically used to provide signals to processor **300** where positioning of sensor **101** is prohibitive, such as in a very confined area, such as within a doorknob or deadbolt assembly.

[0033] It should be understood that in other embodiments, sensor **101** may comprise different types and/or a different number of sub-sensors, including additional external sub-sensors or even no external sub-sensor at all. It should also be understood that some or all of the sub-sensors may comprise sensing devices other than reed switches, magnetoresistive sensors, or mechanical switches, such as photo-sensitive components such as photo-diodes and transistors, IR sensors, shock sensors, glass breakage detectors, accelerometers, vibration sensors, conductivity sensors,, etc.

[0034] The sub-sensors are each coupled to processor **300** to provide signals that enable processor **300** to determine a state or status of each sub-sensor and, hence, a particular door or window status or state. Processor **300** uses the state or status information to determine an installation configuration of sensor **101**, as will be explained below.

[0035] FIG. 4 is an illustration of the self-configuring sensor **101** shown of FIGs. 1 and 3 in a casement window installation configuration, used to monitor both an open/close status of window **105** as well as a locked/unlocked status of window **105**. Sensor **101** is shown about to be inserted into slot **402** formed in stationary, side jamb **404**. Slot **402** is sized and shaped to accommodate the size and shape of sensor **101** and may comprise retaining means (not shown) for retaining sensor **101** within slot **402** after installation of sensor **101** into slot **402**. In this embodiment, sub-sensor **306** and **308** are used, while external sensor **318** and port **310** are not used.

[0036] Installation of sensor **101** comprises removing cover **406** from housing **314** and inserting battery **312** into its designated retaining means on circuitry board **316**. Then, cover **406** is secured back onto housing **314**, and sensor **101** is pushed into slot **402**, where it is retained by the aforementioned retaining means. A magnet (not shown) is secured to the movable portion **404** of window **105** such that it is proximate to sensor **101** when the movable portion **404** of window **105** is in a closed state.

[0037] Sub-sensor **306** in this embodiment comprises a reed switch mounted to circuit board **316**, positioned at an edge of circuit board **316** for use in configurations of sensor **101** that utilize a magnet for detecting a status of a door or window, for example, whether a door or window is open or closed. Sub-sensor **306** is positioned inside of sensor **101** near area **208**, as shown. When sub-sensor **306** inside sensor **101** comes in close proximity to the magnet when window **105** is closed, sub-sensor **306** changes state due to the presence of an magnetic field produced by the magnet, for example, from open to closed. Processor **300** detects when a change in state of sensor **306** occurs. When window **105** is opened, the magnet becomes separated from sensor **306**, thus causing a contact within sub-sensor **306** to change state once again, and processor **300** detects the change.

[0038] To lock and unlock window **105**, handle **410** is used by an operator to rotate pin **412**, which rotates a latch (not shown) that engages a keeper (also not shown) on the vertical frame of movable portion **204** of window **105**. The positioning of sub-sensor **108** on sensor **101**, the positioning of sensor **101** within slot **402**, and the position of the latch causes the latch to physically act upon sub-sensor **308** as handle **410** is being operated, causing, for example, a plunger of sub-sensor **308** to be pushed by the latch, causing a contact within sub-sensor **308** to change state. Thus, when the plunger of sub-sensor **308** is pushed in by the latch, processor **300** determines that window **105** is locked, and when the plunger is not pushed in by the latch, processor **300** determines that window **105** is unlocked.

[0039] FIG. **5** is an illustration of one embodiment of the sensor of FIG. **1** used in a single or double hung window installation configuration. Shown is single hung window **500** comprising jamb **504** and movable panel **512**. A stationary panel (single hung embodiment) or a second movable panel (double hung embodiment) is not shown for purposes of clarity.

[0040] Formed into a lower horizontal edge **514** of movable panel **512** is slot **502**, where sensor **101** is inserted into during use. It should be understood that slot **502** could be

located in different areas of movable panel **512**, or even located on a fixed portion of window **500**, such as jamb **504**.

[0041] In Fig. **5**, sensor **101** is shown having a plunger of sub-sensor **308** protruding therefrom, just prior to insertion into slot **502**. In this embodiment, sub-sensor **306** within sensor **101** and external sub-sensor **318** located on, within or near lock/unlock mechanism **506** as shown, are used to detect the open/close status and lock/unlock status, respectively, of window **500**. In this embodiment, sensor **101** comprises the same sub-sensors as shown in FIGs. **1** and **2**, with sub-sensor **306** comprising a reed switch, sub-sensor **108** comprising a plunger-type, mechanical switch, and external sub-sensor **318** comprising a mechanical switch.

[0042] With regard to sub-sensor **306**, once sensor **101** is installed into slot **502**, sub-sensor **306** detects a magnetic field produced by magnet **510** when movable panel **512** is placed into the closed position. Magnet **510** may be embedded into lower jamb **516** (as shown) or attached to a surface of lower jamb **516** in other embodiments.

[0043] As sensor **101** is placed into slot **502** during initial installation, a physical connection is made between port **310** and a connector located inside slot **502**, best shown in FIGs. **6a** and **6b**. FIG. **6a** illustrates a close-up, top, plan cutaway view of slot **502** and sensor **101** as sensor **101** is just about to be installed into slot **502**. In this embodiment, sensor **101** comprises a convex cutout in housing **314** for rotatable engagement with knob **602** formed inside slot **502** as shown. Once convex cutout **600** is engaged with knob **602**, sensor **101** may be rotated about an axis of knob **602** and pressing sensor **101** fully into slot **502**, as shown in FIG. **6b**. Slot **502** comprises connector **606** located on a rear wall of slot **502**, such that it connects to port **310** when sensor **101** is seating into slot **502**. As shown in FIG. **6b**, connector **606** is connected to port **310**, thus enabling signals from an external sub-sensor (not shown) to be provided to sensor **101** via wire **604**. The sub-sensor in this example may comprise a mechanical switch located near/within lock/unlock assembly **506** to provide signals to sensor **101** when the lock/unlock assembly is moved from a locked position to an unlocked position and vice-versa.

[0044] It should also be pointed out that a plunger of sub-sensor **308** is pushed into sub-sensor **308** as sensor **101** is seated into slot **502** by rear wall **608**. This forces sub-sensor **108** into a single state, either open or closed depending on sub-sensor **308**. The fact that sub-sensor remains in a single state (e.g., open or closed) during operation may be used to define an installation configuration of sensor **101**, as will be explained later. In an alternative embodiment, rear wall **608** comprises an cavity located to receive the plunger

of sub-sensor **308** such that it is not pushed into sub-sensor **308**, thereby maintaining a contact within sub-sensor **308** in a state opposite to a pushed-in state.

[0045] The concepts taught by FIGs. **5**, **6a**, and **6b** can be applied to other installation configurations. For example, for a sliding patio door, the same slot **402**, **502** can be formed into a side jamb of the door, with a magnet installed into the sliding portion, proximate to sub-sensor **306** when the door is closed and also using port **310** and external sub-sensor **318** in the form of a mechanical or magnetic switch to detect the lock/unlock status of the door. Similar to the discussion above with respect to FIGs. **6a** and **6b**, the rear wall of the slot in other embodiments may or may not have an indentation to force a mechanical switch into one state or another, thereby providing additional information to processor **300** in order to determine its installation configuration.

[0046] FIG. **7** is a flow diagram illustrating one embodiment of a method for determining an installation configuration of a sensor, performed by sensor **101**. It should be understood that in some embodiments, not all of the steps shown in FIG. **7** are performed, that the order in which the steps are carried out may be different in other embodiments, and that certain, minor steps have been omitted for brevity.

[0047] At block **700**, sensor **101** is powered on by a user, such as a homeowner or professional installer, by removing a cover **406** from housing **314** and installing a battery **312** inside sensor **101**. Alternative methods of powering sensor **101** on include removing a non-conductive barrier between an already-installed battery inside sensor **101** and a battery contact.

[0048] At block **702**, sensor **101** is installed into a door or a window, by pushing sensor **101** into a pre-formed slot in a door or window sill, jamb or other door or window portion. The slot is sized and shaped to receive sensor **101**.

[0049] At block **704**, in one embodiment, in response to being powered on, processor **300** executes processor-executable instructions stored in memory and causes sensor **101** to enter into a learn mode of operation. The learn mode of operation allows sensor **101** to determine an installation configuration of sensor **101** and typically disables normal operations of sensor **101** to transmit state change signals to gateway **104**.

[0050] In another embodiment, sensor **101** is capable of self-determining its installation configuration without having to enter into a learn mode of operation. In this embodiment, the installation configuration may be determined while sensor **101** is operating normally, i.e., monitoring a door or window for status changes, and transmitting an alarm signal to gateway **104** if a change in state of one or more sub-sensors is detected. For example,

sensor **101** could be configured to determine the time between when one or more sub-sensors changes state, and/or the number of times that a sub-sensor changes state within a predetermined time period, such as three seconds. For example, after being installed into a door or a window, a homeowner or an installer may lock and unlock a locking mechanism on the door or window, causing an associated sub-sensor to change states multiple times within a relatively short time interval. When a sub-sensor changes state very quickly (e.g., from locked to unlock to locked) very quickly, such as within one second, it is an indication to processor **300** that the lock is being exercised for purposes of determining the sensor's installation configuration and, therefore, no alarm signal is transmitted, and processor **300** stores an indication in memory **202** that the sub-sensor that changed state during this time is an active sub-sensor, able to change state in its current installation configuration. Alternatively, when processor **300** detects that a sub-sensor has changed state a predetermined number of times with a short time interval, such as three seconds, it may also be an indication to processor **300** that the lock is being exercised for purposes of determining the sensor's installation configuration and, again, no alarm signal is transmitted. At this point, processor **300** does not have enough information to know what its installation configuration might be, because a determination requires information from a second sub-sensor. When processor **300** determines that a second sub-sensor has changed state as explained above with respect to the first sub-sensor, processor **300** may determine its installation configuration, as described below.

[0051] At block **706**, processor **300** monitors sub-sensors **306** and **308**, as well as port **310**, to determine whether any sub-sensor changes state. One or more contacts of the sub-sensors will change state when a door or window status changes, e.g., a door or window is opened or closed, or a door or window becoming locked or unlocked. Processor **300** typically remains in the learn mode of operation for a predetermined time period, such as one minute, as stored by memory **302**. The user may be instructed to open and close the door or window and also lock and unlock the door or window in order to "exercise" any sub-sensor that may be monitoring the open/close status or the lock/unlock status of the door or window. The user may be instructed to operate the door or window in this manner immediately after powering on sensor **101** and installing it into the door or window, and continue to do so for a predetermined time period, such as thirty seconds or one minute. This allows processor **300** enough time to evaluate signals caused by the sub-sensors changing state as a result of detecting operation of the door or window by the user.

[0052] At block 708, processor 300 determines an installation configuration of sensor 101, e.g., a type of door or window that sensor 101 has been installed into. Processor 300 determines the installation configuration by evaluating any changes (or lack thereof) observed in the sub-sensors, including external sub-sensor 318, if present.

[0053] For example, when processor 300 determines that sub-sensor 306 has changed state during learn mode (“toggled”) at least once and that sub-sensor 306 has also changed state at least once during the learn mode, processor 300 compares this result with results stored in memory 302. Memory 302 stores mapping information, in one embodiment in the form of a look-up table, that allows processor 300 to determine the installation configuration based on the sub-sensor input during the learn mode, as shown:

Installation Config	Sub-sensor 306	Sub-sensor 308	Ext. Sub-Sensor 318	Open/Close Sensor
Casement Window	Toggled	Toggled	Open	Sub-sensor 306
Single/Double Hung Window	Toggled	Open	Toggled	Sub-sensor 306
Sliding Patio Door	Toggled	Closed	Toggled	Sub-sensor 308
Hinged Door	Open	Toggled	Toggled	Sub-sensor 308

[0054] Thus, when processor 300 has determined that sub-sensor 306 and sub-sensor 108 were toggled during the learn mode, it determines that sensor 101 has been installed into a window, and more particularly a casement window, per the information stored in memory 302. In this example, the state of external sub-sensor 318 is immaterial. When processor 300 determines that sub-sensor 306 and external sub-sensor 318 were toggled, while sub-sensor 308 remained in an open state, processor 300 determines that sensor 101 has been installed into a single or double hung window. Sub-sensor 308, e.g., a mechanical plunger switch, could remain open (plunger extended) if the slot into which sensor 101 is placed comprises a cavity in its rear wall that accommodates the plunger, so that it does not change state when sensor 101 is installed into the slot. Conversely, sub-sensor 308 could remain in a closed state (i.e., plunger retracted) if the slot into which sensor 101 is placed comprises a protrusion on its rear wall at a location that engages sub-sensor 308 when sensor 101 is installed into the slot.

[0055] At block 710, after the installation configuration has been determined by processor 300, processor 300 modifies a sensor identification code stored in memory 302

in accordance with the determined installation configuration. For example, sensor **101** could be assigned an 18-bit serial number during manufacturing, with 16 of the bits reserved as a unique serial number to identify the particular sensor, while 2 bits could be reserved to identify the sensor configuration installation. For example, during the manufacturing stage, the first 16 bits of an 18 bit identification code could comprise be assigned a unique 16 bit serial number, followed by a default installation configuration code of two zeros, which may correspond to the most common installation configuration that sensor **101** is installed. In this way, processor **300** does not need to alter the identification code if processor **300** determines that sensor **101** has been installed into this most-common installation configuration. In this example, the last two bits that have been assigned 00 may uniquely define four installation configurations. Increasing this number to three bits obviously allows eight installation configurations to be defined. A greater number of installation configurations could be designated by increasing the number of installation configuration bits.

[0056] At block **712**, in response to changing the identification code, processor **300** may transmit a message to a gateway **104** to inform gateway **104** of sensor **101**'s current installation configuration.

[0057] At block **714**, processor **300** may cease monitoring one or more sub-sensors as a result of knowing which sub-sensors are "active" in the present installation configuration. For example, if the installation configuration was determined to be a sliding patio door, where sub-sensors 306 and 318 are active, while sub-sensor 308 was determined to be "static". In this case, processor 300 may stop monitoring sub-sensor 308, and/or disable sub-sensor 308 (such as de-energizing circuitry necessary for the operation of sub-sensor 308) knowing that in the current installation configuration, sub-sensor 308 does not change state. This feature may increase battery life by reducing overall power consumption by sensor 101.

[0058] At block **716**, processor **300** may cause sensor **101** to exit the learn mode of operation.

[0059] At block **718**, processor **300** may detect a status change of one or more sub-sensors, indicating a status change of a respective door or window being monitored by a respective one of the sub-sensors.

[0060] At block **720**, processor **300** determines whether or not to transmit an alarm signal to gateway **104**, based on the installation configuration. For example, sensor **101** may be configured to transmit an alarm signal only when a door or window opens, and not

transmit an alarm signal if a door or window merely becomes unlocked. The installation configuration further comprises an identification of which sub-sensor is associated with monitoring the open/close status of a door or window for each door or window type. For example, in a casement window, sub-sensor **308** is used to determine the open/close status of a casement door, while for a sliding patio door, the open/close status of the door is determined by sub-sensor **308**. Knowing the type of door or window that sensor **101** has been installed allows processor **300** to determine whether to transmit an alarm signal.

[0061] At block **722**, when processor **300** determines that a sub-sensor relating to an open/closed status of a door or window changes state, processor **300** causes transmitter **304** to transmit an alarm signal to gateway **104**. The alarm signal typically comprises at least the identification code.

[0062] FIG. **8** is a flow diagram illustrating one embodiment for managing installation configuration information provided by one or more sensors in a security system, performed by server **108** executing processor-executable codes stored in memory. It should be understood, however, that the sensors could be used in other applications, such as industrial or home automation applications. It should be understood that in some embodiments, not all of the steps shown in FIG. **8** are performed, that the order in which the steps are carried out may be different in other embodiments, and that certain, minor steps have been omitted for brevity.

[0063] At block **800**, server **108** receives a registration request from a remote device such as a mobile phone, desktop or tablet computer to register with server **108** in order to access security and/or home automation services from server **108**. Registration may occur via a website provided by server **108** or an app that has been downloaded to the remote device. The registration request is provided to processor **200** via network interface **204**.

[0064] At block **802**, in response to receiving the registration request, processor **200** creates an account for a user of the remote device and stores the account in memory **202**.

[0065] At block **804**, gateway **104** receives installation configuration information from a sensor **101** located within wireless communication range of server **108**. The installation configuration information is transmitted by sensor **101** as described in FIG. **7** and its accompanying description above.

[0066] At block **806**, gateway **104** provides the installation configuration information to server **108** via wide-area network **106** and network interface **204**.

- [0067] At block **808**, in response to receiving the installation configuration information, server **108** creates a sensor information record within memory **202**, associated with sensor **101**. Processor **300** stores the installation configuration information in the sensor information record associated with sensor **101**.
- [0068] At block **810**, also in response to receiving the installation configuration information, server **108** retrieves installation configuration description information from memory in conformance with the installation configuration information received at block **800**. The installation configuration description information comprises one or more of a text and/or graphical description of a door or window where sensor **101** has been installed or a text and/or graphical description of a door or window type where sensor **101** has been installed. For example, if the installation configuration information indicates that sensor **101** has been installed into a sliding patio door, the server **108** retrieves installation configuration description information associated with a sliding patio door from the memory and stores it in association with the sensor information record. The installation configuration description information in this case might comprise the words “Patio Door” and an icon of a typical sliding patio door.
- [0069] In another embodiment, server **108** does not store the installation configuration description information in association with the installation configuration information. Rather, server **108** provides the installation configuration description information to the remote device upon registration or at some time after registration.
- [0070] At block **812**, server **108** provides the installation configuration description information to the remote device via wide area network **106**, where it may be provided to a user of the remote device in a variety of ways. For example, a representation of residence **102** could be displayed to the user on the remote device, showing at least some of the sensors installed at residence **102**. Any sensor that has provided installation configuration information to server **108** could be displayed as, for example, an icon representative of the type of door or window where each particular sensor is installed, in accordance with the installation configuration description information provided by server **108**.
- [0071] In another embodiment where users access their accounts via a website rather than an application running on the remote device, the installation configuration information may be displayed to users when they log into their accounts online.
- [0072] The methods or algorithms described in connection with the embodiments disclosed herein may be embodied directly in hardware or embodied in processor-

readable instructions executed by a processor. The processor-readable instructions may reside in RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, hard disk, a removable disk, a CD-ROM, or any other form of storage medium known in the art. An exemplary storage medium is coupled to the processor such that the processor can read information from, and write information to, the storage medium. In the alternative, the storage medium may be integral to the processor. The processor and the storage medium may reside in an ASIC. The ASIC may reside in a user terminal. In the alternative, the processor and the storage medium may reside as discrete components.

[0073] Accordingly, an embodiment of the invention may comprise a computer-readable media embodying code or processor-readable instructions to implement the teachings, methods, processes, algorithms, steps and/or functions disclosed herein.

[0074] While the foregoing disclosure shows illustrative embodiments of the invention, it should be noted that various changes and modifications could be made herein without departing from the scope of the invention as defined by the appended claims. The functions, steps and/or actions of the method claims in accordance with the embodiments of the invention described herein need not be performed in any particular order. Furthermore, although elements of the invention may be described or claimed in the singular, the plural is contemplated unless limitation to the singular is explicitly stated.

CLAIMS

We claim:

1. A self-configuring sensor, comprising:
 - a first sub-sensor for determining a first status of a door or window;
 - a second sub-sensor for determining a second status of the door or window;
 - a wireless transmitter;
 - a memory for storing processor-executable instructions; and
 - a processor coupled to the first sub-sensor, the second sub-sensor, the wireless transmitter and the memory for executing the processor-executable instructions that cause the sensor to:
 - monitor the first and second sub-sensors for detecting changes in a first sub-sensor state and a second sub-sensor state, respectively; and
 - determine an installation configuration based on the changes in the first sub-sensor state and the second sub-sensor state, the installation configuration comprising a type of hardware where the self-configuring sensor has been installed.
2. The self-configuring sensor of claim 1, wherein the first sensor comprises a reed switch and the second sensor comprises a mechanical switch.
3. The self-configuring sensor of claim 1, wherein the processor-executable instructions that cause the sensor to determine an installation configuration comprise instructions that causes the sensor to:
 - determine whether the first sub-sensor or the second sub-sensor is responsible for providing an open/closed status of the door or window; and
 - transmit an alarm signal only if the sub-sensor responsible for providing an open/closed status of the door or window has changed state.
4. The self-configuring sensor of claim 1, wherein the processor-executable instructions that cause the sensor to determine an installation configuration comprise instructions that causes the sensor to:

determine that the sensor is in a first installation configuration when the processor detects a state change in the first sub-sensor and that no state change was detected in the second sub-sensor.

5. The self-configuring sensor of claim 1, wherein the processor-executable instructions that cause the sensor to determine an installation configuration comprise instructions that causes the sensor to:

determine that the sensor is in a multi-sensor configuration when the processor detects a state change in the first sub-sensor and a state change in the second sub-sensor.

6. The self-configuring sensor of claim 1, wherein the processor-executable instructions further comprise instructions that causes the sensor to:

determine that the sensor has been powered on; and

in response to determining that the sensor has been powered on, determine the installation configuration.

7. The self-configuring sensor of claim 1, wherein the processor-executable instructions further comprise instructions that causes the sensor to:

transmit a signal to a central control panel indicative of the installation configuration after the sensor has determined the installation configuration.

8. The self-configuring sensor of claim 1, wherein the memory further stores a sensor identification code, and the processor-executable instructions further comprise instructions that causes the sensor to:

modify the sensor identification code when the sensor determines the installation configuration.

9. The self-configuring sensor of claim 8, wherein the processor-executable instructions further comprise instructions that causes the sensor to:

transmit the modified sensor identification code after the sensor has determined the installation configuration.

10. A method, performed by a self-configuring sensor, to determine an installation configuration, comprising:

monitoring, by a processor, a first sub-sensor and a second sub-sensor for changes in a first sub-sensor state and a second sub-sensor state, respectively; and
determining, by the processor, the installation configuration based on the changes in the first sub-sensor state and the second sub-sensor state, the installation configuration comprising a type of hardware where the self-configuring sensor has been installed.

11. The method of claim 10, wherein the first sensor comprises a reed switch and the second sensor comprises a mechanical switch.

12. The method of claim 10, further comprising:
determining whether the first sub-sensor or the second sub-sensor is responsible for providing an open/closed status of the door or window; and
transmitting an alarm signal only if the sub-sensor responsible for providing an open/closed status of the door or window has changed state.

13. The method of claim 10, wherein determining that the sensor is in a single sensor configuration comprises:
determining that the sensor is in a first installation configuration when the processor detects a state change in the first sub-sensor and that no state change was detected in the second sub-sensor

14. The method of claim 10, wherein determining that the sensor is in a single sensor configuration comprises:
determining that the sensor is in a multi-sensor configuration when the processor detects a state change in the first sub-sensor and a state change in the second sub-sensor.

15. The method of claim 10, further comprising:
determining that the sensor has been powered on; and
in response to determining that the sensor has been powered on, determining the installation configuration.

16. The method of claim 10, further comprising:

transmitting a signal to a central control panel indicative of the installation configuration after the sensor has determine the installation configuration.

17. The method of claim 10, further comprising:
storing a sensor identification code in a memory coupled to the processor; and
modifying the sensor identification code when the sensor determines the installation configuration.

18. The method of claim 17, further comprising:
transmitting the modified sensor identification code after the sensor has determined the installation configuration.

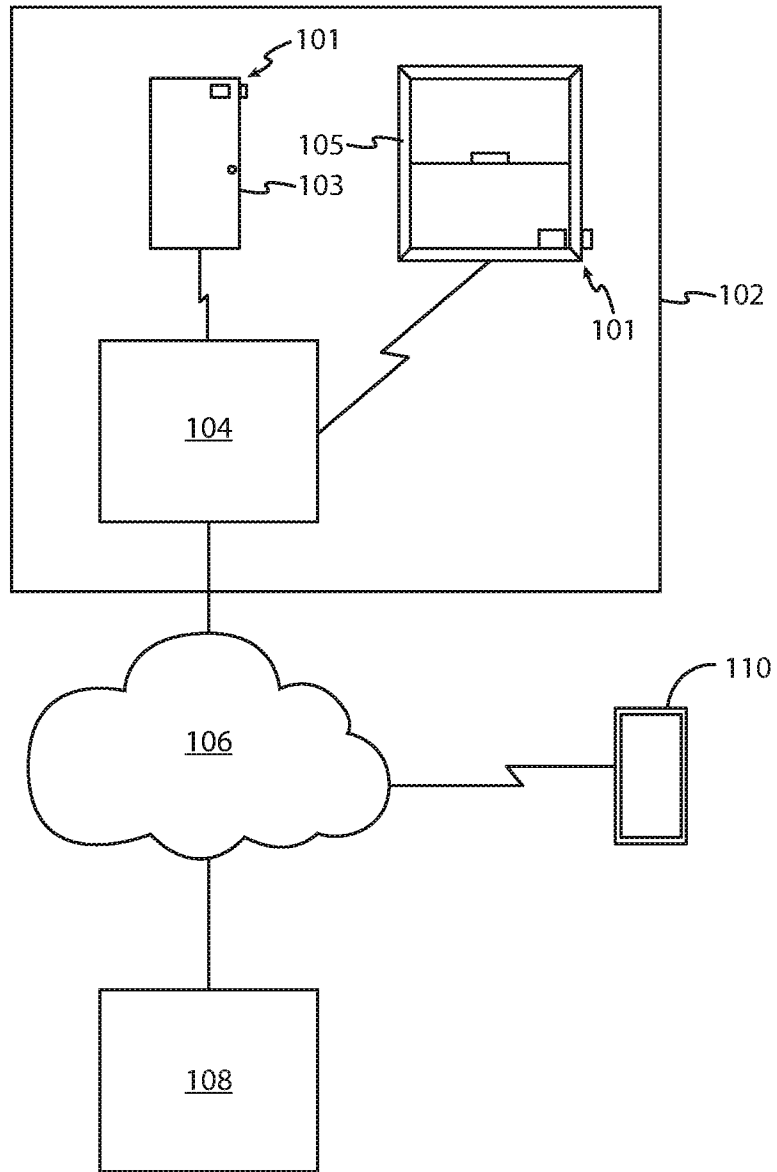


FIG. 1

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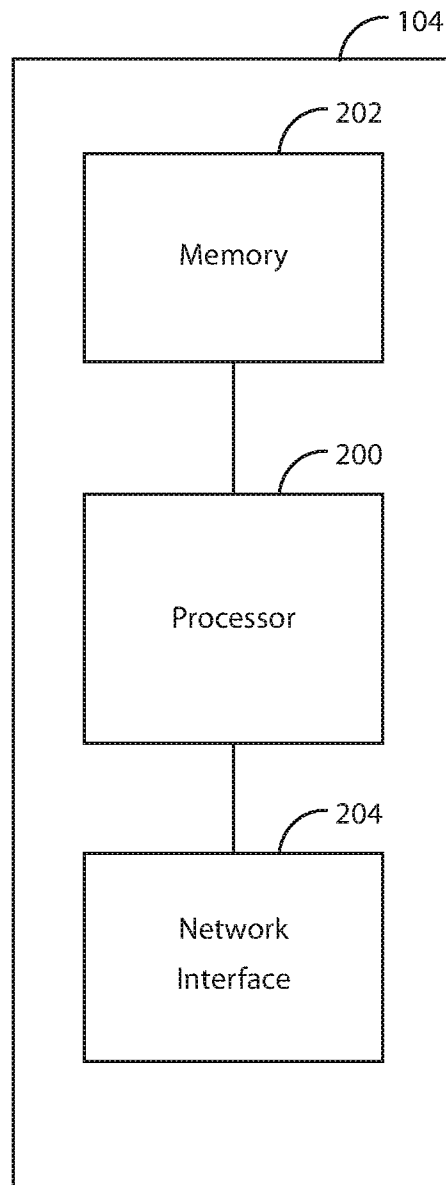


FIG. 2

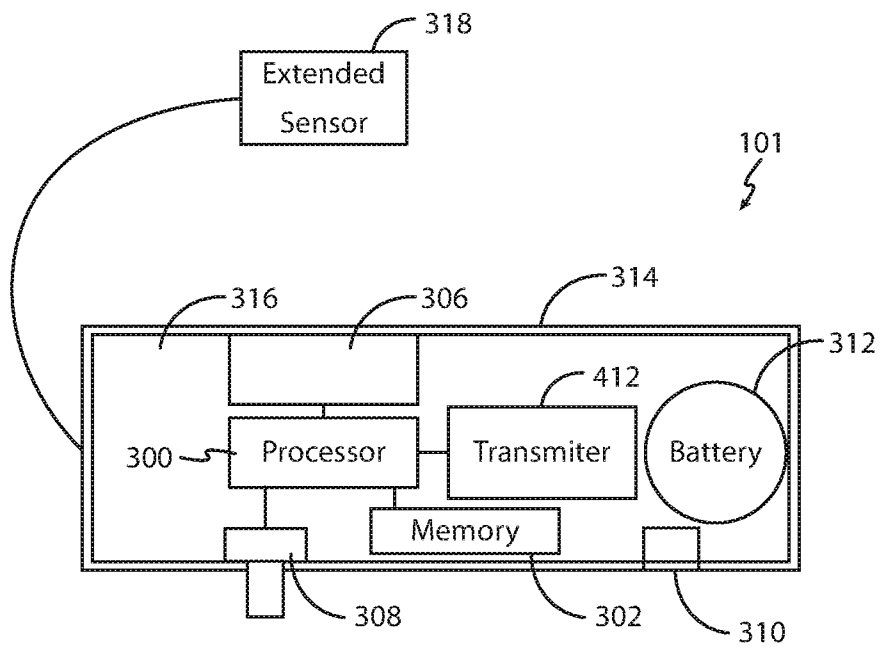


FIG. 3

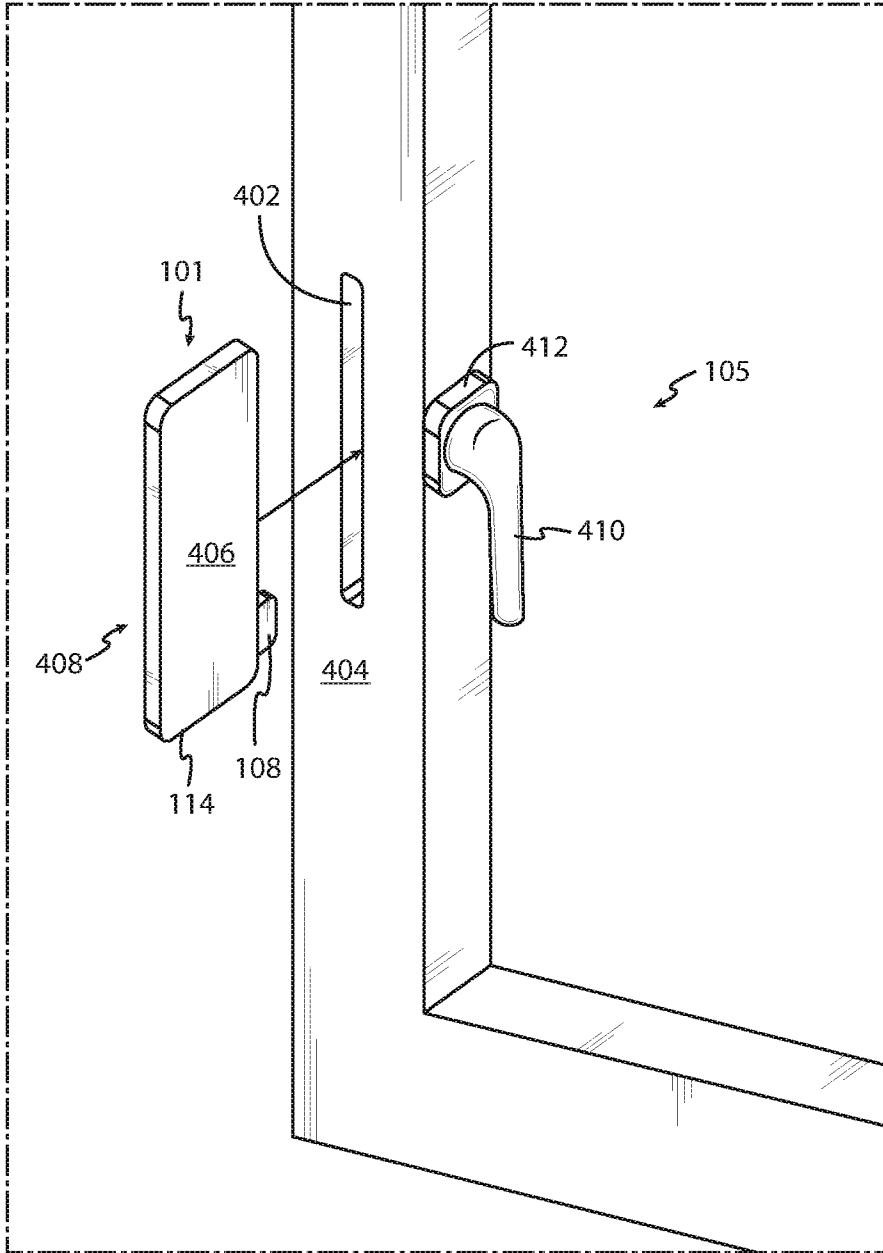


FIG. 4

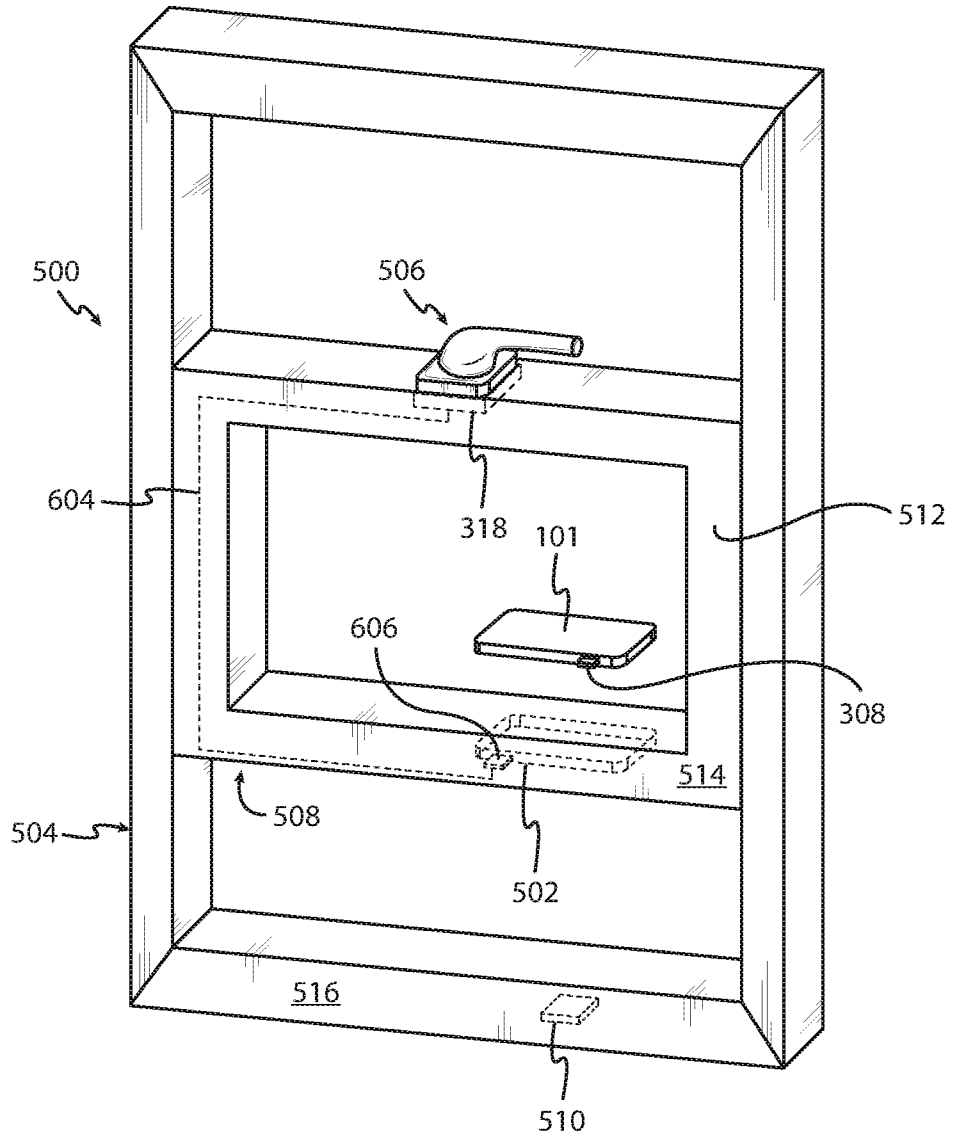


FIG. 5

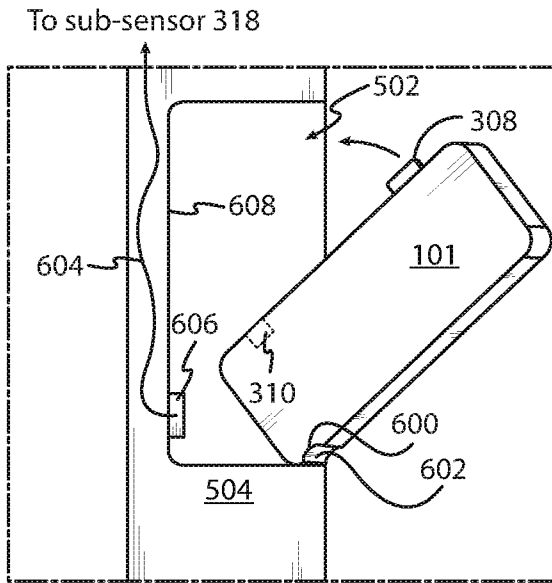


FIG. 6a

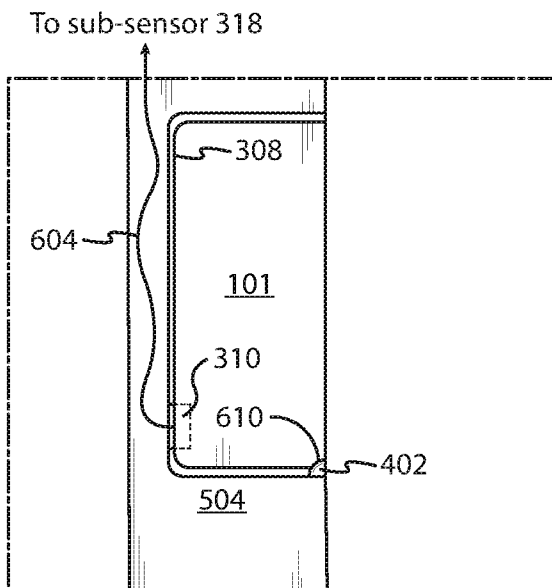


FIG. 6b

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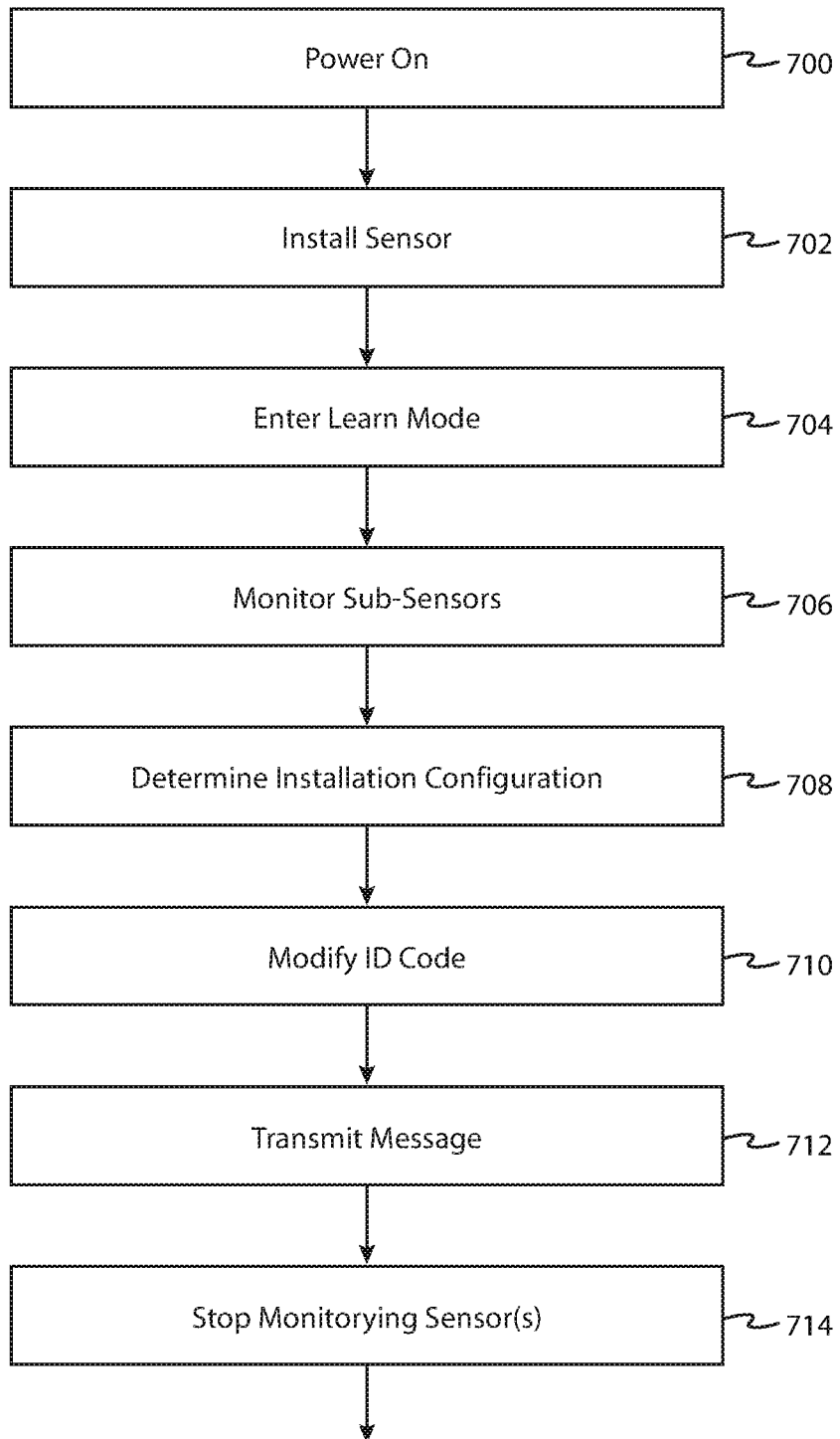


FIG. 7a

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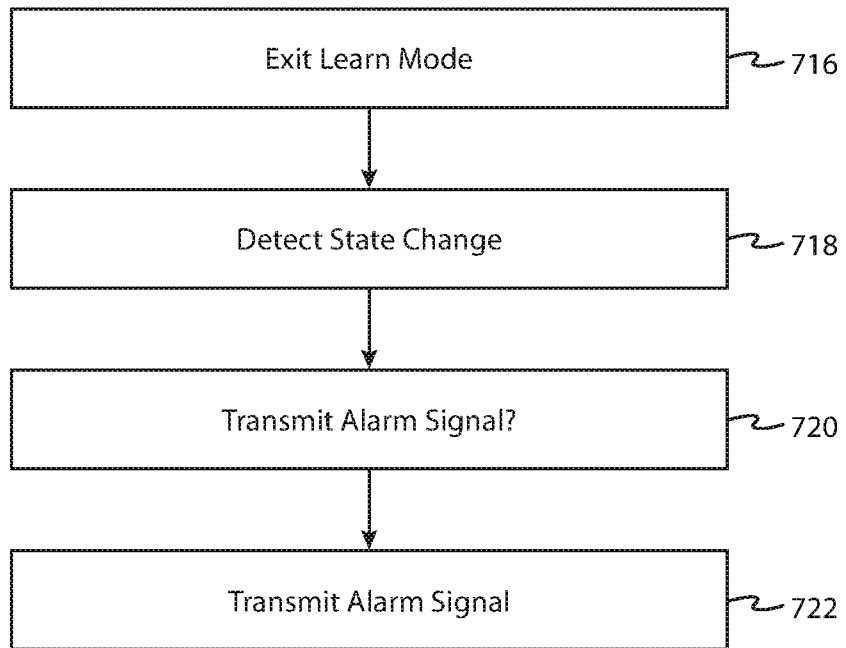


FIG. 7b

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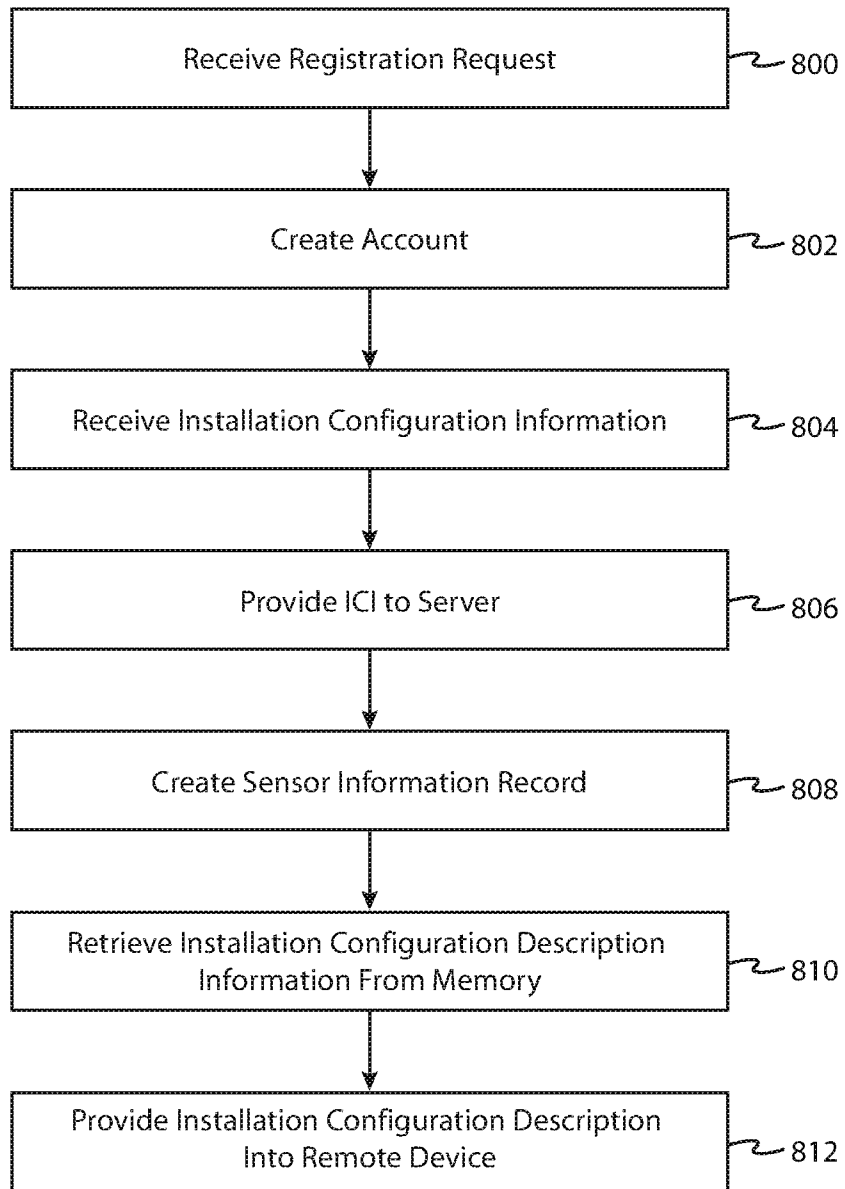


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2017/017206

A. CLASSIFICATION OF SUBJECT MATTER
 IPC(8) - E05B 45/00; G05B 19/00 (2017.01)
 CPC - E05B 45/086; E05B 47/02 (2017.02)

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)
 See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
 USPC - 340/5.610; 340/528.000; 340/545.000 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/0084299 A1 (FISHER et al) 10 April 2008 (10.04.2008) entire document	1-7, 10-16
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Y		8, 9, 17, 18
Y	US 2007/0139183 A1 (KATES) 21 June 2007 (21.06.2007) entire document	8, 9, 17, 18
A	US 2009/0300988 A1 (BEM) 10 December 2009 (10.12.2009) entire document	1-18
A	US 7,086,257 B2 (BÜCKER et al) 08 August 2006 (08.08.2006) entire document	1-18
A	US 2010/0152947 A1 (DENHOLM et al) 17 June 2010 (17.06.2010) entire document	1-18
A	US 6,963,280 B2 (ESKILDSEN) 08 November 2005 (08.11.2005) entire document	1-18
A	US 2007/0139183 A1 (KATES) 21 June 2007 (21.06.2007) entire document	1-18
A	US 20050044908 A1 (MIN) 03 March 2005 (03.03.2005) entire document	1-18
A	US 6,196,037 B1 (URSCHEL et al) 06 March 2001 (06.03.2001) entire document	1-18

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search

24 March 2017

Date of mailing of the international search report

17 APR 2017

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